FOURTH
WHO report on
neglected tropical diseases

INTEGRATING
NEGLECTED TROPICAL DISEASES
INTO GLOBAL HEALTH AND DEVELOPMENT

World Health Organization

FOURTH
WHO report on
neglected tropical diseases

INTEGRATING
NEGLECTED TROPICAL DISEASES
INTO GLOBAL HEALTH AND DEVELOPMENT

World Health Organization

Integrating neglected tropical diseases into global health and development: fourth WHO report on neglected tropical diseases was produced by WHO's Department of Control of Neglected Tropical Diseases.

Regional Directors and members of their staff provided support and advice.

Appreciation is extended to the health ministries, donors, partners, foundations, pharmaceutical companies donating medicines, nongovernmental organizations, academia and colleagues for their generosity and contributions.

Given the space constraints and the large number of contributors, their names have been omitted but their involvement and commitment are gratefully acknowledged.

Integrating neglected tropical diseases into global health and development: fourth WHO report on neglected tropical diseases.

ISBN 978-92-4-156544-8

Design and layout: Patrick Tissot, WHO Neglected Tropical Diseases. Map production: Alexei Mikhailov, WHO Neglected Tropical Diseases.

Please consult the WHO Neglected Tropical Diseases website for the most up-to-date version of all documents (www.who.int/neglected_diseases/en)

Printed in France.

WHO/HTM/NTD/2017.01

66
INTEGRATING NTDS
INTO GLOBAL HEALTH AND DEVELOPMENT

AT A GLANCE

Contents

Foreword

Dr Margaret Chan
Director-General
World Health Organization

With more than one billion people affected, efforts to control the neglected tropical diseases carry great appeal as a pro-poor initiative on a massive scale. I warmly welcome this report of record-breaking progress towards bringing these ancient diseases to their knees and meeting the targets set for 2020.

Some of these diseases are being tackled through the mass administration of donated medicines that prevent the proliferation of parasites and reduce the pool of infection, making elimination a feasible target. During 2015, nearly one billion people – the highest number ever – received protection through preventive chemotherapy for at least one of these diseases. Donations of praziquantel, albendazole, mebendazole and ivermectin or diethylcarbamazine are being distributed as a rapid-impact package to control schistosomiasis, soil-transmitted helminthiases, and lymphatic filariasis. Of these diseases, lymphatic filariasis is racing fastest towards the finish line. With 560 million people covered during 2015, an end is now in sight. WHO estimates that more than 300 million people will no longer require treatment in areas where transmission has been dramatically reduced.

Ivermectin, a drug that earned its co-discoverers the 2015 Nobel Prize in Physiology or Medicine, has already freed 18 million West Africans from the risk of onchocerciasis (river blindness) and is now being used to shrink the map of onchocerciasis ever further. Donations of ivermectin presently amount to about 270 million treatments each year. Trachoma, the world's leading infectious cause of blindness, is also being pushed back through the WHO-recommended four-pronged SAFE strategy: surgery for those with trichiasis, antibiotic treatment to clear conjunctival infection, and facial cleanliness and environmental improvement to reduce transmission. To date, Mexico, Morocco and Oman have been validated by WHO as having eliminated trachoma as a public health problem. As this report shows, more than 56 million people received the antibacterial agent azithromycin in 2015, again thanks to donated medicines.

The incidence of dracunculiasis (guinea-worm disease), slated for eradication, has been reduced from an estimated 3.5 million cases in 1986 to just 25 human cases in 2016 in just three countries: Chad, Ethiopia, and South Sudan. The eradication of dracunculiasis will mark the first time an infectious disease was vanquished by community engagement and behavioural change without support from a vaccine or treatment.

For other diseases, some challenges remain. Unlike diseases amenable to preventive chemotherapy, sleeping sickness, Buruli ulcer, Chagas disease, and leishmaniasis have been identified by WHO as requiring innovative and intensified disease management. All of these diseases have poorly understood burdens, lack optimal control tools, receive insufficient R&D investment, and affect the poorest of the poor. However, this situation has begun to change with the advent of new technical tools, supported by an increasing number of public–private partnerships for product development, which brings the best science to bear on the most neglected diseases.

Attacked on multiple fronts, the burden of sleeping sickness has been reduced from more than 37 000 new cases in 1999 to well under 3000 cases in 2015. Antibiotic therapy has revolutionized the management of Buruli ulcer; WHO and its partners have guaranteed an uninterrupted supply of antibiotics to affected countries to ensure that all patients receive treatment free of charge. The control of Chagas disease continues to benefit from the screening of at-risk patients and the administration of donated medicines. In 2015, the target for the elimination of visceral leishmaniasis was achieved in 82% of sub-districts in India, in 97% of sub-districts in Bangladesh, and in 100% of districts in Nepal. Those countries have adopted single-dose liposomal amphotericin B as the first-line treatment; WHO supplies the medicines donated by the pharmaceutical industry.

Different challenges face the neglected zoonotic diseases, a subset of NTDs where transmission moves back and forth between animals and their close human companions. The greatest burden of these diseases – which range from tapeworm infections to invariably fatal rabies – occurs among the one billion livestock keepers in Africa and Asia who depend on their animals for livelihood and sustenance. Most of these people lack access to the most basic services for their own health and that of their animals.

Many NTDs are transmitted by the insects and other disease vectors that flourish in impoverished settings and filthy environments. The renewed push for vector control, most visibly needed to contain the ongoing outbreaks of Zika virus disease and yellow fever, led WHO to draft a Global vector control response strategy for 2017–2030. Once approved by the Seventieth World Health Assembly in 2017, the reinvigorated strategy will be yet another push towards reaching the targets for elimination and control for several NTDs.

As outlined in this report, an important next step is to ensure that the drive to control – and eventually defeat – these diseases secures an integrated place in the broader 2030 Agenda for Sustainable Development. As a pro-poor initiative on a massive scale, control of the NTDs has much to offer in an agenda that makes poverty alleviation its overarching objective and aims to leave no one behind.

1. Executive summary

This fourth WHO report on neglected tropical diseases (NTDs) reviews the progress made towards achieving the Roadmap targets for 2020, noting the remaining challenges, then looks beyond 2020 to evaluate the changing global health and development landscape, considering the implications of integrating these diseases into the broader 2030 Agenda for Sustainable Development.

Progress towards the 2020 Roadmap targets

Integrating neglected tropical diseases into global health and development shows that significant progress was made in 2015 towards achieving the Roadmap targets. These achievements result from the implementation of the five interventions recommended by WHO to overcome NTDs, namely: preventive chemotherapy; innovative and intensified disease management; vector ecology and management; veterinary public health services; and the provision of safe water, sanitation and hygiene.

Preventive chemotherapy defines the strategy of treating infected individuals to reduce morbidity and preventing transmission by administering medicines in communities at risk. A record of nearly 1 billion[1] people, or 62.9% of those in need, received preventive chemotherapy for at least one disease in 2015 alone. This includes 557.9 million who received treatment for lymphatic filariasis. This rate of treatment coverage (59.3%) is the highest ever achieved by any programme implementing mass drug administration (MDA) for this disease and, as a result, more than 300 million people will no longer require preventive treatment. Furthermore, an increasing number of countries have started to eliminate lymphatic filariasis as a public health problem.

1. "Billion" is defined as a thousand million (10^9).

Also in 2015, more than 185 000 patients had surgery for trichiasis worldwide and more than 56 million people received antibiotic therapy for trachoma. Some 119 million people received ivermectin treatment for onchocerciasis, representing 64.1% coverage of those in need, including in newly defined areas of hypoendemicity.

Dracunculiasis was nearly eradicated in 2015 despite the many challenges that national programmes faced, notably insecurity, conflict situations and the unique phenomenon of *Dracunculus medinensis* infection in dogs, especially in Chad. Yet in 2016, only 25 human cases were reported.

Innovative and intensified disease management uses different interventions – ranging from medicine to surgery – to relieve the symptoms and consequences of those diseases for which effective tools are scarce or where the widespread use of existing tools is limited. Despite the restricted availability of effective responses to these complex diseases, the programmes working within the framework of innovative and intensified disease management have achieved a great deal.

Important reductions occurred in the numbers of new cases of human African trypanosomiasis (by 89%) during 2000–2015, of visceral leishmaniasis in Bangladesh, India and Nepal (by 82%) since 2005 and of Buruli ulcer (by 60%) compared with 2008. Also in 2015, yaws was confirmed as having been eliminated in India by a WHO-led international verification team, and all Latin American countries achieved universal blood screening for Chagas disease among blood donors.

Vector ecology and management strategies, which focus on developing and promoting guidelines, are based on the principles and approaches of integrated vector management, including the judicious use of pesticides. Vector control remains an important component in preventing and controlling the transmission of vector-borne diseases.

After the Sixty-ninth session of the World Health Assembly in 2016, and at the request of Member States, a Global Vector Control Response for 2017–2030 was drafted and requested for consideration by the Seventieth World Health Assembly in May 2017. The draft Response supports the implementation of a comprehensive approach to vector control that will contribute to disease-specific national and global goals and help to attain the health-related SDGs.

The strategies used in **veterinary public health** services and the One Health approach recognize that the health of people is connected to the health of animals and the environment. This is particularly relevant to the neglected zoonotic diseases, a subset of NTDs that are naturally transmitted from vertebrate animals to humans and vice versa, such as rabies.

The greatest burden of these neglected zoonotic diseases affects the 1 billion livestock keepers in Africa and Asia who live in close contact with their animals and depend on them for their livelihoods and nutrition. These same populations have the least access to services for human and animal health and to information. Yet, there are some achievements. As an example, in 2015, only 12 reported human deaths were attributable to dog-mediated rabies in the Region of the Americas.

Providing **safe water, sanitation and hygiene** (known as WASH) is a key component of the NTD strategy and is critical for preventing and providing care for most NTDs. Many of the pathogens that cause NTDs thrive where water and sanitation are inadequate.

Reflecting the cross-sectoral nature of the challenge posed by unsafe water and inadequate sanitation and hygiene, and the fact that the WASH component of the NTD strategy has tended to be neglected relative to its importance, in August 2015 WHO launched a global strategy and action plan to integrate WASH with other public health interventions. The joint NTD–WASH strategy for 2015–2020 aims to intensify the control of, or eliminate, selected NTDs in specific regions by 2020.

Of the five key interventions employed to tackle NTDs, preventive chemotherapy stands out, both in terms of its effectiveness as a strategy against certain NTDs and the resources going into it, the two things being related. However, each of the five interventions is vitally important, and going forward it is essential to ensure that each receives the attention it merits and the resources it requires. Vector ecology and management is particularly important, being woefully under resourced despite its crucial importance, notably in response to outbreaks.

Challenges to 2020 and beyond

As responses to diseases move towards the endgame, evaluation and monitoring to ensure post-control surveillance will become more critical and will demand additional financing, which most national NTD programmes have not yet been able to mobilize at adequate levels. Continued efforts are required to ensure treatments are implemented efficiently and that monitoring and surveillance tools are improved, to seek alternative medicines in the event of a loss of efficacy or the development of resistance, to ensure that reporting systems are effective and to maintain optimal levels of coverage. Sustaining high rates of treatment coverage over many years will also require that health education is adapted to local settings, particularly in remaining pockets of high transmission.

This has implications for all of the interventions described here, and it will drive a trend towards greater integration among NTD programmes. The global integration of vector control efforts is a core aim of the Global Vector Control Response, two of the pillars of which are the strengthening of inter- and intrasectoral action and collaboration, and the expansion and integration of vector-control tools and approaches.

Likewise, overcoming neglected zoonotic diseases requires a multifaceted approach that bridges the human–animal interface, and mandates a broad and inclusive multisectoral programme of work to protect and improve the physical, mental and social well-being of humans. The involvement of multiple sectors is critical, including veterinary, water, sanitation and hygiene.

Integrated inter- and intra-sectoral responses by NTD programmes will need to be aligned with the Sustainable Development Goals and universal health coverage.

Opportunities to 2030: the Sustainable Development Goals

In January 2016, the world entered the era of the Sustainable Development Goals (SDGs), ending a 15-year effort to achieve the Millennium Development Goals. A core contention of this report is that tackling NTDs significantly advances the SDG agenda in all its breadth and diversity.

NTDs have the greatest relevance for achieving the health goal (SDG 3). However, these diseases affect and are affected by many of the other development areas covered under the 2030 Agenda. Goal 1, for example, is to "end poverty in all its forms everywhere". NTD programmes have an important role in reducing not only the financial burden of health care costs but also exposure to the debilitating physical and mental health effects of NTDs, which reduce people's capacity to generate income and contribute to the growth of economies. Similar areas of alignment are discernible for the goal to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (SDG 2); the goal to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (SDG 4); the goal to "ensure availability and sustainable management of water and sanitation for all" (SDG 6); the goal to "make cities and human settlements inclusive, safe, resilient and sustainable" (SDG 11); and the goal to "strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development" (SDG 17). Less obvious connections link NTDs to the other 10 SDGs.

Effective, integrated responses will demand increased intersectoral collaboration. NTD programmes and initiatives have much to contribute, having required collaboration in strong global partnerships for more than a decade, working with governments in countries where NTDs are endemic, international agencies, pharmaceutical companies, international nongovernmental organizations, academia, civil society and United Nations agencies.

A key objective going forward will be finding optimal ways to integrate NTD interventions into broader health systems.

The starting point for integrating activities will be to develop policies based on the principles of universal health coverage (UHC). UHC is at the heart of the SDG health agenda, as evidenced by the Declaration of the 2030 Agenda for Sustainable Development, which states that UHC is essential to promoting physical and mental health and well-being and to extending life expectancy for all. In short, "no one must be left behind". Because UHC is a cross-cutting issue that is linked to achieving the targets of SDG 3, it could serve as a platform to integrate health and health-related activities that, when combined with a Health-in-All-Policies approach, would make it a powerful tool for policy development.

Here too, NTD programmes have an important contribution to make because their missions are so closely aligned with the UHC agenda. This alignment is expressed in many ways. The notion of equity is a central element of the global NTD agenda, and in many instances NTD programmes are leading efforts to ensure that key interventions

reach those who need them most, particularly communities living in remote areas beyond the reach of most health systems. The NTD and UHC agendas are closely connected also because the coverage targets of the Roadmap for 2020 are considered important steps on the path towards achieving the UHC target of 80% essential health service coverage by 2030. Moreover, preventive chemotherapy has been proposed as a tracer intervention for monitoring equity in progress towards achieving UHC across population groups.

The SDGs' focus on UHC, for which an explicit target has been set (SDG 3.8), is also likely to change the way key interventions are supported, especially innovative and intensified disease management. Even if all NTD elimination targets are attained by 2030, millions of people living with chronic debilitating, disabling and disfiguring conditions as a consequence of NTD infection will continue to require medical intervention, ranging from medicines to surgery. It is to be hoped that some of this burden will be taken up by long-term capacity building and health system–wide reforms. A large part of the response will depend on health systems stepping up to meet demands for services as part of their transition towards UHC.

Therefore, there is much that NTD programmes have to share with national health systems as they strive towards UHC. Reciprocally, making progress towards achieving the Roadmap targets for control and elimination will depend on national health systems bringing their resources to bear.

Conclusion

Much has been achieved. However, as the report cautions, significant challenges remain. Some elimination targets for 2015 were missed despite the availability of viable, effectively tested interventions. NTD programmes continue to struggle with limited financial resources, inadequate capacity including capacity to implement effective surveillance, disruptive conflicts and important barriers to accessing needed health services that range from poverty to stigmatization.

The challenge beyond 2020 can be divided into two broad missions: eliminating transmission of NTDs and ensuring that the delivery of health services meets the needs of those living with NTD-related disease. The likelihood of achieving both objectives will depend on successfully integrating NTD-related activities and interventions into broader health systems. Reciprocally, integrating NTD services has the potential to accelerate progress towards UHC while advancing the broader Sustainable Development Goals for 2030.

TOWARDS 2020

PROGRESS MADE ON EXPANDING NTD INTERVENTIONS

As programmes move towards the latter stages of elimination campaigns, priorities will shift by putting greater emphasis on intensified surveillance and targeted interventions to focus on the remaining pockets of disease.

The global integration of vector control efforts is a core aim of the Global Vector Control Response, two of the pillars of which are the strengthening of inter- and intrasectoral action and collaboration, and the expansion and integration of vector-control tools and approaches.

2. Towards 2020: progress made on expanding NTD interventions

2.1 Introduction

The progress made towards achieving the Roadmap's targets for 2020 (*1*) (assessed in **section 5**) can be ascribed to the implementation of the five key interventions[1] that constitute the backbone of the NTD response. The use of MDA to deliver preventive chemotherapy has had the greatest impact on control, and its use marked a turning point in the global campaign against NTDs. Because of the relative simplicity with which preventive chemotherapy can be delivered through MDA and its profound impact on the prevalence of infection, this intervention has received considerable support, not only from the communities that are its chief beneficiaries but also from a variety of stakeholders, including the pharmaceutical companies that have donated the bulk of the medicines on which the intervention depends. However, as this report shows, the other key interventions are also vital to advancing the NTD agenda and must be supported if the 2020 Roadmap and agenda for achieving the Sustainable Development Goals (SDGs) (*2*) by 2030 are to be achieved. This section describes recent developments in the campaign against NTDs and the main challenges faced.

2.2 Preventive chemotherapy

The coordinated use of anthelminthic and antimicrobial medicines along with complementary public health interventions – such as managing chronic complications and disabilities from NTDs, deploying vector control, and providing safe drinking-water, sanitation and hygiene services – is a mainstay of WHO's recommended strategy of providing preventive chemotherapy to treat populations at risk of selected NTDs (*3*). These diseases include lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma. Where the targeted diseases are co-endemic, integrating and coordinating programmatic activities for all relevant diseases increases

1. The five key interventions are innovative and intensified disease management, preventive chemotherapy, vector ecology and management, veterinary public health services, and the provision of safe water, sanitation and hygiene.

cost effectiveness, enhances the impacts on health and supports national health-sector strategic plans, all of which support the successful implementation of national programmes (Fig. 2.1).

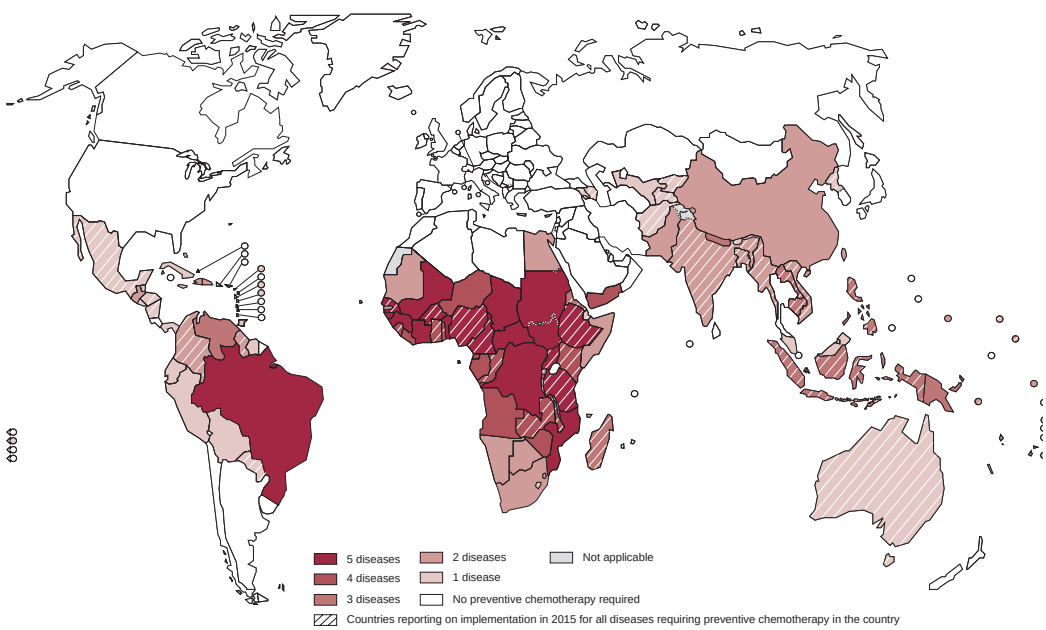
The implementation of preventive chemotherapy was boosted by partners in the pharmaceutical industry following the 2012 *London declaration* on neglected tropical diseases (*4*). Partners' contributions – in the form of large-scale donations channelled through WHO or sent directly to countries – offset the overall costs of NTD programmes whose funding comes from a variety of sources, including endemic countries, bilateral donors, international organizations, trust funds and nongovernmental donor organizations.

Normative guidance and technical support are provided to countries delivering preventive chemotherapy by WHO through the Strategic and Technical Advisory Group for NTDs and its associated thematic working groups.[1] Regional Programme Review Groups remain critical platforms through which national programmes receive country-specific advice.

A diverse group of disease-specific partnerships continues to make major contributions towards taking national NTD programmes to scale and generating opportunities for advocacy and for receiving increased resources from nontraditional donors. The continued success of programmes requires coordinated interactions among endemic countries, international organizations, nongovernmental organizations, pharmaceutical donors, philanthropic foundations and academia.

1. The reports of the WHO Strategic and Technical Advisory Group for Neglected Tropical Diseases are available at: http://www.who.int/neglected_diseases/meeting_reports/en/.

Fig. 2.1. Countries requiring and implementing preventive chemotherapy for five neglected tropical diseases, by number of diseases, worldwide, 2015. Lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma.



2.2.1 Progress on implementation

Tremendous progress has been made towards achieving the goals of the Roadmap in terms of delivering preventive chemotherapy; Table 2.1 summarizes for 2015 the key indicators relevant to each of the five NTDs that are amenable to preventive chemotherapy by WHO region, as reported to WHO by December 2016.

In 2015, approximately a billion people received preventive chemotherapy for at least 1 disease, a significant increase (36%) from 2011 when 729.4 million people were treated for at least 1 disease. The trajectory of coverage continues to accelerate: coverage increased from 35.4% in 2008 to 62.9% in 2015. Based on reports for 2015 from 84 countries where these diseases are endemic, 557.9 million people received preventive treatment for lymphatic filariasis, 572.7 million for soil-transmitted helminthiases, 119 million for onchocerciasis, 74.3 million for schistosomiasis, and 56.1 million for trachoma.

The proportion of implementation units delivering preventive chemotherapy and achieving effective coverage – defined as coverage of at least 65% for lymphatic filariasis and onchocerciasis, at least 75% for soil-transmitted helminthiases and schistosomiasis, and at least 80% for trachoma – shows a significant increase for four of the five diseases amenable to preventive treatment, with the exception being schistosomiasis.

Compared with 2008, by 2015 global coverage of preventive chemotherapy had increased by 76% (Fig. 2.2). Coverage also increased for most of the programmes targeting specific diseases. By the end of 2015, preventive chemotherapy for lymphatic

Fig. 2.2. Coverage of preventive chemotherapy by WHO region, 2010–2015

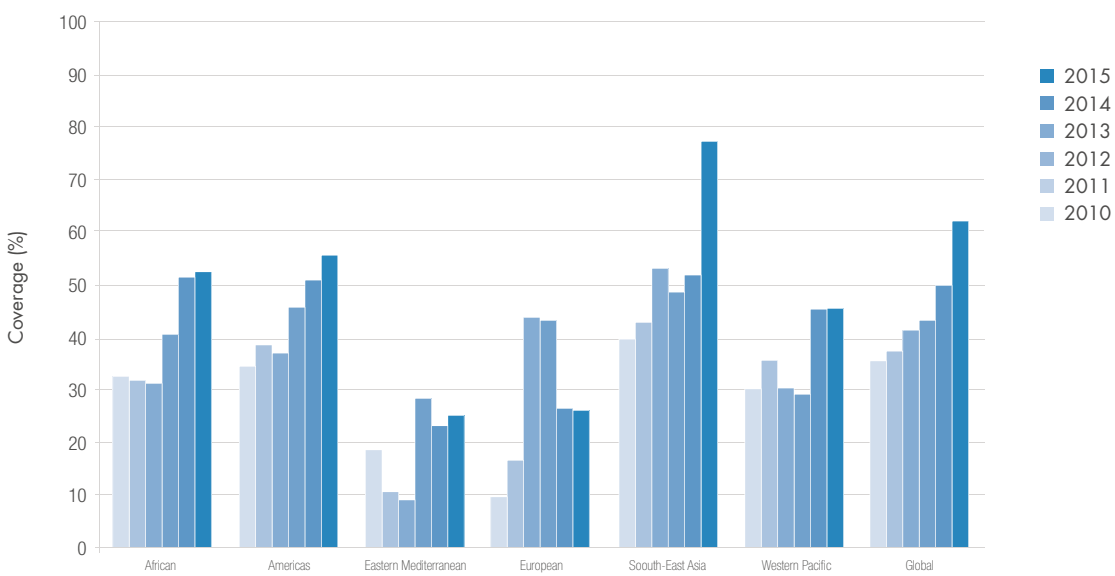


Table 2.1. Preventive chemotherapy delivery for neglected tropical diseases (NTDs) in countries where it was required for at least one disease, by disease and WHO region, 2015

Status of implementation	LF	ONCHO	STH[g]		SCH[h]		TRA	PC[i]
			PreSAC	SAC	SAC	Adults		
GLOBAL								
No. of countries required PC[a]	54	31	102		52		42	109
No. of people required PC (million)	941.3	185.6	266.9	567.8	118.7	99.5	192.1	1554
No. of countries implemented/reported[b]	36	24	56	71	35	23	26	82
No. of people treated[c] (million)	557.9	119	150.4	422.3	58.2	16.1	56.1	991
Global coverage (%)[d]	59.3	64.1	48.6	64.7	44.9	14.5	29.2	62.9
No. of countries achieved target coverage[e]	15	14	30	28	13	7	ND	ND
Geographical coverage (%)[f]	67.8	85.9	ND	65.9	45.7	16.5	33.2	ND
Proportion of IUs with effective coverage (%)[g]	73.7	85.1	ND	71.5	58.6	42.5	72.3	ND
AFRICAN								
No. of countries required PC[a]	32	27	42		41		26	44
No. of people required PC (million)	391.1	184.7	99.7	186.9	107	93.7	173.9	599
No. of countries implemented/reported[b]	21	21	21	30	28	16	18	35
No. of people treated[c] (million)	178.2	118.8	61.8	108.0	52.0	14.2	54.2	321
Regional coverage (%)[d]	45.6	64.3	45.5	55.5	44.2	13.5	31.2	53.6
No. of countries achieved target coverage[e]	6	12	13	8	10	3	ND	ND
Geographical coverage (%)[f]	66.4	85.9	ND	67.6	42.6	14.9	ND	ND
Proportion of IUs with effective coverage (%)[g]	68.2	85.3	ND	69.5	57.9	46.4	ND	ND
AMERICAS								
No. of countries required PC[a]	4	2	25		2		3	25
No. of people required PC (million)	10.6	0.03	12.6	32.1	1.6	0	4.7	52.5
No. of countries implemented/reported[b]	3	2	8	11	0	0	3	12
No. of people treated[c] (million)	5.4	0.021	7.6	28.5	0	0	0.25	39.7
Global coverage (%)[d]	51.2	71	40	63.9	0	0	5.4	56.1
No. of countries achieved target coverage[e]	0	2	4	6	0	0	ND	ND
Geographical coverage (%)[f]	79.5	100	ND	90.8	0	0	ND	ND
Proportion of IUs with effective coverage (%)[g]	81.4	100	ND	58.9	0	0	ND	ND
EASTERN-MEDITERRANEAN								
No. of countries required PC[a]	1	2	7		4		4	8
No. of people required PC (million)	13.4	0.7	23.2	51.2	8	4.6	10.7	84.6
No. of countries implemented/reported[b]	0	1	4	5	3	2	3	9
No. of people treated[c] (million)	0	0.2	14.8	5.8	5.8	0.6	1.6	21.3
Global coverage (%)[d]	0	22	56.8	11.2	70.4	13.1	14.7	25.2
No. of countries achieved target coverage[e]	0	0	2	1	2	1	ND	ND
Geographical coverage (%)[f]	0	80	ND	29.1	77.9	29.9	ND	ND
Proportion of IUs with effective coverage (%)[g]	0	0	ND	49.1	67.9	0	ND	ND

Status of implementation	LF	ONCHO	STH[g]		SCH[h]		TRA	PC[i]
			PreSAC	SAC	SAC	Adults		
EUROPEAN								
No. of countries required PC[a]	NA	NA	5		NA		NA	5
No. of people required PC (million)			0.9	1.5				2.4
No. of countries implemented/reported[b]			1	4				4
No. of people treated[c] (million)			0.001	2.6				2.6
Global coverage (%)[d]			0.1	36				26.5
No. of countries achieved target coverage[e]			0	2				ND
Geographical coverage (%)[f]			ND	37.5				ND
Proportion of IUs with effective coverage (%)[g]			ND	66.7				ND
SOUTH-EAST ASIA								
No. of countries required PC[a]	6	NA	8		1		1	8
No. of people required PC (million)	501		107.4	248	0	0.021	0.25	726
No. of countries implemented/reported[b]	6		9	8	1	1	0	9
No. of people treated[c] (million)	363		56	254	0	0.006	0	564.5
Global coverage (%)[d]	72.4		52.1	86.8	25.8	25.8	0	77.7
No. of countries achieved target coverage[e]	5		3	6	0	0	ND	ND
Geographical coverage (%)[f]	85.1		ND	66.1	100	100	ND	ND
Proportion of IUs with effective coverage (%)[g]	89.6		ND	81.6	0	0	ND	ND
WESTERN PACIFIC								
No. of countries required PC[a]	11	NA	14		4		8	19
No. of people required PC (million)	25.1		23.2	48.6	2	1.3	2.6	89.6
No. of countries implemented/reported[b]	6		13	13	3	4	2	13
No. of people treated[c] (million)	11.7		10.1	23.4	0.3	1.3	0.035	41.9
Global coverage (%)[d]	46.4		43.7	45	16.5	96.5	1.3	45.6
No. of countries achieved target coverage[e]	4		5	4	1	3	ND	ND
Geographical coverage (%)[f]	45.7		ND	64.2	96.9	90.6	ND	ND
Proportion of IUs with effective coverage (%)[g]	86		ND	82.3	35.5	31	ND	ND

NA, not applicable; ND, no data available; PC, preventive chemotherapy.

a Endemic countries that moved to post-treatment surveillance stage after meeting the WHO criteria or validated as having achieved elimination as a public health problem are not included in total.

b Number of countries reporting data on PC implementation. Countries submitted blank reports are not included in total.

c Number of people covered by PC calculated based on data provided in PC Joint Reporting Forms submitted by countries. It may also include number of people treated in areas where PC is not required based on WHO recommended infection prevalence levels.

d Coverage is calculated as number of people treated in need of PC out of population requiring PC. Numerator does not include number of people treated in areas where PC is not required.

e Number of countries which reached the target stated in the NTD roadmap.

f Geographical coverage is calculated as a proportion of IUs implementing PC out of total IUs requiring PC in the countries reported.

g Proportion of IUs implementing PC and achieved the defined effective coverage for the disease >65% for LF and ONCHO, >75% for STH and SCH, and >80% for trachoma.

h Number of countries implemented PC for STH and SCH may also covering some population living in districts which do not required PC.

i PC refers to where treatment is required or implemented against at least one of the parasitic diseases among LF, ONCHO, STH and SCH.

filariasis had been implemented in 36 countries, achieving treatment coverage of 59.3%, a 56% increase compared with 2008. Similarly, coverage for soil-transmitted helminthiases increased significantly between 2008 and 2015, reaching 59.5% in 2015, well above the 50% global coverage target set for that year. And overall, onchocerciasis control and elimination programmes achieved 64.1% coverage in 2015. This represents only a 6% increase in coverage since 2008, but it actually represents a doubling in the number of people treated for the disease by 2015, given increases in the number of people requiring treatment. The global trachoma elimination programme also showed encouraging results, with a 29.2% coverage rate, a threefold increase in global coverage of preventive chemotherapy since 2008. Similarly, the number of people treated for schistosomiasis increased between 2008 and 2015, mainly because treatment was expanded in WHO's African Region; the coverage of treatment for schistosomiasis achieved in 2015 was the highest ever, representing a more than fourfold increase from the 2008 level. However, there is a long way to go to reach the coverage required for national schistosomiasis control programmes to achieve the control and elimination targets set for 2020 and beyond.

From the regional perspective, WHO's South-East Asia Region achieved the highest coverage of preventive chemotherapy (77.7%), reaching 564.5 million people. This region also had the highest proportions of implementation units with effective coverage for lymphatic filariasis (89.6%) and soil-transmitted helminthiases (81.6%). The African Region follows the South-East Asia Region in terms of the burden of NTDs amenable to treatment with preventive chemotherapy as well as the progress made in implementing preventive treatment. In 2015, coverage in the African Region (53.6%) was achieved by treating 321 million people for at least one of the five NTDs that benefit from preventive treatment. Progress in the Region of the Americas and the Western Pacific Region was also encouraging; the Eastern Mediterranean and European regions lagged in terms of the percentage of the population treated for these NTDs.

2.2.2 Progress on monitoring

Accurately determining the distribution of a disease is a prerequisite for refining the global estimate of the number of individuals requiring preventive chemotherapy. Estimates of the number of people who need treatment are regularly updated for each disease based on the most recent epidemiological data generated by monitoring and evaluation activities undertaken by national programmes and on demographic information reflecting population growth rates. The mapping project undertaken by WHO's Regional Office for Africa and the NTD Support Center (part of the Task Force for Global Health, together with the Global Trachoma Mapping Project, resulted in more than 85% of districts in the African Region being fully mapped for these diseases. This major step towards improving the global understanding of trends in disease burdens will help to allocate resources more effectively and efficiently.

A second global inventory was conducted to assess the coordination of reported treatments among WHO, ministries of health and nongovernmental organizations. Comparing 2010 with 2014, the total number of individuals treated globally for soil-transmitted helminthiases increased from 261 million to 447 million; individuals treated by nongovernmental organizations increased from 65.4 million (25% of all treatments)

to 158 million (35%); and the number of treatments delivered by nongovernmental organizations that were not reported to WHO decreased from 23.3 million (36% of all unreported treatments) to 13.5 million (9%). In 2014, treatments that were not reported by nongovernmental organizations constituted only 3% of the global total compared with 9% in 2010. These findings demonstrate the ongoing improvements being made in data reporting and in collaboration among nongovernmental organizations and health ministries at the country level, which must continue to be actively pursued.

A joint mechanism and a set of application and reporting forms – the Joint Application Package – has been developed to facilitate the process of applying for preventive chemotherapy medicines and for reviewing and reporting national epidemiological data, as well as to improve coordination and integration among different programmes. The package comprises three forms: the Joint Request for Selected Preventive Chemotherapy Medicines, the Joint Reporting Form, and the Preventive Chemotherapy Epidemiological Data Reporting Form. In June 2015, the new release of the application package was published, addressing feedback received from countries and partners after 2 years of use. Currently, the package is available in four languages (English, French, Russian and Spanish) and can be accessed through WHO's website.[1]

Countries wishing to receive preventive medicines donated through WHO are invited to submit the application package to WHO throughout the year, but applications must be made at least 9 months before the planned intervention and no later than either 15 April or 15 August of the preceding year for which medicines are being requested; this is to allow time for the request to be reviewed and approved, for orders to be placed, and the medicines to be manufactured and shipped to the country. However, countries are always encouraged to submit application packages as soon as they have finalized the details for implementing the distribution of preventive chemotherapy; this avoids the problem of too many applications being accepted at the same time, which could strain the production capacity of the pharmaceutical companies.

To facilitate the application process for preventive medicines and reporting, WHO has developed training materials that include a user guide (available only in English) and video tutorials (available in English, French and Spanish) with step-by-step instructions about how to complete the application package. These materials are available also on WHO's website.[1]

Because larger volumes of data are generated when efforts are expanded, particular emphasis has been placed on ensuring that the information generated and reported by national programmes is of good quality in terms of accuracy, reliability, completeness, timeliness, precision, integrity and confidentiality. WHO, in collaboration with its NTD partners, has developed a series of tools to identify the challenges to collecting good quality data and to formulate appropriate corrective measures. Commonly used survey protocols have been reviewed to ensure their feasibility for use in the field. As a result of these efforts, new surveys and methodologies using probability sampling with segmentation are being recommended by WHO for use by national NTD programmes.

Field guides for implementation are in preparation for coverage evaluation, coverage supervision and data quality assessment. The tool for assessing data quality is intended for use at the programme level for quantitative verification of the reported data as well as for qualitative assessment of the underlying data management and systems parameters.

1. http://www.who.int/neglected_diseases/preventive_chemotherapy/reporting/en/

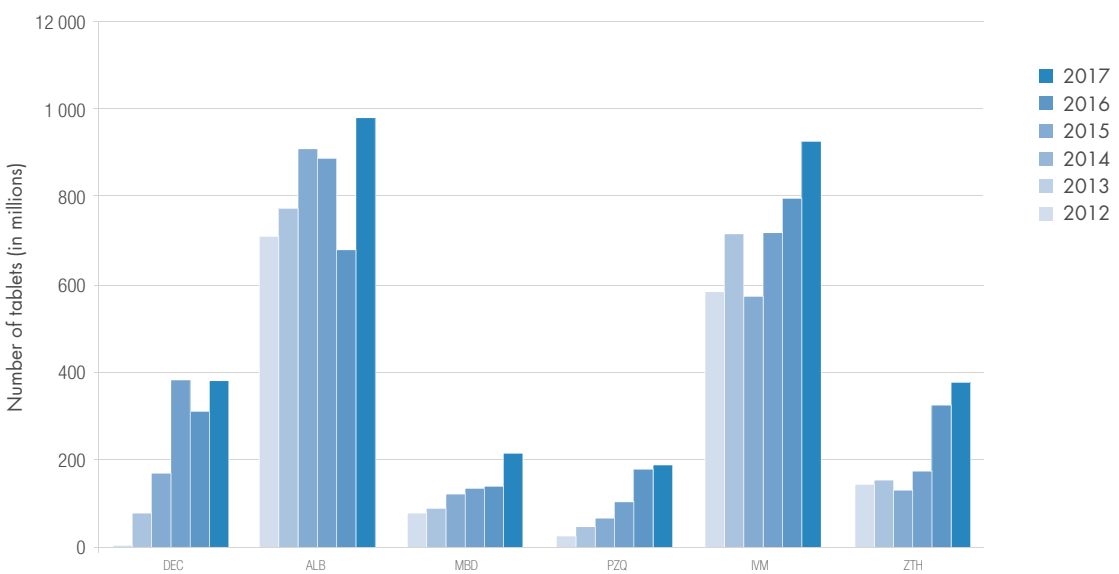
In response to repeated requests from managers of national programmes, the Coverage Supervision Tool has been designed to evaluate and strengthen the performance of community drug distributors and their first-level supervisors. This tool will allow for rapid evaluation of coverage followed by immediate remediation, so that low coverage can be improved without having to wait for the next treatment round. The development by the NTD community of a coverage evaluation method with probability sampling segmentation and the Coverage Supervision Tool represent significant innovations in the realm of information science.

Other notable innovations include the publication of standardized dossier templates to document the information required for validation and verification processes for lymphatic filariasis (*5*) and trachoma (*6*). The templates provide guidance to national programmes about which data need to be collected and how they should be organized for submission to the relevant Regional Programme Review Groups and expert groups.

2.2.3 Progress on the global supply of donated medicines for preventive chemotherapy, 2015

Donations of medicines to eliminate or control NTDs are the foundation of the preventive chemotherapy programme. Several pharmaceutical companies have pledged to donate essential medicines. WHO manages all of the donated medicines except ivermectin and azithromycin, which are coordinated by, respectively, the Mectizan Donation Program and the International Trachoma Initiative.

Fig. 2.3. Number of tablets supplied to countries for planned, annual, large-scale preventive chemotherapy 2012–2017



ALB, albendazole; DEC, diethylcarbamazine; IVM, ivermectin; MBD, mebendazole; PZQ, praziquantel; ZTH, azithromycin

Generally, the quantity of donated medicines is increasing as part of efforts undertaken to meet the required donation trajectory (Fig. 2.3).The number of tablets donated through WHO increased more than four-fold from 353 million in 2009 to more than 1.5 billion in 2015. The requested number for distribution in 2016 has declined to 1.33 billion due to a decrease in the population requiring treatment in the South-East Asia Region, as India has successfully stopped treatment for lymphatic filariasis in many implementation units after passing evaluations made as part of transmission assessment surveys (TAS). In 2017, the total number of tablets shipped for planned treatments will exceed 3 billion; part of this increase is due to scaling up by the global trachoma programme.

Prospects for distributing praziquantel, used to treat schistosomiasis, are beset by several challenges, notably a decline in the amount of praziquantel procured in addition to that donated. If this trend continues, by 2020 the amount of medicine donated and available globally for school-aged children will be 250 million tablets, which would cover only 30% of the global need. The 2020 goal for schistosomiasis control is to achieve at least 75% coverage of preventive chemotherapy for all at-risk populations (see **section 5.15**).

2.2.4 The way forward

Unprecedented levels of global coverage of preventive chemotherapy have been attained during the past few years as a result of a sustained expansion of interventions that treated approximately 1 billion individuals for at least one disease in 2015. Continuing efforts are required to enhance the efficiency of treatment implementation, ensure improvements are made to monitoring and surveillance tools, seek alternative medicines in the event of a loss of efficacy or the development of resistance, ensure that reporting systems are effective and to maintain optimal levels of coverage. Sustaining high rates of treatment coverage over many years will also require that health education programmes are adapted to local social and cultural settings, particularly in areas of persistently high transmission. As responses to diseases move towards the endgame, evaluation and monitoring to ensure post-control surveillance will become more critical and will demand additional financing, which most national programmes have not yet been able to mobilize at adequate levels.

Critical to success have been ensuring effective coordination and communication among stakeholders involved in policy-making and those involved in financing and implementing programmes. Endemic countries have a central role to play. It is essential therefore that they are supported at the country level, notably with good-quality data that they are empowered to use for decision-making within the contexts of their national programmes.

While celebrating the many achievements outlined here, there are important challenges that must be overcome if the Roadmap's goals are to be achieved by 2020. These include persistently large implementation deficits in high-burden countries that either have not started MDA or have not achieved the necessary geographical coverage; irregular or partial implementation of MDA due to resource constraints affecting the distribution of medicines in countries considered to have medium and high densities of populations; the inaccessibility of some endemic areas owing to insecurity or violent conflict; unforeseen public health events, such as the 2015 outbreaks of Ebola virus disease in West Africa and yellow fever in Angola and the Democratic Republic of the Congo; and the as yet undetermined role of new disease parameters and their effects on transmission patterns (for example, zoonotic schistosomiasis). New efforts and partnerships, as well as

innovative delivery mechanisms for medicines will be required to mitigate the regressive effects of such unanticipated situations to attain global and regional targets within the established timelines.

Although preventive chemotherapy interventions are generally perceived to be equitable, there are observable disparities in access to treatment for preschool-aged children and women of childbearing age, as well as inequities in access to praziquantel for adults, all of which need to be addressed. Current strategic plans and the associated donations of medicine will need to be strengthened or revised to minimize the differences that result in the systematic exclusion of these subpopulations in some endemic communities. Additionally, gender equity frameworks should be applied when considering the design and delivery of NTD programmes to improve gender mainstreaming practices that promote access to preventive chemotherapy for women, girls and other marginalized groups.

2.3 Innovative and intensified disease management

Innovative and intensified disease management uses different medical and other interventions – ranging from medicine to surgery to vector control– to redress the impact of complex NTDs. A group of six diseases are targeted for intervention: three distinct vector-borne diseases that are caused by related kinetoplastid protozoan pathogens (Chagas disease, cutaneous and visceral leishmaniasis, and human African trypanosomiasis); those caused by bacteria (Buruli ulcer, leprosy and yaws); and mycetoma, which is caused by bacteria and fungi groups and that was added to the list of NTDs after the adoption in 2016 by the Sixty-ninth World Health Assembly of resolution WHA66.12 on addressing the burden of mycetoma (*7*). Although the kinetoplastid diseases originate from the same family, they have different geographical distributions due to their different vectors and range of vector contact with humans.

Despite the limited availability of effective interventions to these complex diseases, the programmes working within the framework of innovative and intensified disease management have achieved a great deal during the past two decades, their successes being primarily attributable to the commitment and stewardship of Member States and their key partners, supported by WHO in its coordination and guidance role.

The strategies pursued to achieve the control, elimination or eradication goals of these NTDs comprise four main components:

- ensuring universal access to early diagnosis and prompt treatment;
- improving surveillance and integrating passive surveillance into health-services provision;
- accelerating efforts towards elimination and eradication by intensifying core interventions; and
- implementing supportive components, such as fostering collaboration, community engagement and advocacy.

2.3.1 Ensuring universal access to early diagnosis and prompt treatment

Controlling those NTDs that are amenable to innovative and intensified disease management relies on the capacity of health professionals to diagnose the diseases early and correctly and to manage cases appropriately. Because of the focal nature of these diseases, targeted, in-service training of health workers in endemic and high-risk areas is the cornerstone of response strategies, and training has improved health workers' skills in surveillance, managing patients and in providing health education to the community. Activities focused on capacity building have increased the number of health facilities providing good quality diagnostic and treatment services in endemic areas, thereby improving access for remote and affected communities. This strategy is in keeping with the agenda of the SDGs and the universal health coverage targets of ensuring that 100% of the population has access to affordable diagnosis, treatment and care for NTDs, leading to 100% of the at-risk population being protected against out-of-pocket payments related to NTDs by 2030.

Key areas for action include taking steps to increase the capacity of all peripheral health facilities in endemic areas to diagnose patients and either treat or refer them to nearby facilities; address the needs of specific vulnerable groups, including children, women, migrants and displaced populations in areas of conflict or crisis; and ensure an uninterrupted supply of diagnostics and medicines. Optimal organization is required to ensure that care and services are delivered effectively and successfully. Innovative approaches are also required, including social innovation in health, a concept that is becoming more widely accepted and promoted because it provides effective, efficient and sustainable solutions to societal problems and to controlling diseases of poverty.

Another focus for innovation is integrated case management, notably in regard to NTDs that affect the skin and subcutaneous tissue (also known as skin NTDs) and cause disabilities, stigmatization, disfigurement and worsening poverty (Box 2.1). Integrating treatments for such diseases not only increases cost efficiency and helps expand coverage and sustainability but also increases ownership by national programmes; some examples of implementing integrated case management include providing comprehensive training for health workers and village volunteers, as well as including community-level control activities, such as active case-finding or detection, and surveillance.

Box 2.1. Integrated case management: the case for the integrated control of skin NTDs

A number of NTDs are characterized by cutaneous manifestations that are associated with long-term disfigurement and disability. These include Buruli ulcer, cutaneous leishmaniasis, leprosy, mycetoma, yaws, onchocerciasis and lymphoedema (resulting from lymphatic filariasis); their long-term effects include hydrocele (caused by lymphoedema), depigmentation, subcutaneous nodules, severe itching and hanging groin (caused by onchocerciasis). All of these diseases require similar detection and case-management approaches that present opportunities for integration, which both increases cost effectiveness and expands coverage (*8*).

The major areas in which integrated approaches can be developed include epidemiological surveillance and disease mapping, training for health workers, and programme monitoring and evaluation. For example, skin examination undertaken as part of surveillance activities offers an opportunity to screen people in their communities and children in schools to identify multiple conditions during a single visit. Also, teaching about skin care, elevation of the affected limb and hygiene for the management of lymphoedema can be integrated into national control programmes that address chronic diseases, such as those for leprosy, diabetes, podoconiosis and Buruli ulcer (*9*).

In Africa, several countries are poised to integrate case management by combining vertical programmes. In Benin and Togo, the programmes for Buruli ulcer, leprosy and yaws have already been integrated. In Cameroon, a combined programme is targeting the same three diseases plus leishmaniasis. In Liberia and Nigeria, strategic plans have been designed to integrate the programmes for NTDs that affect the skin. Several nongovernmental organizations are moving also to support integrated programmes and activities that tackle NTDs of the skin. Key review papers have been published to support the integration of programmes to control these so-called skin NTDs (*8, 10–12*).

WHO in collaboration with Member States and other partners is preparing the following documents to provide the required strategic guidance to support integration in the African Region: an integrated strategy on NTDs amenable to case management, a manual on integrated case management of NTDs for health workers at peripheral level by district health management teams, and a guide on integrated monitoring and evaluation of interventions and programmes against NTDs that benefit from case management.

2.3.2 Integrating passive surveillance into health-service delivery

Early case detection and surveillance are central pillars of efforts to control and eliminate all NTDs that benefit from innovative and intensified disease management. Delayed diagnosis results in severe complications and death in Chagas disease, human African trypanosomiasis and visceral leishmaniasis. In people affected by Buruli ulcer, cutaneous leishmaniasis, leprosy, mycetoma and yaws, delays can lead to disfigurement, disabilities and social stigmatization. Early detection is also critical in averting transmission of pathogens because prompt treatment stops the spread of infections and reduces the reservoirs of infection in humans. Efforts should thus focus on enhancing case detection and on active and passive surveillance, which are also essential parts of preparedness and responses to epidemics. To support the surveillance effort for NTDs, WHO's Innovative and Intensified Disease Management unit has been developing and implementing an integrated online platform for the surveillance and control of these diseases (Box 2.2).

Box 2.2. Building an integrated online platform for the case management, surveillance and control of NTDs

The aim of this innovative and intensified disease management initiative is to create an online platform to facilitate the integration of disease-specific surveillance activities into a more efficient and sustainable health information system. Such a system will strengthen health information systems at the national level as well as disease surveillance at the health-facility level, thus also strengthening evidence-based decision-making. The platform is also intended to promote and improve data standardization, collection, analysis and dissemination at the national, regional and global levels. Globally, the system will act as a data warehouse to ease the collection of good-quality data and support the identification and analysis of trends; it will also host monitoring and evaluation data from all programmes in a single place. The platform will also contribute to the process of validating or verifying whether elimination goals have been met.

A flexible, open-source information system known as DHIS2[1] has been selected for the platform, and it will handle the reporting, analysis and dissemination of health data, with visualization features including a geographic information system, charts and tables. In 2016, the system was being used by more than 50 countries (largely those with a high burden of NTDs); 16 of them are using it as their national health information system.

By investing in this tool, WHO is both leveraging an existing infrastructure to improve the collection, analysis and sharing of good-quality data in a sustainable way and strengthening national health information systems in affected countries. To harmonize processes within WHO, build in-house capacity and support integration, the Department of Control of Neglected Tropical Diseases – Neglected Zoonotic Diseases unit (for rabies) and the Vector Ecology and Management unit (for dengue) are collaborating with other WHO departments, including the Global Tuberculosis Programme, the Joint United Nations Programme on HIV/AIDS, the Global Malaria Programme and the Department of Health Statistics and Information Systems.

The project started in 2016 by standardizing the minimum data to be collected at the health-facility level and drafting indicators to be tracked at both the national and global levels for all NTDs amenable to individual case management. Retrospective data shared by endemic countries has been imported into the online platform to gather all data in a single place and enable the creation of dashboards and reports to monitor trends and share interpretations of calculated indicators.

Several workshops have taken place in endemic countries to introduce the platform, discuss the standardized forms and indicators, and get feedback. At the same time, WHO's programme for Chagas disease control has been collaborating with the Polytechnic University of Catalonia to develop a complementary generic platform, called World Information System to Control Chagas Disease, which will be able to automatically gather data collected by other systems.

DHIS2 is being used as a manual data-entry interface so that different users will be able to share, visualize and standardize the data they are collecting in their geographical area. In 2016, the global Chagas disease programme implemented a world information system to control the disease. This system will also allow the Chagas disease programme and other programmes such as those to control and eliminate the leishmaniases, to automatically integrate data by other systems such as WHO's Event Management System (for information about outbreaks[2]), WHO's Global Pharmacovigilance Database (for information about adverse events[3]) and the METATRI database (for information about vector distribution and density[4]). Moreover, it will be a crucial tool for detecting epidemiological blind spots and for collating information before validating the elimination of transmission.

Because DHIS2 is a flexible and evolving tool, additional modules will be developed to collect data about other topics that are relevant to reaching disease elimination, such as vector-control activities, outbreak-related information and the distribution of medicine. Starting in 2017, capacity will be built at all levels of surveillance systems (from health facilities to the global level) so that users understand how to improve data collection, validation, analysis and sharing on the platform, and the platform will be tested in several countries at the health-facility level.

1. http://www.dhis2.org
2. http://www.who.int/csr/alertresponse/en/
3. http://www.who.int/medicines/news/glob_pharmvig_database_qa/en/
4. http://www.conicet.gov.ar/new_scp/detalle.php?keywords=&id=22517&congresos=yes&detalles=yes&congr_id=1350068

2.3.3 Advancing elimination and eradication by intensifying the use of core interventions

Innovative and intensified disease management is only part of the response to these diseases, and efforts will be required in other areas, notably among the core interventions, such as vector control, which has already contributed significantly to the control or elimination of these diseases. There is a need to strengthen integrated vector management activities by improving the skills of those who manage and implement vector-control programmes and by enhancing the coverage and quality of integrated vector-management programmes. Similarly, making progress on the NTDs that benefit from innovative and intensified disease management will depend on strengthening the capacity of health systems.

2.3.4 Supportive components

A range of supportive activities are required to advance the agenda on innovative and intensified disease management, including fostering collaboration and integration. Promoting interdepartmental and intersectoral collaboration and integration is of paramount importance because many of the interventions required to address these NTDs cut across disciplines. Examples of cross-cutting interventions include integrated vector-management activities; the provision of safe water, sanitation and hygiene (known as WASH); veterinary public health activities; and health-system strengthening.

Collaboration between WHO and other United Nations agencies, such as the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and the United Nations Children's Fund (UNICEF), is also a prerequisite for making progress on these NTDs. Also important is international technical cooperation among the endemic countries, which has taken the form of successful subregional initiatives – for example, in interrupting vectorial transmission of *Trypanosoma cruzi* (the causative parasite of Chagas disease) in the Southern Cone region of Latin America. This subregional initiative was technically supported and guided by WHO and PAHO (the Pan American Health Organization). Ensuring that collaboration occurs among key research groups is also critical.

Collaboration, and in particular cross-sectoral collaboration, will be brought to the fore in the SDG era. From a systems perspective, orienting systems towards delivering high-quality health services is fundamental to making progress and to meeting the expectations of communities and health care workers. Thus, there is an urgent need to explore ways to align disease responses incorporating innovative and intensified disease management with health-service strengthening within the context of UHC. As 2020 approaches, an aggressive and accelerated approach should be implemented to achieve the targets set out in the Roadmap for these diseases, in particular the elimination goals. There is an opportunity to integrate detection, surveillance and treatment within primary health care and also to deploy veterinary public-health interventions.

Advocacy efforts are also vital, particularly in regard to policy – for example, calling for the inclusion of diseases benefiting from innovative and intensified disease management in the minimum health-service package at the lowest-level health facility. Advocacy should also focus on harnessing high-level political commitment, which is key to increasing

domestic investment and ensuring continued support. Finally, increasing community awareness and involving the communities in a structured way will be key both to achieving and sustaining the targets for NTDs amenable to innovative and intensified disease management and to advancing the UHC agenda.

2.3.5 Challenges to innovative and intensified disease management

The hard-won successes of the past few years demonstrate that dedication, purpose, collaboration, partnerships, and the expansion and implementation of innovative approaches are fundamental for effective control and elimination, and these can be achieved despite the absence of ideal intervention tools.

Yet several challenges remain. The greatest of these is the lack of robust, sustained international and domestic financing. The financing challenge is exacerbated by the endgame challenges of maintaining political commitments in the face of shrinking epidemics and of ensuring that actions are sustained at the lower levels of health systems, in particular making certain that services extend to hard-to-reach populations, including migrants, people affected by humanitarian crises, and rural communities with poor access to health services.

Other challenges that need to be met to accelerate progress include improving the inadequate performance of health systems in most of affected countries and the problems posed by the diseases themselves. For example, many of the people who harbour infections remain asymptomatic or undiagnosed and act as potential reservoirs. In some parts of the world, vector-control tools cannot effectively protect against a disease given the diversity of vectors and the differences in their behaviours (for example, visceral leishmaniasis in East Africa, zoonotic cutaneous leishmaniasis in the Middle East and Latin America, and human African trypanosomiasis in Africa). Additionally, human infection with zoonotic parasite species presents continued challenges to controlling and eliminating some of the NTDs that otherwise benefit from innovative and intensified disease management. The emergence of resistance to medicines and insecticides is another major concern. Meeting these challenges will require not only the continued commitment of the various stakeholders working to combat these NTDs but also increased collaboration and partnerships to exploit synergies and optimize use of resources.

2.4 Vector ecology and management

Vector ecology and management strategies focus on developing and promoting guidelines based on the principles and approaches of integrated vector management, including the judicious use of pesticides. Vector control is an important component in preventing and controlling vector-borne diseases, specifically for transmission control. The vector-borne NTDs include dengue, lymphatic filariasis, onchocerciasis, Chagas disease, leishmaniasis and human African trypanosomiasis, but vectors of NTDs also carry other pathogens. Dengue, for example, is carried by the *Aedes aegypti* mosquito (and to a lesser extent, by *Ae. albopictus*) which also carries the Zika and chikungunya viruses as well as other arboviruses.

The major vector-borne diseases together account for 17% of the estimated global burden of communicable diseases and claim more than 700 000 lives every year. More than 80% of the global population lives in areas at risk from at least one major vector-borne disease; more than half of the world's population are at risk from two or more. Since 2014, major outbreaks of dengue, chikungunya and Zika virus disease have afflicted populations in all WHO regions. Despite the threat posed by these diseases, vector control remains neglected. To optimize the delivery of interventions there are needs for increased strategic investments, improved public-health capacity for entomology, better coordination within and among sectors, and strengthened monitoring systems. It will also be necessary to develop and make available more interventions with a proven evidence base.

The *Ae. aegypti* mosquito is the principal vector of the dengue, Zika, yellow fever and chikungunya viruses. It is found in close association with humans, and it lays its eggs in water that collects in containers commonly found in domestic and peridomestic habitats, such as those used for water storage, and in flower pots, and small, discarded containers, as well as tyres. Because this mosquito has spread to most tropical and subtropical towns and cities, it threatens the health of millions. In some areas, *Ae. albopictus* also sustains transmission, even in the absence of *Ae. aegypti*.

Community-based actions to combat *Ae. aegypti* comprise activities to educate and empower communities to identify, empty, and remove mosquito-breeding habitats in households and the immediate vicinity, as well as other settings where human–vector contact occurs, such as schools, hospitals and workplaces. Mosquito breeding can also be prevented through the provision of reliable piped water and regular solid-waste management and by installing screens in houses. Other vector-control methods include ensuring personal protection by using insect repellents and insecticide-treated bednets and by providing indoor residual spraying. However, increasing resistance to insecticides may reduce their effectiveness over time.

2.4.1 Vector control and Zika virus disease

Although Zika virus disease is not currently listed as an NTD, it may be a suitable candidate for inclusion. The disease has recently emerged as a matter of particular concern, notably because of its association with microcephaly and Guillain-Barré syndrome. On 1 February 2016, WHO declared Zika virus transmission to be a public health emergency of international concern when temporally associated with clusters of microcephaly and Guillain-Barré syndrome. To review the evidence on vector control for Zika virus disease, including the potential for developing new tools to address it, WHO convened an extraordinary meeting of its Vector Control Advisory Group and other experts (Geneva, March 2016). This section summarizes the main outcomes of the meeting.

Well-implemented vector control programmes using existing tools and strategies are effective in reducing the transmission of *Aedes*-borne diseases including Zika virus disease. Appropriate vector-control interventions for responding to Zika virus outbreaks were determined to include the following.

- The primary vector-control intervention to be used to immediately respond to an outbreak should be targeted residual insecticide spraying of the resting sites of *Aedes* species mosquitoes inside houses and, to a lesser extent, around houses.
- Space spraying with insecticides is seen as being effective inside buildings where *Aedes* species mosquitoes rest and bite. It has no residual effect. Using space spraying outdoors suppresses vector populations only temporarily and is not as effective as spraying indoor spaces.
- Larval control, including reducing sources of larvae and using larvicides, should be applied where appropriate through community mobilization.
- Personal protection measures should be used against mosquitoes that bite during the day. These include using appropriate repellents and wearing light-coloured loose-fitting clothing. These measures are especially important during pregnancy.

The strength and rigour of implementing vector-control activities must be improved to reduce infected vector populations and the transmission of *Aedes*-borne diseases. All of these interventions should be targeted, and guided by local conditions as well as by entomological and epidemiological data, including data about susceptibility to insecticides. WHOPES recommended insecticides, to which mosquitoes are susceptible, should be used for vector control.

Several promising new vector-control tools were reviewed in the context of the response to the outbreak of Zika virus disease. These new tools have the potential to reduce vector populations or viral multiplication, or both, to minimal levels and, thereby, to prevent transmission. Although several tools showed strong evidence of entomological effects, given the absence of strong data on their epidemiological impact for any *Aedes*-borne viruses, full-scale programmatic deployment is not currently recommended for any of them. The evidence does warrant time-limited pilot deployment under operational conditions for two of the new tools; however, this should be accompanied by rigorous monitoring and evaluation. Plans for randomized control trials with epidemiological outcomes should continue to build evidence for routine programmatic use. The two tools that warrant pilot deployment are implementing microbial control of human pathogens in adult vectors (using *Wolbachia*) and reducing mosquito populations through genetic manipulation.

- Using *Wolbachia* to control human pathogens in adult vectors is based on evidence indicating that when symbiotic *Wolbachia* species bacteria are introduced into *Ae. aegypti* populations, they reduce the mosquitoes' ability to transmit arboviruses to humans. Laboratory results show that *Wolbachia* infection reduces viral replication of dengue, chikungunya and Zika viruses within *Aedes* mosquitoes, and it eliminates or substantially delays the appearance of the virus in mosquito saliva, thus reducing mosquitoes' competence for transmitting dengue viruses. The strategy involves establishing and sustaining *Wolbachia* in local *Aedes* species mosquito populations, thereby providing ongoing protection from virus transmission.
- Reducing mosquito populations through genetic manipulation involves using a transgenic strain of *Ae. aegypti* (OX513A) engineered to carry a dominant, repressible, non-sex-specific, late-acting lethal genetic system together with a fluorescent marker

to attract the mosquito. Larvae carrying the OX513A gene develop normally but die before functional adulthood. This technology has demonstrated the ability to reduce the *Ae. aegypti* populations in small-scale field trials in several countries, but there is an absence of data about its epidemiological impact. Additionally, the sustained release of transgenic male mosquitoes is needed to maintain suppression of wild *Ae. aegypti* populations.

The outbreak of Zika virus disease highlighted the lack of a comprehensive understanding of the bionomics of the vectors and their role in transmission. Sustained vector-control interventions are critical for *Aedes* control, and active community involvement is needed to regularly monitor and reduce populations of this vector.

Activities to control species of *Aedes* mosquitoes must change from reactive approaches to sustained, proactive control interventions that are based on entomological and epidemiological evidence. The focus must be on improving the quality and extent of vector-control interventions to ensure optimal impact, both within the context of an immediate response to an increase in arboviral diseases and, more broadly, against all *Aedes*-borne diseases. When planning and implementing programmes to control *Aedes*-borne diseases, a number of key factors should be considered, such as the country's commitment, opportunities for intersectoral collaboration and capacity building for entomological surveillance, and the ability to organize sustained and effective control and a rapid outbreak response. Controlling *Aedes*-transmitted viruses by targeting vectors requires an integrated approach that involves multiple partners within and outside the health sector, in particular it requires community involvement. *Aedes* control efforts also need more innovative tools that could bring about lasting impacts on reducing the mosquito population and on the disease.

The Vector Control Advisory Group was constituted in 2012 by WHO to advise on the efficacy of new tools, technologies and approaches for public health vector control. It is jointly managed by the Department of Control of Neglected Tropical Diseases and the Global Malaria Programme and issues advice not only to WHO to inform policy recommendations but also to innovators of new vector-control interventions to guide product development. The Group has assessed a number of new product classes for controlling vectors that have diverse entomological modes of action and outcomes that aim to reduce the transmission and burden of vector-borne diseases in humans.[1]

2.4.2 WHO Global Vector Control Response

After the Sixty-ninth session of the World Health Assembly in 2016, and at the request of Member States in the 139th Executive Board, WHO's Department of Control of Neglected Tropical Diseases, in close collaboration with the Global Malaria Programme and the Special Programme for Research and Training in Tropical Diseases drafted the Global vector control response 2017–2030 (*13*), which was reviewed by the 140th session of the Executive Board in January 2017 and requested for consideration by

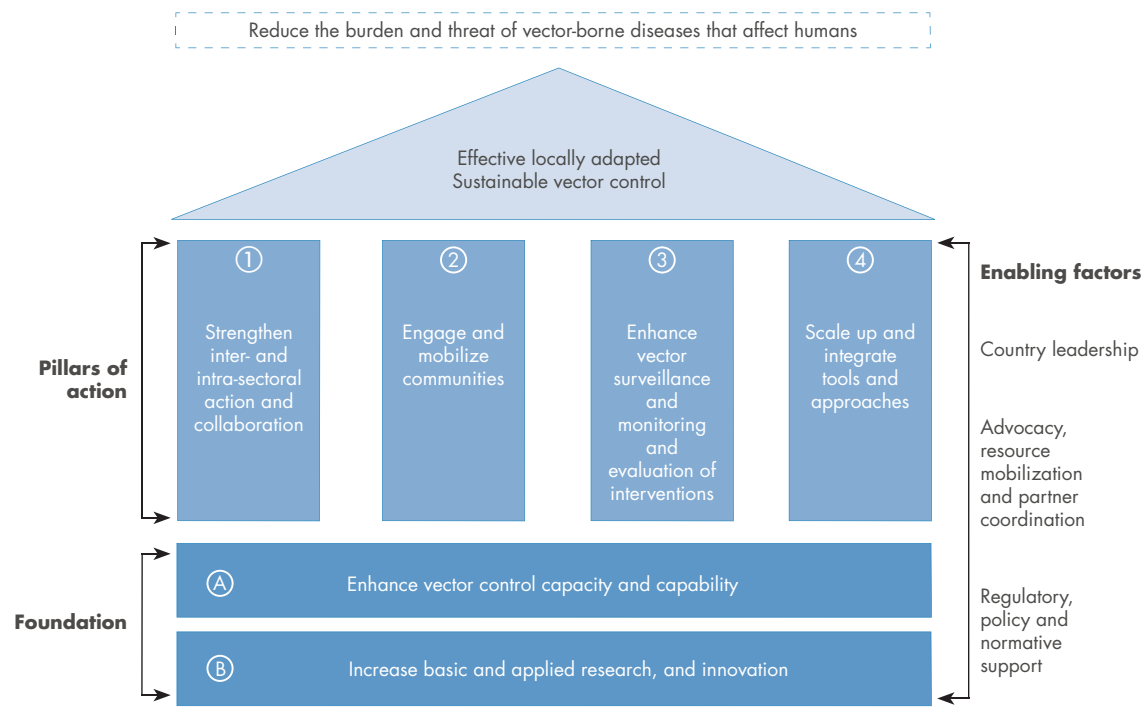
1. More information, including meeting reports, is available from http://www.who.int/neglected_diseases/vector_ecology/VCAG_resources/en/

the Seventieth World Health Assembly in 2017. The draft Response aims to support the implementation of a comprehensive approach to vector control that will enable the setting and achievement of disease-specific national and global goals and contribute to attaining the SDGs.

The Response provides strategic guidance to countries and development partners to help them strengthen vector control strategies as a fundamental approach to preventing disease and responding to outbreaks. This Response calls for significant enhancement of vector-control programming supported by increased numbers of technical staff, stronger monitoring and surveillance systems, and improved infrastructure. The vision of this Response is a world free of human suffering from vector-borne diseases, with the goal of reducing the burden and threat of vector-borne diseases by implementing effective, locally adapted and sustainable vector-control measures. The Response sets an ambitious target of achieving at least a 75% reduction in global mortality due to vector-borne diseases by 2030 relative to 2016, with interim milestones of at least a 30% reduction in mortality by 2020 and at least a 50% reduction in mortality by 2025.

The Response comprises two core elements (Fig. 2.4): (i) enhancing human, infrastructural and health-systems capacity for vector control and vector surveillance within all locally relevant sectors; and (ii) increasing basic and applied research to underpin optimized vector-control measures and innovation for developing new tools and approaches.

Fig. 2.4. Framework for the Global Vector Control Response



Source: reference *13*

Action is required in four key areas (known as pillars) that are aligned with the key elements for adopting an integrated vector-management approach:

1. strengthen inter- and intrasectoral action and collaboration;
2. enhance entomological surveillance and monitoring and the evaluation of interventions;
3. scale-up and integrate tools and approaches; and
4. engage and mobilize communities.

Most vector-borne diseases can be prevented by vector control if it is implemented well. Proven interventions that target vectors offer some of the best cost–effectiveness ratios in public health. Major reductions in the incidence of malaria, onchocerciasis and Chagas disease have largely been achieved as a result of strong political and financial commitments and significant investments in vector control.

2.4.3 WHO Pesticide Evaluation Scheme and vector ecology and management

Since 1960, the WHO Pesticide Evaluation Scheme (WHOPES) has been the leading global mechanism for assessing the efficacy and safety of pesticides used for public health activities and for setting quality standards for pesticides. The World Health Assembly established WHOPES to facilitate the testing and evaluation of pesticides and pesticide-related products for vector control and to provide guidance and set policies for the judicious use of these products for public health activities. Countries rely on WHOPES recommendations when registering vector-control products and, similarly, international purchasers of vector-control products depend on these recommendations to guide procurement. In the 55 years since its inception, WHOPES has managed the independent testing and evaluation of pesticides through a network of collaborating centres and other institutions. Up to the end of 2016, the scheme was housed within WHO's Department of Control of Neglected Tropical Diseases.

2.4.4 The need for reform

Increasing insecticide resistance, rapidly spreading arboviral diseases and the impact of climate change on vector distributions threaten to thwart the global gains made in controlling vector-borne diseases. New tools and strategies are needed to respond to these challenges, in particular innovative products that can safely and effectively target key transmission settings (for example, outdoors, high-resistance areas) and high-risk populations. Effective strategies for using new tools and products are also needed. These vector-control products may be pesticide or non-pesticide tools, or techniques within an existing product class – such as an indoor residual spray product using a new, chemically active ingredient – or an entirely new product class with no precedent for use in vector control – such as microbial control of human pathogens in adult vectors, for example by using *Wolbachia* to affect *Aedes* mosquitoes.

Since early 2016, WHO has been detailing plans to improve its systems and procedures for pesticide evaluation and to strengthen vector-control normative functions, as part of a larger innovation to impact initiative, supported by the Bill & Melinda Gates Foundation. The primary aim of these plans is to encourage the use of innovative, safe, effective and high -quality products for vector control. These reforms will transfer the testing of vector-control products to the WHO prequalification process so their evaluation will be aligned with, and similar to, the assessment of medicines and vaccines. At the same time, the normative functions – including strengthening the Vector Control Advisory Group in response to an ever-increasing number of applications for new tools and technical support, as well as policy recommendations made by WHO – will be strengthened and streamlined to keep pace with the development of innovative tools. WHO has also provided technical support for the control of visceral leishmaniasis in India and China and for the surveillance and control of vectors at points of entry under the *International health regulations* (2005) (*14*).

2.5 Veterinary public health services

The strategies of veterinary public health activities and the One Health approach recognize that the health of people is connected to the health of animals and the environment (*15*). This is particularly relevant to the neglected zoonotic diseases: rabies, echinococcosis, taeniasis and cysticercosis, and foodborne trematodiases, a subset of NTDs that are naturally transmitted from vertebrate animals to humans and vice versa. The greatest burden of endemic zoonoses falls on the 1 billion poor livestock keepers in Africa and Asia (*16*) who live in close contact with their animals and depend on livestock production for their livelihoods and nutrition. These same populations have the least access to services for human and animal health and to information.

Overcoming these diseases requires a multifaceted approach that bridges the human–animal interface, and it mandates a broad and inclusive multisectoral programme of work to protect and improve the physical, mental and social well-being of humans. For example, it is not sufficient to focus rabies-control efforts on post-exposure prophylaxis for humans. It is also necessary to vaccinate dogs and implement waste management activities because, as with the other dog-transmitted NTDs, the management of waste has a direct impact on roaming dog populations. Thus, the involvement of multiple sectors is critical, including veterinary, water, sanitation and hygiene. For cross-sectoral approaches to work, it is necessary to ensure there is appropriate communication, coordination and partnership among the sectors responsible for human health, animal health and environmental health (*17*), while also ensuring the engagement of communities and a wide range of sectors and stakeholders.

Improving surveillance is also key to advancing the agenda to tackle neglected zoonotic diseases. Preventable endemic diseases, including neglected zoonotic diseases,[1] are rarely prioritized for surveillance because they do not have epidemic or pandemic potential and, therefore, do not trigger the same international concern, even if the year-to-year death rate from these diseases exceeds that of the recent outbreaks of

1. The zoonotic NTDs for which veterinary public health interventions are needed are rabies, *Taenia solium* taeniasis/cysticercosis, echinococcosis and foodborne trematodiases. However, the concept of One Health includes a much broader range of communicable and noncommunicable diseases, and veterinary public health approaches are equally rational for use against a range of other NTDs with zoonotic characteristics.

emerging diseases (*18*). However, as the human population continues to grow, and the interconnection among people, animals and the environment becomes more significant, the risk of epidemic and pandemic outbreaks increases, as evidenced by the epidemics of Ebola virus disease, H5N1 influenza and Middle East respiratory syndrome (or MERS), as well as the HIV pandemic.

It is essential that resources focus on surveillance for neglected zoonotic diseases, not only to monitor the overall state of the health system by detecting the presence of preventable diseases but also to ensure early detection of the unusual by monitoring the usual. Strengthening surveillance and other systems for endemic diseases, infectious or otherwise, is also key to providing the infrastructure needed for disease response activities. Recent developments in this area include the implementation of an integrated online platform that uses the open source information system DHIS2 (**Box 2.2**). Starting with rabies data, reporting, analysis, visualization and dissemination will be operationalized; data from the other neglected zoonotic diseases will gradually be added to facilitate open access and direct data entry and manipulation for endemic countries.

Linking the prevention and control objectives for emerging and endemic zoonoses would also support the attainment of SDG 3 which includes an enabling target (SDG 3.d) that aims to strengthen the capacity of countries "for early warning, risk reduction and management of national and global health risks", not only for those of international concern but equally for those related to "unattended diseases affecting developing countries".[1] Linking these objectives is also closely associated with SDG 3.8, which focuses on the UHC target (*19*).

In 2010, the OIE, the FAO, and WHO formed a tripartite coalition to combat zoonotic diseases using the One Health approach (*20*). Initial priorities for the coalition were to address resistance to antimicrobial medicines, zoonotic influenza and rabies. The aim of the coalition is to coordinate global activities to address health risks at the human–animal–ecosystem intersection, leading to a world capable of responding to risks to animals and public health, both endemic and emerging, that also impact food security and food safety. The coalition continues to coordinate activities around emerging and endemic veterinary public health–related issues through annual meetings and through direct collaboration in its daily work.

In 2016, the coalition jointly hosted a meeting with the Global Alliance for Rabies Control that was attended by public-health and veterinary public-health professionals from countries affected by rabies as well as other stakeholders (*21,22*). The meeting agreed a strategic framework for ending human deaths from dog-mediated rabies globally by 2030 (*23*).

Other developments in veterinary public health in 2016 include increased interactions between WHO–FAO–OIE and pharmaceutical companies to learn more about veterinary medicines in the pipeline, as well as to discuss needs and identify new products for human health. Discussions include donations of medicines but also the possibility of developing sustainable bulk procurement mechanisms for vaccines and antiparasitic medicines. Also notable is the development of a communications package

1. For more information, see http://www.who.int/mediacentre/events/meetings/2015/un-sustainable-development-summit/en/

that emphasizes the importance of WASH, with special attention paid to the interaction among animals, people and food.

The key areas for future action in veterinary public health activities are listed below.

- Proof-of-concept strategies must be designed to integrate the delivery of interventions that target multiple neglected zoonotic diseases or other diseases in animals. Such strategies might include delivering MDA for soil-transmitted helminth infections coupled with mass vaccination of domestic dogs against rabies in the United Republic of Tanzania; disseminating messages about animals, food hygiene and health through school curricula; conducting disease surveillance for intestinal parasites including *Taenia* species and other zoonotic intestinal parasites.
- Access to preventive measures that target the animal sources of a disease must be increased. For example, vaccines are available for echinococcosis and taeniasis but investment is required to support testing in endemic settings and to expand delivery. Vaccination has several advantages – for example, vaccinating pigs against *T. solium* can prevent cysticercosis. Vaccination will increase the health of pigs, leading to higher market prices for pigs and a higher value for pork in the food-value chain and, thus, higher revenues for farmers, but at the same time it contributes to breaking the transmission cycle and, thus, prevents epilepsy in humans that is associated with neurocysticercosis. Neurocysticercosis – the leading cause of preventable epilepsy worldwide – is an area in which veterinary public health is closely linked with mental health.
- Practicable mechanisms for closer intersectoral cooperation must be devised to build capacity for inter- and transdisciplinary know-how, and empower multiple stakeholders beyond the health sectors, all of which must be supported by rigorous monitoring and evaluation.
- Building community trust, engagement and ownership must be emphasized, as underscored in relation to the West African outbreak of Ebola virus disease (*24*). Regular, intersectoral interactions with all stakeholders to focus on One Health goals to reduce zoonotic risks can significantly contribute to building trust. These interactions can also provide a more stable, multisectoral platform for emergency responses and support the extra effort needed during the last stages of the eradication or elimination of a disease.
- The animal cycle and the environmental sources of infection and interventions must be addressed. These are linked to endemic zoonotic diseases and many other infectious diseases through various risk factors, such as unhygienic food preparation and storage, open defecation, and the use of contaminated water, including contaminated drinking-water. Thus, veterinary public health interventions never stand alone but are cross-cutting, involving other sectors and related areas, such as WASH and food safety.
- Guidance based on the best evidence available must be developed to improve and support standard care for persons affected by these diseases and streamlined into the health system; additionally, prevention and control strategies to ensure animal health and food safety must be integrated into delivery platforms.

- Research must aim to improve and develop more cost–effective tools for diagnosis and treatment; for example, using long-acting praziquantel to treat the adult echinococcosis worm in dogs could be coupled with rabies prevention programmes and improving surveillance and monitoring tools.

Veterinary public health not only provides a useful framework for addressing the zoonoses and animal cycles of transmission of NTDs, and the complex interactions among people, animals and the environment, but it is also useful for developing and implementing more equitable strategies for disease control and prevention. Powerful tools are available, but support – including implementation research – is needed to exploit their full potential. Increased investment in this area is also vital, with primary funding for neglected zoonotic diseases being the lowest among all of the NTDs.

2.6 Water, sanitation and hygiene

Providing safe water, sanitation and hygiene (known as WASH) is a key component of the global NTD strategy and is critical for preventing and providing care for most NTDs. Many of the pathogens that cause NTDs thrive where water and sanitation are inadequate. For example, water contaminated with faeces and urine can contain worm eggs that lead to the transmission of schistosomiasis (*25*). Similarly, poorly constructed latrines facilitate the breeding of the *Culex* mosquito, which transmits filarial parasites (the cause of lymphatic filariasis) to humans (*26*). WASH is particularly important for controlling schistosomiasis and soil-transmitted helminthiases, the ending of which are contingent on providing universal access to sanitation by 2030.

Reflecting the cross-sectoral nature of the challenge posed by unsafe water and inadequate sanitation and hygiene , and the fact that the WASH component of the NTD strategy has tended to be neglected relative to its importance, in August 2015 WHO launched a global strategy and action plan to integrate WASH with other public health interventions (*27*). The joint NTD–WASH strategy for 2015–2020 aims to intensify the control of, or eliminate, selected NTDs in specific regions by 2020. The strategy has four objectives: improving awareness of the benefits of implementing joint WASH and NTD actions; monitoring WASH and NTD actions to track progress; strengthening the evidence about how to deliver effective WASH interventions; and involving all stakeholders in planning, delivering and evaluating WASH and NTD programmes.

Since the publication of the strategy in 2015, the momentum for greater joint action between WASH and NTD control efforts has continued to grow, and it includes progress being made at the country level for trachoma, soil-transmitted helminthiases and schistosomiasis, diseases for which transmission is closely linked to poor water, sanitation and hygiene. Several countries, including Ethiopia, Sudan and Uganda, have set up coordinating platforms at the national, regional or district level that include ministries of health, water resources and education. In Cambodia and the Lao People's Democratic Republic, consultations between the NTD and WASH sectors improved the targeting of WASH efforts for communities affected by schistosomiasis and soil-transmitted helminthiases; and

many countries that have trachoma-elimination programmes – including Kenya, Malawi, Uganda and the United Republic of Tanzania – have introduced a robust WASH and trachoma planning process that is based on situational analyses conducted by both sectors.

In 2016, examples from more than one dozen countries were reported, and the lessons learnt have been documented and analysed to identify good practices and entry points for collaboration to improve the effectiveness and cost effectiveness of these programmes. Globally, collaboration continues to be sustained and encouraged through the sharing of experiences at meetings and conferences, resulting in a growing community of practice that includes the WHO Alliance for the Global Elimination of Trachoma by 2020, the annual meeting of the NTD Non-Governmental Development Organization, the Soil-Transmitted Helminthiases Advisory Committee, and World Water Week, as well as regional WASH forums.

New initiatives for mapping the endemicity of NTDs at district level and designing WASH indicators have involved greater consultation with stakeholders in response to the need for shared monitoring frameworks to incentivize joint planning and improve the targeting of interventions.

One of the four objectives of the strategy is to monitor WASH and NTD actions to "highlight inequalities, target investment, and track progress" (*27*). A set of core indicators that can be used consistently across programmes has been developed following an extensive expert review process. (See **section 4** for the operationalized NTD–WASH strategy for joint monitoring that could also satisfy reporting requirements under the SDGs.) Several organizations and countries have begun to incorporate WASH indicators into their monitoring frameworks.

Operational research to strengthen implementation of the facial cleanliness and environmental improvement components of the SAFE strategy to control trachoma (the acronym stands for surgery for trichiasis, antibiotics, facial cleanliness and environmental improvement) and to estimate the cost of integrated interventions has also been initiated. Mapping initiatives have been used to strengthen the evidence base and better understand the associations between WASH and trachoma. Similar efforts are under way to elucidate the role of WASH on the transmission patterns of soil-transmitted helminthiases and its implications for MDA. The design of guidance on WASH or NTDs has involved consultation between experts from both disciplines; training material and tools have also been developed.

Sustaining momentum on this joint initiative is critical, and as the great progress during 2016 has demonstrated, success is achievable when collaboration is prioritized and sufficient and sustainable resources are available (**Box 2.3**). Further efforts are needed to continue generating models of collaboration and to encourage the sharing of experiences and best practices. Capacity building is needed to equip NTD and WASH stakeholders to communicate and collaborate more effectively and to continue to engage actively. As new tools and experiences emerge, the vision of ending the suffering caused by NTDs is more attainable than ever.

Box 2.3. Coordinating WASH and NTD efforts in Ethiopia

Trachoma, soil-transmitted helminthiases and schistosomiasis are important public health problems in Ethiopia. Large-scale implementation of the SAFE strategy to prevent trachoma as well as MDA against soil-transmitted helminth infections, schistosomiasis and lymphatic filariasis are being implemented through the national programme, led by the Ministry of Health, which is coordinating support from multiple donors and agencies.

Significant efforts have also been made towards providing universal access to clean water and sanitation facilities in the country through multisectoral action undertaken with the launch of the One WASH national programme in 2013. This initiative brings together different ministries and development partners to deliver WASH (water, sanitation and hygiene) services to underserved populations in the country.

Building on the momentum provided by NTD-control initiatives and the One WASH programme, recent efforts by the national programme have centred on strengthening collaboration between the two programmes, including undertaking joint situational analyses and a series of organizing workshops and symposia to support coordinated implementation and monitoring – for example, behavioural change campaigns implemented as part of One WASH incorporate NTD-specific messages, and there have been efforts to improve the coordination of One WASH and NTD activities in schools.

2.7 Conclusions

This section has described the principal developments relative to the five key interventions employed to tackle NTDs. Integrated MDA with preventive chemotherapy stands out, both in terms of its effectiveness as a strategy against certain NTDs and the resources going into it, the two things being related, of course. Clearly, however, each of the interventions described in this section is vitally important, and going forward it is essential to ensure that each receives the attention it merits and the resources it requires. Vector ecology and management is particularly important, being woefully underresourced despite its crucial importance, notably in response to outbreaks.

As programmes move towards the latter stages of elimination campaigns, priorities will shift – for example, by putting greater emphasis on intensified surveillance and targeted interventions to focus on the remaining pockets of disease (*28*). This has implications for all of the interventions described here, and it will drive a trend towards greater integration among programmes, especially with vector ecology and management. The global integration of vector control efforts is a core aim of the Global Vector Control Response, two of the pillars of which are the strengthening of inter- and intrasectoral action and collaboration, and the expansion and integration of vector-control tools and approaches.

The SDGs' focus on UHC, for which an explicit target has been set (SDG 3.8), is also likely to change the way key interventions are supported, especially innovative and intensified disease management. Even if all NTD elimination targets are attained by 2030, millions of people living with chronic debilitating, disabling and disfiguring conditions as a consequence of NTD infection will continue to require medical intervention, ranging from medicines to surgery (*9*). It is to be hoped that some of this burden will be taken up by long-term capacity building and health system–wide reforms. A large part of the response will depend on health systems stepping up to meet demands for services as part of their transition towards UHC (*29*).

References

1. Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation [Roadmap approved by the Strategic and Technical Advisory Group for Neglected Tropical Diseases in 2011]. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/2012.2; http://www.who.int/neglected_diseases/NTD_RoadMap_2012_Fullversion.pdf).
2. Transforming our world: the 2030 Agenda for Sustainable Development [A/RES/70/1]. New York (NY): United Nations General Assembly; 2015 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).
3. Preventive chemotherapy in human helminthiasis. Coordinated use of anthelminthic drugs in control interventions: a manual for health professionals and programme managers. Geneva: World Health Organization; 2006 (http://apps.who.int/iris/bitstream/10665/43545/1/9241547103_eng.pdf).
4. The London Declaration on neglected tropical diseases. Uniting to Combat NTDs; 2012 (http://unitingtocombatntds.org/resource/london-declaration, accessed 13 March 2017).
5. Strengthening the assessment of lymphatic filariasis transmission and documenting the achievement of elimination. Geneva: World Health Organization; 2014 (WHO/HTM/NTD/PCT/2016.09; http://apps.who.int/iris/bitstream/10665/246176/1/9789241508797-eng.pdf).
6. Validation of elimination of trachoma as a public health problem. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/2016.8; http://apps.who.int/iris/bitstream/10665/208901/1/WHO-HTM-NTD-2016.8-eng.pdf).
7. Resolution WHA69.21. Addressing the burden of mycetoma. In: Sixty-ninth World Health Assembly. Geneva, 23–28 May 2016. Resolutions and decisions, annexes. Geneva: World Health Organization; 2016; 25 (WHA69/2016/REC/1; http://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_R21-en.pdf).
8. Mitjà O, Marks M, Bertran L, Kollie K, Argaw D, Fahal AH et al. Integrated control and management of neglected tropical skin diseases. PLOS Negl Trop Dis. 2016;11:1–13. doi:10.1371/journal.pntd.0005136.
9. Gyapong JO, Gyapong M, Yellu N, Anakwah K, Amofah, Bockarie M et al. Integration of control of neglected tropical diseases into health-care systems: challenges and opportunities. Lancet. 2010;375:160–5. doi.org/10.1016/S0140-6736(09)61249-6.
10. Hay RJ, Johns EN, Williams HC, Bolliger IW, Dellavalle RP, Margolis DJ et al. The global burden of skin disease in 2010: an analysis of the prevalence and impact of skin conditions. J Invest Dermatol. 2014;134:1527–34.
11. Walsh DS, De Jong BC, Meyers WM, Portaels F. Leprosy and Buruli ulcer: similarities suggest combining control and prevention of disability strategies in countries endemic for both diseases. Lepr Rev. 2015;86:1–5 (http://www.lepra.org.uk/platforms/lepra/files/lr/Mar15/1962.pdf).
12. Engelman D, Fuller LC, Solomon AW, McCarthy JS, Hay RJ, Lammie PJ et al. Opportunities for integrated control of neglected tropical diseases that affect the skin. Trends Parasitol. 2016;32:843–54. doi.org/10.1016/j.pt.2016.08.005.
13. Draft global vector control response 2017–2030. Geneva: World Health Organization; 2016 (http://www.who.int/malaria/areas/vector_control/Draft-WHO-GVCR-2017-2030.pdf).

14. Vector surveillance and control at ports, airports, and ground crossings. Geneva: World Health Organization; 2016 (http://apps.who.int/iris/bitstream/10665/204660/1/9789241549592_eng.pdf).
15. One Health: history [website]. Atlanta (GA): United States Centers for Disease Control and Prevention (http://www.cdc.gov/onehealth/basics/history/index.html, accessed 13 March 2017).
16. Grace D, Mutua F, Ochungo P, Kruska R, Jones K, Brierley L et al. Mapping of poverty and likely zoonoses hotspots [Zoonoses Project 4]. Report to the UK Department for international Development. Nairobi (Kenya): International Livestock Research Institute (https://cgspace.cgiar.org/handle/10568/21161).
17. Molyneux D, Hallaj Z, Keusch GT, McManus DP, Ngowi H, Cleaveland S et al. Zoonoses and marginalised infectious diseases of poverty: where do we stand? Parasit Vectors. 2011;4:106. doi:10.1186/1756-3305-4-106.
18. Cleaveland S et al. One Health contributions towards more effective and equitable approaches to health in low- and middle-income countries; Phil Trans R Soc Lond B Biol Sci. 2017 [in press].
19. Health in 2015: from MDGs, Millennium Development Goals, to SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf).
20. Sharing responsibilities and coordinating global activities to address health risks at the animal–human–ecosystems interfaces: a tripartite concept note. Rome–Paris–Geneva: the FAO–OIE–WHO Collaboration; 2010 (http://www.who.int/foodsafety/zoonoses/final_concept_note_Hanoi.pdf).
21. Lembo T, Attlan M, Bourhy H, Cleaveland S, Costa P, de Balogh K et al. Renewed global partnerships and redesigned roadmaps for rabies prevention and control. Vet Med Int. 2011;923149. doi:10.4061/2011/923149.
22. FAO, OIE and WHO unite in their goal to eliminate human rabies and control the disease in animals [web release]. Geneva: World Health Organization; 2013 (http://www.who.int/neglected_diseases/WRD_rabies_2013/en/index.html; accessed 13 March 2017).
23. Global elimination of dog-mediated human rabies: report of the rabies global conference, 10–11 December 2015. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/NZD/2016.02; http://apps.who.int/iris/bitstream/10665/204621/1/WHO_HTM_NTD_NZD_2016.02_eng.pdf).
24. High level meeting on building resilient systems for health in Ebola-affected countries: report of a meeting, 10–11 December 2014. Geneva: World Health Organization; 2014 (http://www.who.int/mediacentre/events/meetings/2014/ebola-health-systems/en/).
25. Bain R, Cronk R, Wright J, Yang H, Slaymaker T, Bartram J. Fecal contamination of drinking-water in low- and middle-income countries: a systematic review and meta-analysis. PLoS Med. 2014;11:e1001644. doi:10.1371/journal.pmed.1001644.
26. Castro MC, Kanamori S, Kannady K, Mkude S, Killeen GF, Fillinger U. The importance of drains for the larval development of lymphatic filariasis and malaria vectors in Dar es Salaam, United Republic of Tanzania. PLoS Negl Trop Dis. 2010;4:e693. doi:10.1371/journal.pntd.0000693.
27. Water sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/182735/1/WHO_FWC_WSH_15.12_eng.pdf).

28. Macpherson E, Adams ER, Bockarie MJ, Hollingsworth DT, Kelly-Hope LA, Lehane M et al. Mass drug administration and beyond: how can we strengthen health systems to deliver complex interventions to eliminate neglected tropical diseases? BMC Proc. 2015;9(Suppl 10):S7. doi:10.1186/1753-6561-9-S10-S7.

29. Investing to overcome the global impact of neglected tropical diseases: third WHO report on neglected diseases. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/2015.1; http://apps.who.int/iris/bitstream/10665/152781/1/9789241564861_eng.pdf).

BEYOND 2020

THE CHANGING NTD LANDSCAPE

As diseases start to recede and MDA is reduced, programmes will begin to focus resources on areas and populations most at-risk and affected.

This will require engaging in highly targeted monitoring in areas that continue to be at risk.

Also key to attaining the 2030 SDG elimination target is ensuring that data gathering is seen as a core activity that can be used to track progress.

Greater efforts will also focus on vector control and environmental factors.

3. Beyond 2020: the changing NTD landscape

3.1 Introduction

As NTDs recede, the challenges that they present change. The progress that will be made during the next 4 years (2017–2020) will continue to inform that evolution. This process will not come to an abrupt halt in 2020, but will continue into the following decade. This section focuses on the possible core elements of a strategic vision for NTDs after 2020.

As programmes move towards the latter stages of elimination campaigns, disease is still present but at reduced levels, a phase sometimes referred to as "the endgame" (*1*). During the endgame, priorities shift from extending the reach of interventions to meet the high coverage levels needed to attain elimination targets to using intensified surveillance and targeted interventions to focus on the remaining pockets of disease (*2*).

However, the endgame means different things for different diseases, and progress towards the endgame varies enormously from programme to programme. Some programmes – notably those to eliminate echinococcosis and taeniasis – are still defining the size and nature of the challenges they face and developing the strategies required to address them; for these programmes, discussions of endgame strategies are premature. For others, such discussions are not only pertinent but required, including programmes to eliminate human African trypanosomiasis, visceral leishmaniasis (in South-East Asia) and lymphatic filariasis.

The challenges after 2020 can be broken down into two broad missions: (i) eliminating NTD transmission and (ii) ensuring that health services meet the needs of those living with NTD-related disease. Both missions are reflected in the 2030 Agenda for Sustainable Development, namely SDG 3.3 ("end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, waterborne diseases and other communicable diseases") and SDG 3.8 ("achieve universal health coverage, including financial risk protection, access to quality essential health care services and access to safe, effective, quality and affordable essential medicines and vaccines for all.").

The most obvious example of how elimination efforts will change over time is in the use of MDA for preventive chemotherapy, the delivery of which is already being reduced in some countries and will eventually be reduced in all. However, MDA will remain a core intervention well into the next decade, and reducing MDA delivery will be a protracted process that needs to be undertaken with the greatest care. This phase will rely heavily on assessing the impact of MDA or preventive chemotherapy on the prevalence of infection as defined for each targeted disease. In all cases, reducing the delivery of MDA by programmes will lead to local health systems partially or fully taking responsibility for these functions and services, and this change will give rise to its own challenges.

Ensuring that those who need care for NTD-related disease receive appropriate care will require long-term efforts to build capacity and bring about health system–wide reform. These efforts will largely depend on health systems becoming able to meet the demands for services as they transition towards UHC (*3*). Although making that transition depends fundamentally on good governance and national resources being committed to it, there is much that NTD programmes can do to support it.

3.2 Eliminating transmission

Ending the transmission of NTDs will require prioritizing several key areas, starting with ensuring there is optimal coverage of high-impact interventions that have demonstrated their efficacy during the past 10 years. The goal will be not only to consolidate the progress made but also to avoid major reversals in trends towards elimination. Among those high-impact interventions, MDA looms large. As coverage goals are met and transmission levels fall, it will be necessary to reduce MDA, a task to be undertaken carefully because MDA is used to target multiple diseases simultaneously. After MDA is reduced, it will be important to focus efforts on the areas and populations most at-risk and affected, including those that have been overlooked in the past.

3.2.1 Mass drug administration after 2020

The 2020 Roadmap target aims to ensure that at least 75% of people who need preventive chemotherapy receive it. Assuming this goal is reached and that the global burden of NTDs declines, it will be possible to reduce MDA activities and divert resources to priority areas as countries transition from MDA delivery to post-MDA surveillance.

This process has already begun for some programmes, and valuable lessons are being learned. For example, the Global Programme to Eliminate Lymphatic Filariasis, which now reaches 59.3% of the total population requiring MDA, has started cutting back activities. Because the criteria for stopping MDA were met in more than 30% of endemic districts, 315 million individuals no longer require it. Of the 73 countries where lymphatic filariasis is endemic, 18 have already stopped MDA nationally and are under post-MDA surveillance, and at least 1 implementation unit has stopped MDA in 44 countries.

However, in 29 countries MDA has not reached all endemic areas, including 9 countries that had not started delivering MDA by 2015. Alternative MDA strategies

are being considered that could help these countries make up for lost time, but under the current strategy, which requires at least five rounds of MDA, by the end of 2020 only 45% of countries may be in a position to stop MDA nationally. However, MDA will be significantly reduced in countries that have not reached that milestone. In 2015, 248.8 million persons lived in implementation units in endemic areas that were not yet covered by MDA and, therefore, are considered likely to require MDA after 2020 (*4*). This scenario means that by 2020, an 80% reduction in the population requiring MDA is possible. Improving this outlook requires additional investments, such as financing for expanded implementation of preventive chemotherapy, research into alternative MDA strategies, and the implementation of TAS.

It is evident that MDA will continue to be a core intervention well into the next decade, even for programmes that have made good progress, such as those targeting onchocerciasis, trachoma and schistosomiasis. Overall, the coverage of MDA is 62.9% of people who require preventive chemotherapy for at least one NTD.

MDA will continue to be a core intervention well into the next decade, even for programmes that have made good progress.

In some cases, MDA implementation has been beset by problems with the supply of medicines. One of the main obstacles to expanding MDA for schistosomiasis Is the so-called "praziquantel gap". In 2016, 285 million praziquantel tablets were available, but in 2017 it is likely that there will be only 263 million, which is less than 50% of the amount required to treat all of the people who need preventive chemotherapy for the disease. Of particular concern is the increase in praziquantel donations to the promised 250 million tablets per year coinciding with a decrease in donations from other sources (apparently due to a lack of funds) and the expansion of national programmes.

In other instances, programmes have yet to reach the level of disease mapping required to implement effective MDA. This is true of foodborne trematodiases, for which MDA is one of the core control interventions. The lack of the crucial epidemiological information required to delineate endemic areas of diseases that are highly focalized in occurrence (*5*) has meant that populations affected by these diseases frequently have no access to MDA. The development and standardization of serological and molecular diagnostic tools that allow better identification of affected individuals may sharpen the focus on NTDs and, thus, support MDA implementation.

MDA strategies will also need to be adjusted to accelerate the progress being made towards achieving elimination goals. In some instances, this will include increasing the frequency of MDA. For example, it has been proposed that MDA of ivermectin for onchocerciasis should take place twice yearly in Africa (*6*) and that albendazole should be administered twice yearly for lymphatic filariasis in areas where *Loa loa* infection is co-endemic (*7,8*). The future expansion of chemotherapeutic interventions for schistosomiasis may be greatly enhanced by the introduction of paediatric formulations of praziquantel. These are being developed, and their use in the future will allow for preschool-aged children to be included in programmes delivering preventive chemotherapy (*9,10*). As new chemotherapies become available, including new ways to use old medicines, it will be necessary to update recommended medicines. For example, new treatments are emerging for onchocerciasis (*11*), lymphatic filariasis (*12*) and human African trypanosomiasis (*13*).

3.2.2 Reducing mass drug administration

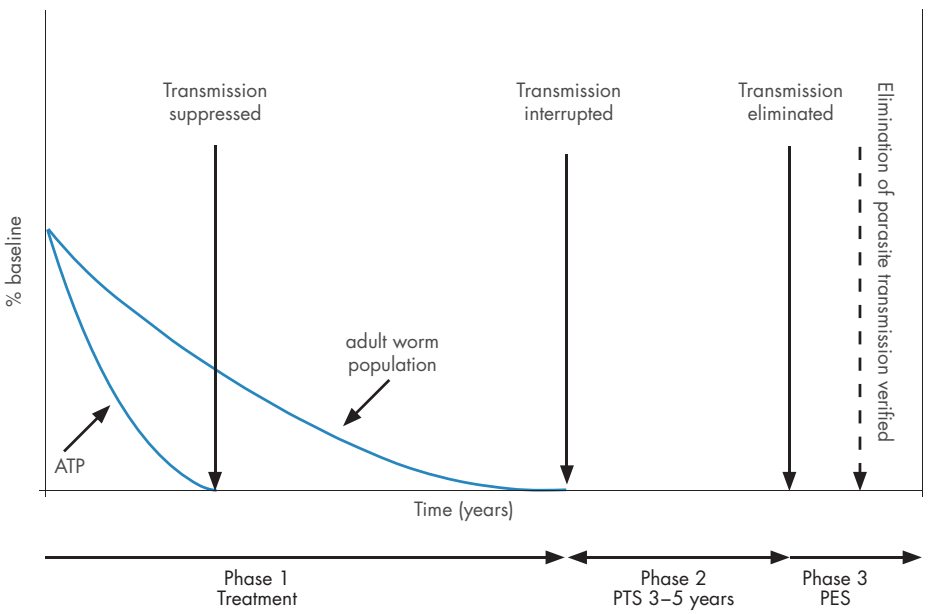
Cutting back on MDA typically takes several years and requires careful management and monitoring. WHO's guidelines on stopping MDA for human onchocerciasis and verifying its elimination, which were released in early 2016, outline the steps required (*14*); the guidelines also offer guidance on stopping MDA and transitioning to post-treatment surveillance and, finally, to post-elimination surveillance (Fig. 3.1).

Because of the integrated nature of MDA, the planning and timing for reducing delivery must take into account collateral impacts on other programmes.

Because of the integrated nature of MDA, the planning and timing of reductions in MDA are demanding: collateral impacts on other disease programmes must be considered. For example, by the early 2020s, the elimination programmes for lymphatic filariasis will have probably reached their targets, and the extensive annual campaigns that provide part of the infrastructure that is also used to treat children to prevent soil-transmitted helminthiases will be phased out. Therefore, it will be essential to ensure that the progressive reduction of GPELF takes into account the need to maintain preventive coverage for soil-transmitted helminthiases, which also relies on albendazole and mebendazole. GPELF provides an important platform for distributing albendazole, accounting for 32% of the albendazole treatment delivered to school-aged children worldwide.

The effects of discontinuing MDA for lymphatic filariasis must be carefully analysed, and remedial action must be taken to ensure that deworming coverage is maintained (*15*). For example, India has made significant progress and stopped MDA in 72 districts. This discontinuation of preventive chemotherapy will have only a marginal impact on the coverage of treatment for soil-transmitted helminthiases in children because a

Fig. 3.1. Phases in the elimination of human onchocerciasis.

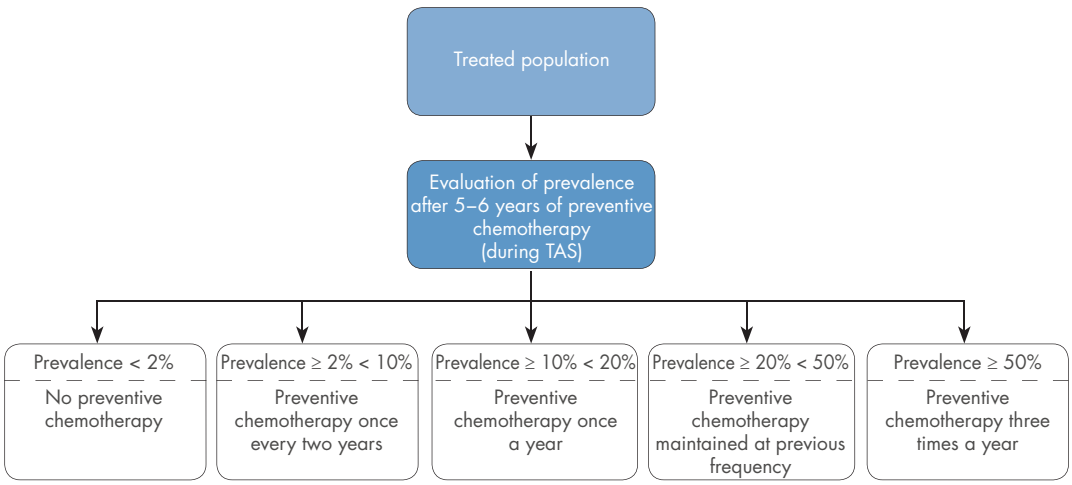


ATP, annual transmission potential; PES, post-elimination surveillance ; PTS, post-treatment surveillance
Source: reference *14*

national school deworming programme has been established. The expected, progressive reductions in the Global Polio Eradication Initiative may also impact MDA coverage for soil-transmitted helminthiases. The Initiative enables the distribution of around 60% of all albendazole treatments to preschool-aged children, so it will be important to assess the impact of discontinuing financial support for child health days and immunization days after poliomyelitis has been eradicated.

Another challenge that will have to be faced as MDA is reduced is the transfer of responsibility for programme activities to the health system as part of the transition to UHC, especially responsibilities for maintaining surveillance and managing morbidity. Key to achieving this transfer will be to reduce the cost of the relevant interventions and to ensure that the widespread NTD intervention campaigns are part of the transition to UHC. The main costs in MDA programmes are the costs of training personnel, procuring medicine, distributing medicine and engaging in monitoring activities. It is expected that training costs will plummet as programmes mature, but to keep costs down in other areas it will be necessary to maintain medicine donations at current (2016) levels and, once low levels of prevalence and intensity are reached, reduce the frequency of MDA. It will also be important to institutionalize MDA where possible, for example by routinely providing preventive chemotherapy to all children entering their first year of primary school and during their last year of primary school. As an example, a decision tree for soil-transmitted helminthiases based on TAS results has been published to support this process (Fig. 3.2) (*16*).

Fig. 3.2. Treatment options for soil-transmitted helminthiases, by prevalence rates found using a transmission assessment survey (TAS)



Source: reference *16*

Finally, it is essential to recognize the importance of non-health-sector determinants of health when considering the timing for reducing MDA. For several NTDs for which MDA is the primary intervention, the only definitive way to reduce transmission in the long term is to tackle vector-control and water and sanitation issues (using WASH strategies). Notwithstanding the renewed focus on water, sanitation and hygiene that is expected to occur as a result of SDG 6 – which aims to "ensure availability and sustainable management of water and sanitation for all" – the lack of adequate sanitation, a key driver of transmission for soil-transmitted helminthiases among other NTDs, is expected to continue to be a problem after 2020 in many countries in which NTDs are endemic. For this reason, there is a good possibility that within a few years of ending programmes aimed at soil-transmitted helminthiases, the prevalence will return to pre-MDA levels (*15*). Therefore, decisions on reducing MDA, including when reductions should start, should consider whether adequate coverage levels have been achieved by WASH interventions. The same is true of coverage levels for vector-control interventions.

3.3 Approaching the endgame

As NTDs recede and mass treatment interventions are cut back, programmes will prioritize the areas and populations most at-risk and affected, including those who have been overlooked in the past. Effectively focusing resources will require ramping-up monitoring and surveillance efforts to provide more granular data and building robust, integrated information systems.

Reaching populations and subgroups that either have been passed over or are beyond the reach of disease programmes will be key to achieving the 2030 target for the Sustainable Development Goals.

3.3.1 Focusing on specific areas and populations

Reaching populations and subgroups that either have been passed over or are beyond the reach of disease programmes will be key to achieving the 2030 target for the SDGs. Making sure that specific areas or populations are reached not only ensures equity but also helps optimize the use of limited resources as programmes wind down.

Stamping out the last transmission hot spots is not a simple task, as demonstrated by the experiences of the dracunculiasis eradication campaign. However, as daunting as the task may be, it is essential that momentum be maintained until the very end. The danger posed by residual foci acting as reservoirs of disease transmission that can spread into areas from which the disease has been eliminated is real, especially for vector-borne diseases and zoonoses. The history of infectious disease campaigns includes too many examples of resurgent NTDs. Within the sphere of NTDs, yaws (endemic treponematoses) is an obvious example; mass treatment campaigns led by WHO and UNICEF between 1952 and 1964 reduced the worldwide prevalence of treponematoses from 50 million to 2.5 million (*17*) but momentum was not carried through to complete eradication and the disease resurged in the 1970s.

Usually, the populations that have been hard to reach and, thus, require targeting are isolated for one or more of four main reasons: they live in remote or otherwise inaccessible places; they are socially marginalized; they are on the move; or they live in conflict zones. In most settings, these factors interact (for example, people in conflict zones are often forced to move), and frequently several factors are in play.

3.3.2 Geography and topography

Many NTDs are widely distributed, affecting large numbers of people, some of whom live in remote locations that are extremely difficult to access. This is true, for example, of lymphatic filariasis: progress has been hampered by the difficulty of getting into mountainous and swampy regions, and areas of dense forest (*18*,*19*). Similarly, persistent foci of human African trypanosomiasis in West Africa are associated with the difficulties of reaching people living in extensive mangrove swamps (*20*). For Chagas disease, inaccessible areas include the Gran Chaco region (which covers parts of Argentina, the Plurinational State of Bolivia, Brazil and Paraguay), the frontier between El Salvador and Guatemala (which has seen the highest number of acute cases in recent years), and the Amazon basin (which has seen outbreaks of foodborne transmission with high mortality rates). Human rabies transmission mediated by vampire bats is a public health issue of particular concern in the remote Amazonian regions of Brazil, Colombia and Peru, where access to appropriate medical treatment is limited.

In order to "ensure healthy lives and promote well-being for all at all ages" (SDG 3, known as the health goal), it will be necessary to access these areas and implement surveillance and context-specific interventions, such as chemotherapy, environmental management and vector control. As the endgame approaches, the last bastions of disease are likely to be the hardest to reach geographically. Delivering services to such areas will require political commitment (which must be maintained in the face of a declining sense of urgency about diseases that may be perceived as no longer a threat), continued donor and partnership support, and the participation and engagement of affected communities.

3.3.3 Marginalization

NTDs, as diseases of poverty, are all diseases of economic marginalization, but some diseases lead to specific kinds of exclusion that keep people from accessing the treatment they need and also create transmission hot spots. The psychosocial aspects of stigmatization associated with disfiguring NTDs are well documented, but there is also evidence that stigmatization impacts help-seeking behaviour and treatment adherence (*21*,*22*).

The age-old stigmatization associated with leprosy has been well documented and remains an obstacle to self-reporting and early treatment. Going into the next decade, programmes will need to focus on initiatives that encourage social inclusion, similar to those undertaken by the Sri Lankan Ministry of Health in the 1990s; these initiatives included a communication strategy that reduced the stigmatization attached to leprosy and facilitated a shift from reactions of fear and loathing to understanding and compassion (*23*). It will also be essential to ensure there is increased empowerment of people affected by a disease, and greater engagement of communities.

Those who are living with leprosy are not the only population affected by stigmatization, others include people living with Buruli ulcer, Chagas disease, cutaneous leishmaniasis, lymphatic filariasis and onchocerciasis. There are commonalities in the reasons for and nature of the stigmatization applied to all of these diseases and an integrated approach may reduce stigmatization (*24*).

3.3.4 Conflict

Conflict is a significant obstacle to making progress towards elimination goals. It contributes to the destruction of health systems that might otherwise provide services, discourages donor-supported programmes from going where they are needed, and causes movements of people that spread diseases and make it impossible to target interventions or track the progress of those interventions. Ongoing conflicts in Mali and South Sudan have led to population displacement both within and outside the borders of these countries, thus hampering progress towards eradicating dracunculiasis and controlling visceral leishmaniasis. Conflict has relevance for many other NTDs too. Progress on eliminating human African trypanosomiasis has been hampered by insecurity in the Central African Republic and South Sudan. Several areas of onchocerciasis transmission in WHO's African and Eastern Mediterranean Regions are located in unstable post-conflict areas and areas where conflict is continuing. Conflict in the Eastern Mediterranean Region has also hampered efforts to control soil-transmitted helminthiases and schistosomiasis. It has led to the re-emergence of infection and widespread outbreaks of cutaneous leishmaniasis in the Syrian Arab Republic and neighbouring countries.

Detecting infection or disease at very low levels is not only harder, it is also often carried out in contexts of declining support and motivation.

3.3.5 Migration

Diseases may travel with mobile populations. Migration may introduce a disease to urban areas and then spread it further, thus posing challenges to diagnosis and care for those infected with an NTD, such as Chagas disease, which was once most likely to be found in Latin America. The exchange of populations between Latin America and the rest of the world, mainly for economic reasons, has led to the disease being detected in Canada, the United States of America, and up to 17 European and two Western Pacific countries (*25*). WHO's strategy for Chagas disease recognizes the importance of providing services to travellers and immigrants from endemic countries but acknowledges the difficulty of doing so.

3.3.6 Surveillance

Data gathering and analysis is a vital part of elimination and control campaigns at all stages of their evolution, not least during the endgame when it serves to identify the remaining cases, helps measure, monitor and map diseases and assess the uptake of vaccines or medicines, and is used to detect the emergence of resistance (*1*). Although the implementation of surveillance is always demanding, particular challenges arise as campaigns move towards the endgame. For example, not only does detecting a very low prevalence of infection or disease require greater vigilance, as well as more accurate detection methods, it is also often carried out in the contexts of declining support and motivation. Simply put, as the threat of infection diminishes or is perceived to diminish, so does the will, including the political will and donor and community commitment and awareness to sustain progresses.

Almost all NTD programmes, whatever their stage of development, struggle with surveillance challenges. This is the case for Buruli ulcer, Chagas disease, cutaneous leishmaniasis, dengue, echinococcosis and onchocerciasis. Dengue surveillance varies from country to country and current tools to diagnose the disease are insufficient. The concurrent distribution of chikungunya and Zika viruses which share clinical symptoms, further hamper accurate detection. Currently, burden estimation relies on modelling studies, one of which generated an estimate of 390 million dengue infections per year (95% credibility interval, 284–528 million), of which 96 million (95% credibility interval, 67–136 million) manifest clinically (with any severity of disease) (*26*). Another study of dengue prevalence estimated that 3.9 billion people in 128 countries are at risk of infection with dengue virus (*27*).

The 2020 Roadmap target calls for dengue control and surveillance systems to be enhanced or established in all WHO regions. Regions and Member States have now adopted the strategy, and work plans have been developed at the regional level that align with global objectives. However, there is much to be done, as evidenced by a survey undertaken in Brazil that revealed a substantial underestimate of the disease burden during what are usually considered to be periods of low transmission (*28*). Underreporting was attributed to relying on passive case detection, which does not identify people with dengue who do not seek health care (*29*). However, the same survey showed that surveillance also failed to detect dengue cases among symptomatic patients who did seek health care.

Dengue in the African Region is of serious concern and needs to be included in existing surveillance systems to map the distribution of the disease and its vectors and to develop policy at the country level. WHO has received a grant from the Bill & Melinda Gates Foundation to estimate the burden of dengue in selected countries and to design methods and guidelines for dengue surveillance that would be adopted by Member States. Studies to estimate the disease burden have been completed in five countries and are in progress in five others, including the African Region.

Surveillance tools, such as active syndromic surveillance, monitor the clinical signs and symptoms (the syndrome) recorded for patients at medical facilities and should be applied to improve the estimates of dengue prevalence. Point-of-care testing should also be used for dengue infection. Improved surveillance and laboratory diagnostics are also needed to avoid the misclassification and mismanagement of cases, particularly in light of the recent emergence of the chikungunya and Zika viruses (*30*).

The lack of reliable epidemiological data had previously been also a major problem for trachoma, but the Global Trachoma Mapping Project (*31,32*) completed in January 2016, has changed that. The Project revealed not only that public health interventions are required to eliminate trachoma for 100 million people living in areas that were previously only suspected to be endemic but also showed where efforts need to be focused. Through the Project, the estimated global population considered to be at risk has risen to 192 million. Areas identified for increased focus include Ethiopia, where approximately 39% of the people considered to be at risk of trachoma live. The project also identified areas where resources can now be saved, such as Cambodia and the Lao People's Democratic Republic, because trachoma is no longer a public health problem and will not require widespread treatment.

Although establishing solid baseline estimates is crucial during the initial stages of NTD programmes, as they progress towards the endgame, the surveillance challenges will change. One challenge will be to track progress in remote areas. For instance, the only area with ongoing transmission of onchocerciasis in the Americas is believed to be the Yanomami area (*33*), which straddles the border between Brazil and the Bolivarian Republic of Venezuela, is remote, and has a highly mobile population.

Similarly, Chagas disease will have to be tracked into the remote reaches of the Amazon basin. In Brazil alone, the Amazon region occupies 4 871 500 km^2 (or 57% of its national territory) and contains the largest river complex in the world. Disease surveillance is particularly challenging in the region because of the immense areas involved, the difficulty of the terrain encountered, and the widely dispersed communities. Key areas of focus for the Chagas disease programme are maintaining disease-free geographical territories, preventing transmission, and detecting any re-emergence of the disease in regions where transmission is thought to have been interrupted. Countries in the Amazon basin are implementing surveillance interventions that include information, education and communication activities; early detection of cases through community health workers or professional caregivers in health centres; and diagnosis of *T. cruzi* infection in malarial blood films. Key interventions include visits to homes by health workers, as well as epidemiological investigation of the presence of triatomine bugs and reservoirs in targeted dwellings and their surroundings. Particular attention is focused on transmission involving sylvatic rather than domestic transmission cycles, particularly those linked to harvesting fruits or other plant products, and fishing or hunting. Indeed, transmission frequently includes local microepidemics of orally transmitted infection, and tracking these will require innovative surveillance approaches (*34*).

Integration of activities with other programmes and or health systems will be key to improving NTD surveillance.

The surveillance challenges are different for human African trypanosomiasis, but opportunities for integration will also be sought. As described in **section 5.8**, these programmes have made considerable progress during the past decade, with 2804 cases reported in 2015, down from 26 574 reported in 2000 (*35*), most of which (84% in 2014) occurred in the Democratic Republic of the Congo (*36*). Generally speaking, areas where there is still a high risk of transmission have been identified, and going forward the focus will be on maintaining a functional, integrated, reactive surveillance system by using the sentinel sites established in the areas where transmission has declined. Thus, as with Chagas disease, integration with other programmes or other parts of the health system, or both, will be key to maintaining or enhancing surveillance. However, achieving integration with the relevant health systems will be challenging given the weaknesses of peripheral health systems in countries where the disease is endemic. Therefore, any efforts that focus on strengthening the capacities of health systems, especially efforts focused on rural areas, will also support the sustainable elimination of human African trypanosomiasis (*37*).

Where zoonotic vectors are involved, the surveillance challenge includes finding opportunities for integration with animal health services. Rabies surveillance poses a number of challenges, including the perception that it is no longer a public health problem in Latin America (*38*). Because of this perception, rabies surveillance is virtually non-existent in many settings. Therefore, it is crucial that countries and their development partners invest in expanding monitoring capacity to capture human exposure to rabies, thus ensuring immediate reporting of suspected and confirmed cases from the local level (as reported by the diagnosing physician and laboratory) to the intermediate and central levels.

3.3.7 The need for innovation

Advancing the surveillance agenda depends on innovations in diagnostic tools (Box 3.1) as well as in research and development (Box 3.2). Relative to other health programmes, NTD programmes are constrained by having the smallest number of products with which to conduct surveillance, including diagnostic products, and, along with maternal and child health programmes, having the smallest number of products in the pipeline (*39*). As of 2015, most of the potential tools are in the early stages of development, and it will be some time before any of them reach the market.

All programmes require better diagnostic systems. For example, human African trypanosomiasis and visceral leishmaniasis require diagnostic tools sensitive enough to identify asymptomatic individuals or those with early infection, as well as to identify resistance to medicines; devices are also needed to monitor patients' responses to treatment and inform patients' care. Rapid diagnostic tests for visceral leishmaniasis in east Africa and Latin America need improved sensitivity and specificity. Because of the conditions encountered in the field, it will be important for devices to be portable, simple to use and robust enough to withstand heat and humidity; they will also need to use minimally invasive sampling methods (*40*).

Examples of minimally invasive devices include the Ov–16 rapid diagnostic test (SD BIOLINE Onchocerciasis IgG4 rapid test) that was developed to detect onchocerciasis. The test which can be performed on finger-prick blood samples, determines the presence of immunoglobulin G4 antibodies to the antigen Ov–16, and is useful for detecting exposure to the *Onchocerca volvulus* parasite. The test replaces the skin snip biopsies that are insufficiently sensitive in low-transmission settings (*41*). Mapping onchocerciasis in low-transmission areas using the Ov–16 rapid diagnostic test is under way in WHO's African and Eastern Mediterranean Regions.

Progress has also been made in developing a rapid point-of-care diagnostic test for Buruli ulcer. One innovation – the direct detection of the toxin mycolactone using thin-layer chromatography in human tissues – may offer a simpler, faster and less expensive way to confirm suspected cases of Buruli ulcer; thus, this test could replace current diagnostic methods that require reference laboratories. Studies are in progress in Benin, the Democratic Republic of the Congo and Ghana to assess the feasibility of using this technique at the district level. Other diagnostic tests are in development, but progress has been hampered by technical hitches (*42,43,44*).

Another diagnostic method that may make a difference to surveillance accurately identifies individuals with elevated loads of *Loa loa* microfilariae. To date, lymphatic filariasis and onchocerciasis elimination campaigns have been beset by unacceptably high numbers of severe adverse events occurring following ivermectin treatment in individuals with high loads of *L. loa* microfilariae. Although lymphatic filariasis programmes have devised an alternative strategy (that is, treatment with albendazole twice each year), onchocerciasis programmes have not. The LoaScope, which turns a smartphone into an automated microscope, appears to be able to rapidly identify individuals to whom it would be safe to give ivermectin. More work is needed to determine whether the technology can be used on a programmatic scale. Other researchers are investigating an antigen unique to *L. loa* microfilariae that can be detected in blood and urine and could form the basis for an assay. Further work will be needed to establish its usefulness in the field (*45*).

The global yaws programme is also focused on developing new diagnostics, notably a nontreponemal luminex assay that is part of a multiplex assay for NTDs in general and could also be used to determine baseline and impact measures of MDA. A recent study has suggested that a treponemal membrane protein can be used as an antigen marker for recent or active infection; this finding could lead to the development of an assay that would replace the rapid plasma reagin test in a high-throughput multiplex tool and this could enable widespread yaws surveillance (*46*).

The global trachoma programme is also calling for research into alternative diagnostic strategies to supplement or replace clinical diagnosis to enable impact surveys to be carried out, as well as to support surveillance activities.

Box 3.1. Innovations in diagnostic tools

Diagnostic tools are essential for guiding clinical management and treatment strategies at different thresholds of control, interruption of transmission, elimination and for surveillance after elimination. Because NTDs affect the least well off of the world's population, national programmes need to leverage the rapid technological advances that are being led by programmes that are better resourced, and need to call for more open technology platforms as part of global emergency preparedness and outbreak response efforts.

New "sample in, answer out" lateral flow assay technologies that can be performed at the point-of-care offer improvements over current technologies and have the potential to test for multiple pathogens using a single specimen. Different combinations of antigen or antibody detection assays can be customized on a single platform using a single specimen, such as single specimens from patients at sentinel sites. Identifying commonalities among NTDs in terms of their geographical overlap, sentinel populations and treatment strategies will allow national NTD programmes to leverage these innovations to build cost–effective, multi-disease surveillance platforms. Connectivity solutions can be built into diagnostic technology platforms to link data from regional or district surveillance sites to central diagnostic laboratories or a national database. Automated systems for transmitting data will provide real-time data from surveillance sites across a country so that disease control interventions will be evidence-based and timely.

Innovation is also needed to both design and deliver tests. Progress has been slow because most diagnostic companies perceive that diseases of poverty yield little return on investment. New models of public–private product development partnerships are needed to encourage stakeholders concerned about social impact to invest in overcoming NTDs, with the shared objectives of succeeding in business and creating social justice. An investment case that emphasizes the broader agenda of strengthening health systems to deliver services, eliminate NTDs and alleviate poverty will go some way towards redressing this perceived imbalance. New models of de-risking investments and incentivizing the development of tests by public sector partners will be critical to attract major industry stakeholders and their know-how, stimulate diagnostic innovation and accelerate the elimination of NTDs.

Innovation in delivering health care services is warranted because poor people are typically marginalized in traditional health systems. Point-of-care tests can be deployed at the lower levels of the health care system to reach the poorest of the poor. Implementing these novel tools will require careful planning across the health system so that all of the NTDs can be managed through a single programme. Using a single programme to test for multiple diseases allows countries to maximize synergies and economies of scale.

Decentralizing testing can strain already fragile health systems. However, it has been shown that if point-of-care technologies are expanded and accompanied by quality assurance and connectivity solutions, they can improve the efficiency of a health care system and the quality of patients' care, even at the lowest level of the system. Adapting these innovations to improve the surveillance of NTDs and assess the impact of disease control interventions will help countries to refine strategies for elimination and surveillance after elimination.

Box 3.2. Innovations in research and development

Although significant progress has been made in reducing the burden of NTDs, sustaining their control and elimination calls not only for innovations in interventions (medicines, diagnostics, vector control) but also for innovative mechanisms of delivery.

The key interventions (discussed in **section 2**) have been instrumental in reducing the burden of selected NTDs, but they may not be suited to sustaining control or elimination in the long term. Furthermore, the efficacy of some medicines is threatened by parasite resistance.

New tools should be designed to serve the changing needs of NTD efforts, according to target product profiles that are guided by public health concerns. As elimination approaches and fewer cases occur, diagnosis becomes more challenging, and more sensitive and specific tests will be required. Treatment requirements may also change as the need for preventive chemotherapy moves to individual case management (or vice versa).

The product landscape has evolved dramatically during the past 15 years, with product development partnerships redressing inequities in research and development for NTDs. Contributions from the pharmaceutical industry have increased following the adoption of the London Declaration, but needs persist. Guidance must be provided to developers about what products are needed, along with an environment that enables and facilitates research and development.

WHO is increasing access to new treatments by promoting the de-linkage of end product pricing from research costs, as recommended by the Consultative Expert Working Group on Research and Development: Financing and Coordination.[1] A positive consequence has been the establishment of WHO's Global Observatory on Health Research and Development[2] to help identify priorities and direct investments.

The Special Programme for Research and Training in Tropical Diseases (TDR) is contributing in various ways.

At WHO's request, in 2016 TDR issued a proposal for a Health Product Research and Development Fund (*47*) using an analysis of the current research and development landscape for diseases of poverty proposed by the Observatory, and presenting options for setting up and operating a financing mechanism to address them. The Fund will be discussed at the Seventieth World Health Assembly in May 2017.

To provide direction for the research and development of new products, TDR is leading efforts to build an online resource to collate existing technical documentation describing the diagnostic tools, vaccines and therapeutics that are needed for NTDs. This compendium, due for release in May 2017, will allow the products needed for NTDs to be mapped.

TDR is also supporting open access to database platforms and identifying innovative ways to deliver and target interventions effectively.

1. http://www.who.int/phi/cewg/en/
2. http://www.who.int/research-observatory/en/

3.3.8 Sharpening the focus on resistance

Tracking down the remaining pockets of disease will not be the only surveillance priority after 2020; surveillance for emerging resistance will also be crucial. Resistance issues are a concern for all programmes and for all of the interventions they rely on. For example, every year more than 1 billion tablets of albendazole and mebendazole are administered in MDA preventive chemotherapy programmes, increasing the likelihood of anthelminthic resistance developing. Research has demonstrated that helminths in humans and animals can acquire resistance to benzimidazoles and that the widespread use of such medicines can select for resistant parasite strains (*48*,*49*). Thus, monitoring the emergence of resistant strains is crucial to MDA efforts, as is the development and testing of alternatives to albendazole and mebendazole.

Antimicrobial resistance has also been reported for some of the first-line medicines used in NTD case management. Azythromicin resistance in treponemal and other bacterial infections, rifampicin resistance in mycobaterial tuberculosis and antimonials (sodium stibogluconate) in *Leishmania donovani* infections. This calls for drug efficacy and resistance monitoring in selected sentinel sites

Surveillance of emerging resistance will be high on the agenda after 2020.

The biggest strategic concern about pesticides is the development of resistance to pyrethroids, the only class of pesticide used in long-lasting insecticide-treated nets and also in many indoor residual spraying programmes. Increasing levels of resistance to pyrethroid-based insecticides currently being used threaten the progress of the global malaria programme and, potentially, the lymphatic filariasis elimination programme in Africa (*50*).

WHOPES established the Global Collaboration for the Development of Pesticides for Public Health in response to the need to stimulate the development of alternative insecticides and application technologies.[1] In 2012, WHO launched the *Global plan for insecticide resistance management in malaria vectors*, with a five-pillar strategy to tackle the growing threat of insecticide resistance and to facilitate the development of innovative vector-control tools and strategies (*51*).

Going forward, it will be necessary to develop additional field-friendly assays that allow the amount of insecticide being sprayed or used in nets to be tracked. For example, one such tool is the easy-to-use insecticide quantification kit. These kits have been shown to be important tools for assessing the coverage and quality of indoor residual spraying (*52*). The quantification kit is currently being adapted for use in the visceral leishmaniasis elimination programme in India (*53*).

Also available are inexpensive assays that can be used on-site to measure the quantity of an insecticide sprayed inside a house and on bednets.

Tools for monitoring vector populations have been developed for the mosquitoes that transmit malaria. These tools include a suite of high-throughput assays, based on a single closed-tube platform, which can be used to screen mosquito vector populations for a number of traits, including insecticide resistance (*54*). This information can be used by programme managers to evaluate transmission and mitigate potential resistance. The genomic data accruing about NTD vectors could be used to develop DNA-based vector-monitoring tools (*40*). Additionally, it will be important to develop new methods to track the genes involved in resistance (*40*).

1. For more information, see http://www.who.int/whopes/gcdpp/en/

In the future, it may be possible to implement surveillance strategies using probes that are capable of identifying genes with the potential to induce insecticide resistance. Such probes have recently been developed (*55*), and they may lead to early warning systems capable of detecting emerging resistance.

3.3.9 Surveillance for resurgence

Clearly, one of the central concerns of programmes after 2020 will be ensuring that diseases that have been reduced to their last hot spots do not recur. This is an issue that has always beset elimination campaigns, but the warming of average global temperatures and resultant climate change is likely to exacerbate the problem, notably by expanding the geographical distribution of several mosquito-borne diseases (*56*), including dengue, for which there is increasing evidence of an association between outbreaks of dengue and temperature, rainfall and relative humidity (*57*). Human encroachment on wilderness areas and unplanned urbanization will also be significant triggers of disease outbreaks, as will the increased movement of people and goods. Among the most recent examples of the spread of an NTD is the establishment of schistosomiasis in Corsica, which could herald the establishment of the disease in southern Europe (*58*).

Responding to the findings of surveillance has been a part of NTD activities, with notable initiatives including the symposia on surveillance and response systems that have been held every 2 years since June 2012 (*59*). The areas that have been prioritized for research and strategy development for endgame scenarios include developing dynamic methods for detecting and mapping transmission, particularly low-level transmission; using electronic communications and processes, known as eHealth, and mobile-based strategies, known as mHealth; developing techniques for near real-time monitoring of population dynamics; using modelling to establish minimal essential databases and indicators to be collected in space and time; designing effective response packages tailored to different transmission settings and prevalence levels; and ensuring that approaches and response packages are rigorously validated in terms of their effectiveness within elimination programmes. At the most recent symposium on surveillance and response in 2016 (*60*), bilateral and multilateral agreements were signed, including memoranda of understanding between five Chinese provinces and five African countries on cooperating on research for schistosomiasis control and elimination.

Guaranteeing that data gathering is seen as a core activity that can be used to track progress, ensure accountability and inform the development of policies and strategies is crucial to optimizing the effectiveness of surveillance.

National health systems, supported by NTD programmes, will have a key role in supporting surveillance–response activities, but they will require the support of local communities, who are often the first witnesses of resurgences. To optimally use the data generated, robust surveillance–response systems will need to be developed and integrated into an early warning system. The foundations for these systems include the existing global early warning systems for health, such as the Global Outbreak Alert and Response Network, a multidisciplinary network of technical and operational resources that harnesses international resources at the request of affected WHO Member States to augment their responses to ongoing or potential public health emergencies, and the Global Early Warning System, designed by FAO, OIE and WHO to monitor and report on health threats and emerging risks at the intersection of humans, animals and

ecosystems. Research is needed to identify how diagnostic technologies that can be used remotely and innovative monitoring systems, such as the xenomonitoring of vectors (*61*) and reservoir hosts, can be used at sentinel sites and how data from these can be rapidly disseminated to national and global centres.

3.3.10 The need for integration

Clearly, the core activities in the future will involve collecting, organizing, and analyzing data with subsequent dissemination and feedback. Already a great deal of information about diseases and interventions has been collected by national NTD programmes, but much of it has not been used to inform decision-making. Going forward, strategic priorities for surveillance will include promoting the integration of disease-specific information systems into broader public health systems and ensuring that data gathering is not seen as a peripheral exercise but as a core activity that can be used to track progress, ensure accountability, and inform the development of policies and strategies.

For this vision to become a reality, countries will need easy access to a central data repository and straightforward ways to interpret the data to guide decisions about how to achieve the greatest impact with limited resources. Informed decision-making will also allow programmes to identify priority areas for surveillance, as well as when and where to implement further control measures. To support this agenda, WHO has led the development of an integrated NTD database to improve evidence-based planning and the management of NTD programmes at the national and subnational levels. The Integrated NTD Database consolidates all NTD data into a single repository that harmonizes data flow pathways, promotes country ownership of NTD programme data and improves data security.

The development of an integrated platform for surveillance of those NTDs that are amenable to individual case management will also help to improve monitoring trends in morbidity and mortality, validation/verification and elimination/eradication; to detect outbreaks early; to determine the magnitude and exact distribution (that is, mapping) of where these NTDs cluster; and to target appropriate interventions and measure their impact.

Although it is clear that integration is vital, it will not solve every problem unless integration also includes surveillance of animals and food production. The four NTDs with prominent zoonotic aspects (known as neglected zoonotic diseases) are rabies, echinococcosis, foodborne trematodiases, and taeniasis and cysticercosis; all suffer from particularly weak surveillance, in part because the surveillance of animals and food production is often not linked to surveillance for human diseases. The lack of integrated data on neglected zoonotic diseases supports the misconception that the burden of these diseases is low, which, in turn, leads to a lack of funding for surveillance, and reporting and control efforts.

The cross-cutting benefits of vector control present numerous opportunities for collaboration.

3.4 Vector control after 2020

Although vector control has been an important component of NTD programmes for many years (*35*), and is one of the key interventions comprising the responses to NTDs, it is worth emphasizing the many opportunities for increasing the use of these activities in the coming decade. This includes using simple vector-control interventions that offer multiple

benefits and, in many settings, act against multiple vectors; for example, long-lasting insecticide-treated nets and indoor residual spraying not only reduce the transmission of dengue and lymphatic filariasis by mosquitoes but also reduce the transmission of Chagas disease by triatomine bugs and the transmission of visceral leishmaniasis by sandflies. Similarly, treating livestock with insecticides kills the tsetse fly, the vector of human African trypanosomiasis, and also livestock-biting species of mosquito and sandfly (*2*).

Such cross-cutting benefits present opportunities for collaboration. In many cases, the vector-control methods used against mosquito-borne diseases – such as malaria, lymphatic filariasis and dengue – are identical. Vector control is a core component of the global strategy to fight malaria, and it has a proven record of successfully reducing disease transmission. The two core interventions for fighting malaria are indoor residual spraying and long-lasting insecticide-treated nets, both of which are recommended for indoor biting vectors. Given their success in anti-malaria activities, they are strongly recommended for integration into NTD programmes for lymphatic filariasis, dengue, visceral leishmaniasis and Chagas disease (*62*). Other vector-borne NTDs, such as human African trypanosomiasis and human onchocerciasis, are more difficult to integrate into existing programmes because the vectors require different approaches. However, vector control can still be used for them. For example, adding vector control to onchocerciasis programmes could accelerate progress towards elimination goals. Vector control is not feasible in all areas and may be expensive, but it could be particularly valuable in areas where there are problems ensuring that populations comply with MDA and as a temporary measure to accelerate progress while waiting to expand to twice yearly delivery of ivermectin treatment, if funds are available (*63*).

The development of a programmatically friendly macrofilaricidal regimen for onchocerciasis (for example, a one- or two-dose regimen), even in the absence of perfect efficacy, would be welcomed. If such a medication had no impact on the microfilariae of *L. loa*, it would simplify the strategy needed to eliminate onchocerciasis in co-endemic areas because it would be safe to use in these areas and the population would not require testing for *L. loa* infection before treatment. Work is continuing to develop macrofilaricidal medications. Assessments of macrofilaricidal efficacy would be facilitated if there were a test for the presence of live adult female worms, an added benefit of which would be that programmes could more rapidly demonstrate the interruption of transmission.

New approaches for controlling human African trypanosomiasis using a strategy known as "tiny target technology" or the selective spraying of cattle to control the acute zoonotic form of the disease have proven effective, but they require widespread implementation (*64*). Innovative vector control tools and approaches are required also to control or eliminate leishmaniasis, particularly in east Africa and Latin America where there is a diversity of vector populations and vector behaviours. Developing novel tools and methods to curb the spread of the day-biting and outdoor-biting *Ae. aegypti* mosquitoes that transmit dengue and chikungunya is a high priority, reinforced by the emergence of the Zika virus (**Box 3.3**).

In some cases, vector control will not be enough to control vector borne diseases on its own. For example, with Chagas disease, owing to the large reservoir of *T. cruzi* parasites in wild animals, the parasite cannot be eradicated. Thus, the control targets are to eliminate transmission (by using bednets) and to ensure early case detection and management of the infected population.

Without a concerted effort to improve access to safe water and sanitation, diseases will return to their former levels.

The vector-control challenge for zoonoses is somewhat different, requiring collaborative, cross-sectoral efforts among those involved in both the human and animal health systems, as well as a multidisciplinary approach that reflects the complexities of the ecosystems in which humans and animals coexist. For example, collaboration between those involved in human health services and those involved in animal health is essential for ensuring a rapid and sustained reduction in the prevalence of *T. solium*, which causes taeniasis. However, there are also opportunities for interprogramme collaboration owing to similarities in the interventions used to combat infection. This is true, for example, of taeniasis and cysticercosis, and schistosomiasis (*65*).

WHO's work in this area includes establishing a Vector Control Advisory Group in 2012 to guide approaches to vector control (see **section 2.4.1**) and drafting the Global Vector Control Response in 2016 to support the implementation of a comprehensive approach to vector control that will enable the setting and achievement of disease-specific national and global goals, as well as contribute to attaining the SDGs (see **section 2.4.2**).

Box 3.3. *Aedes aegypti*: a complex mosquito vector

The greatest challenge posed by vector-borne diseases today is in managing *Ae. aegypti*. This species – the main vector of dengue, Zika, yellow fever and chikungunya viruses – is found in close association with humans, and lays its eggs in containers commonly found in domestic and peridomestic habitats, such as water-storage jars, flower pots and discarded plastic containers. Its spread to most tropical and subtropical towns and cities in more than 128 countries threatens the health of nearly 4 billion people.

Interventions against *Aedes* mosquitoes often rely on using insecticides within living spaces, although this is difficult to do properly and is often insufficient. Vector control can be enhanced by educating and empowering communities to identify and eliminate breeding sites around their homes. Urban settings can also be made more resilient by "building out" *Aedes* mosquitoes, such as by providing a reliable supply of piped water to circumvent the need for households to store domestic water. Management of solid waste can also reduce *Aedes* larval habitats, and screened housing will reduce the densities of mosquitoes biting humans. This multipronged approach requires the health sector to work closely with those involved in urban planning, and water, sanitation and solid waste management services, as well as housing design and construction to ensure adequate management of domestic and peridomestic habitats.

Controlling *Aedes*-transmitted viruses by targeting this principal vector requires an integrated approach involving multiple partners within and beyond the health sector; in particular, it requires community involvement. Promising new vector-control tools against *Aedes* are on the horizon and these will provide further options for controlling vector-borne diseases.

3.4.1 Environmental interventions after 2020

Although MDA has been invaluable for controlling some of the NTDs with the highest burden, without improvements in water and sanitation, diseases will return to their former levels of incidence and prevalence, especially soil-transmitted helminthiases and schistosomiasis. Despite the fact that nearly 90% of the global population now has access to an improved water source – which means water is piped into a dwelling, plot or yard, or obtained from a public tap or well, or collected from a protected spring or rainwater (*66*) – many people are still drinking dirty water. A literature review in 2014 reported that in 38% of 191 studies, more than 25% of samples from improved sources contained faecal contamination (*67*). And 36% of the world's population, or nearly 2.5 billion people, still lack access to improved sanitation facilities (*66*).

NTDs thrive where water and sanitation are inadequate; for example, worm eggs that contaminate surface water lead to the transmission of schistosomiasis. *Culex* mosquitoes can breed in poorly constructed latrines; these mosquitoes transmit the filarial parasites that cause lymphatic filariasis in humans. In some instances water may be clean but stored in such a way that it becomes a breeding ground for the *Ae. aegypti* and *Ae. albopictus* mosquitoes, which transmit dengue, among other diseases. For other NTDs, access to clean water is essential for control; for example, trachoma, a leading cause of preventable blindness, is caused by a bacterial infection transmitted through contact with fingers, fomites and eye-seeking flies. Facial cleanliness and environmental improvements are the primary prevention components of WHO's SAFE strategy for trachoma elimination, and clean water is required for face-washing to remove eye discharge. In the coming decade, NTD programmes and their partners need to invest to provide sanitation facilities and invest in cross-sectoral initiatives to bring about behavioural change – for example, to discourage the practice of open defecation.

In August 2015, WHO launched the NTD–WASH Strategy 2015–2020, a global strategy and action plan to integrate WASH activities with other public health interventions (*68*). Although the water, sanitation and hygiene sector and the NTD sector work in the same communities, they have historically worked in parallel rather than coordinating their efforts, in part due to focusing on different areas (*69*). The idea behind the new strategy is to generate synergies by planning collaboratively, delivering and evaluating programmes together, strengthening and sharing evidence, and using monitoring tools to improve the equity of health services (see **section 2.6**) (*68*).

In the future, a more integrated approach to NTDs and WASH efforts will increase efficiencies and will also ensure that investments in WASH reach those who are most in need. Achieving the SDG 6 target of ensuring universal access to clean water and adequate sanitation requires focusing on people who are the poorest and hardest to reach – that is, the same groups most affected by NTDs. The Roadmap targets for 2020 and the target for SDG 6 are expected to add impetus to WASH-related initiatives. The progress or lack of thereof made on certain NTDs can also serve as a proxy for equity and the effective targeting of WASH programmes (*70*).

One of the greatest challenges in the next decade will be maintaining commitments to control and elimination as diseases recede.

Substandard water, sanitation and hygiene are not the only environmental factors that spread diseases. Others include poorly planned, built and maintained urban areas that are characterized by substandard housing, extensive slums and inadequate waste management, all of which sustain disease vectors, such as the *Ae. aegypti* mosquito (*71*).

Responses to these vector-borne diseases need to be multifaceted – including using larvicides or insecticides to spray spaces – but, clearly, environmental management and improvement are needed for progress to be made. Approaches to controlling rabies also require cross-sectoral collaboration, notably with regard to waste management because waste has an impact on where dogs roam. Thus, the involvement of other sectors is critical, including the veterinary and the water, sanitation and hygiene sectors. In December 2015, WHO, FAO, OIE and the Global Alliance for Rabies Control hosted a meeting attended by public health and veterinary representatives of countries affected by rabies (*72,73*). At the meeting, a strategic framework was agreed that has the aim of ending human deaths from dog-mediated rabies worldwide by 2030 (*74*).

3.5 Maintaining commitments after 2020

One of the greatest challenges that will need to be faced in the coming decade will be to maintain commitments to disease-response efforts as the burden of NTDs decreases. Given the lessons learnt in the efforts to eradicate dracunculiasis and yaws (and outside the sphere of NTDs, to eradicate poliomyelitis) there is good reason to think that the endgames for different NTDs will be protracted and frustrating, and they will entail further expenditures. Thus, maintaining the support and engagement of international partners, governments and communities in the face of these challenges will be crucial.

Commitments to elimination efforts waver for several reasons, the most obvious being the perception of diminished risk. This is felt at the grass-roots level as disengagement by communities as disease incidence declines. In some cases, communities become less invested in control activities, or they may actively refuse treatment. This can be particularly problematic in situations in which communities are also dealing with life-threatening infections for which they are receiving comparatively little support, but are still receiving treatment for an apparently vanished NTD. Thus, understanding how to continue to empower and engage communities will be essential to ensuring that momentum at the community level is maintained during the endgame.

The perception of diminished risk also affects governments, partly because the perception of risk and, therefore, importance determines where issues are positioned on governments' agendas. This lack of prioritization is already observable in some programmes; for example, because canine rabies is no longer perceived as a threat in many countries in Latin America, it is not receiving the attention and funding needed to achieve the elimination target in the region (*38*). Greater political commitment is, therefore, needed at the country level, as well as increased collaboration among FAO, OIE and WHO, and countries still affected by rabies to ensure that rabies responses remain a priority. Setting clear, credible, achievable goals, and establishing clear strategies to reach them, is essential to keep attention from wavering.

The notion of a diminishing problem can also cause difficulties with donors. For example, maintaining the commitment of stakeholders to ensure the investment needed to reach the 2030 target for human African trypanosomiasis is considered a key challenge because of the impressive success that has already been achieved (*75*). The human African trypanosomiasis programme is an unequivocal NTD success story, but maintaining the awareness, commitment and coordination of all partners is crucial to ensure their continued investment in the process. As elimination of the disease advances, finding residual cases becomes more challenging, but it is essential to terminate transmission in endemic areas. Improved diagnostic tools would be of great help, but the crucial gap is in ensuring access to diagnosis in areas of rural Africa where transmission is continuing. The programme is working to integrate the capacity for screening into peripheral health facilities. The human African trypanosomiasis programme also focuses on coordinating support for countries where the disease is endemic, as well as on encouraging increased ownership of the elimination process by those countries. Similar considerations arise for visceral leishmaniasis programmes, with programmes highlighting the challenges that countries will face once they reach an incidence rate of less than 1 case/10 000 population because it may prove difficult to obtain adequate human and financial resources to continue actions to maintain progress towards the target.

Conversely, when success is elusive, donors may lose interest, especially if targets are missed. The more reverses encountered during the endgame, the more difficult it becomes to continue to secure financial support (*1*,*2*). To secure commitments and focus, elimination programmes typically set deadlines, with the Roadmap and SDG targets providing two obvious examples. Targets are useful in that they give stakeholders something to work towards and, like a baseline, serve as references by which to judge performance. But when missed, they can be a burden, making it harder to obtain support for future elimination efforts. Diminishing donor support is a serious problem, especially for programmes already running on shoestring budgets. One way to address this problem is to ensure that countries maintain their commitment to and take ownership of programmes, and to ensure that support from donors continues. Domestic financing of programmes is key, and it is hoped that the mainstreaming of NTDs in the context of the SDGs will increase leverage for countries and stakeholders, allowing them to mobilize more resources.

It is essential that programmes stay the course until elimination targets are attained. Until a disease has been eliminated globally, there is a risk of re-emergence. The presence of endemic disease in neighbouring regions poses a threat to disease-free countries. Although this is clearly a problem, it can also be used to incentivize investment among neighbours. This kind of solidarity is already evident in the Americas, where countries capable of producing surplus vaccine or with greater wealth have provided support to countries struggling to eliminate canine rabies (*76*).

3.6 Ensuring health-service delivery meets the needs of those living with NTD-related disease

Even if NTD elimination targets are achieved by 2030, millions of people will continue to require clinical care and social support.

Even if all of the NTD elimination targets are attained by 2030, millions of people living with chronic and disabling conditions as a consequence of NTD infection will continue to require medical or surgical interventions (*77*), particularly those living with Chagas disease and the leishmaniases. However, people living with other diseases – such as Buruli ulcer, leprosy, lymphatic filariasis and trachoma – will also require long-term care, especially in instances in which they have received treatment late; for example, those living with lymphatic filariasis will require morbidity management and disability prevention services, such as hydrocele surgery and lymphoedema management.

Efforts to innovate and intensify the management of NTDs have focused on ensuring that these diseases are detected and managed within primary health care systems in the affected countries. This will continue to be the focus after 2030. Despite increasing attention being given to most of the NTDs, cutaneous leishmaniasis, yaws and the zoonoses remain the most neglected of the neglected. Access to diagnosis and treatment for the majority of people affected by cutaneous leishmaniasis remains a daunting task owing to the costs of medicines, the side-effects of treatments, the inadequacy of donors' commitments and the low priority that this form of the disease is afforded in national health services and policies. Global commitments have highlighted the importance of alleviating suffering and providing support for those affected by NTDs (*78*), but little progress has been made in establishing clinical and social programmes to provide this support. The shortage of funding to address the zoonoses is dire (**Box 3.4**). Despite an estimated 40 million individuals living with lymphatic filariasis and 15 years since the inception of GPELF, just 41 of the 73 countries where the disease is endemic have reported morbidity data at national level, and fewer are monitoring the care that is available at subnational level (*79*).

Box 3.4. Underfunded neglected zoonotic diseases

The zoonotic diseases are severely underfunded, having received no or only limited donations. Intersectoral collaboration is required to avoid fragmentation of efforts being made among sectors to address these diseases.

Medicines donated for preventive MDA can be part of the solution for some of these diseases (for example, infection with *T. solium*, which causes taeniasis), but additional approaches will be required to sustain progress. However, as the human population expands, the risks to public health arising where humans, animals and ecosystems interact must be addressed, as highlighted by the outbreaks of Ebola virus disease, H5N1 influenza and Middle East respiratory syndrome (known as MERS), and the need to address endemic zoonotic NTDs. For example, a business plan is being prepared for rabies that incorporates essential aspects of control and elimination – including raising awareness about the disease and its transmission in humans and animals – as well as advocacy components. It is hoped that continuing investment will result in the development of urgently needed, sustainable programmes that have proven to be cost effective and that can be paid off rapidly (*80,81*). At the core of investments in zoonoses are holistic, integrated approaches that will strengthen health systems and the delivery of care and generate knock-on effects by improving animal health and systems to ensure food safety.

Going forward, it will be vital to develop and implement effective and sustainable models of health-service delivery that can help reduce the impact of the physical and mental disabilities caused by NTDs. This will include finding ways to integrate morbidity management services into existing health systems. The issue of NTD mainstreaming is considered in section 4.2.

WHO has long supported greater integration of disease-specific programmatic services with broader national health programmes (*82*), and has published practical guidance to support such initiatives for infectious diseases (*83,84,85*). It would be a mistake to underestimate the size of the challenges faced or to fail to acknowledge that not all integration attempts have been immediately productive (*86,87*), but a body of evidence is developing regarding the benefits of combining interventions against HIV, tuberculosis, malaria and NTDs (*88*).

There are also many opportunities to integrate services to address communicable and noncommunicable diseases, especially for chronic and subchronic diseases, such as integrating care for HIV infection and tuberculosis with care for several of the NTDs (*89*). The sharing of decades of experience among experts in communicable and noncommunicable diseases is leading to new policies that combine the prevention and treatment of both types of disease. Although it is clear that the implementation of novel joint strategies will require adjustments to health systems, there is mounting political momentum to initiate these changes (*90*).

Making progress in disease management will rely on health systems becoming more resilient. The majority of health systems in countries where NTDs are endemic continue to face significant challenges, particularly at the level of first-contact primary health care. This will have to change if in-clinic services are to be delivered efficiently to offer the community interventions that have been shown to be effective in NTD programmes; this change will require a shift towards the greater decentralization of health services to provide people-centred integrated health services for all, regardless of their location, gender or socioeconomic status (*91*).

3.7 Conclusions

This section has sought to outline the main elements of an agenda for NTDs after 2020, identifying the two broad missions of continuing momentum towards eliminating NTD transmission and ensuring that health services meet the needs of those living with NTD-related diseases. In moving towards elimination, it is clear that MDA will continue to be a crucial intervention after 2020, and MDA will require continued support, especially in countries with weak health systems. The priorities for guaranteeing that MDA continues are to secure long-term commitments from national and global financing partners and ensure the participation of national governments (*92*), including commitments to contribute to the relatively small costs of delivery – estimated to be 1–3% of national health budgets – to ensure access to donated products that have an annual value of US$ 2–3 billion (*3.5*). The section has also emphasized the importance of carefully managing reductions in MDA activities. Integrated MDA cannot be dismantled without careful consideration of the collateral effects.

As diseases start to recede and MDA is reduced, programmes will begin to focus resources on areas and populations most at-risk and affected. Effectively focusing resources will require engaging in highly targeted monitoring in areas that continue to be at risk, including undertaking surveillance for resistance and ramping-up surveillance efforts to detect outbreaks in areas formerly at risk. It is important to build robust, integrated information systems to provide granular data. Also key to attaining the 2030 SDG elimination target is ensuring that data gathering is considered a core activity that can be used to track progress, ensure accountability and inform the development of policies and strategies.

Greater efforts will also focus on vector control and environmental factors. The many cross-cutting benefits of vector control have been highlighted, as have the numerous opportunities for collaboration that exist, particularly between anti-malaria activities and NTD programmes targeting lymphatic filariasis, dengue, visceral leishmaniasis and Chagas disease (*6.2*). It will be difficult to attain the SDG 2030 target without making a concerted effort to improve access to safe water; if such improvements are not made, there is a clear risk that some diseases will return to their former levels once preventive chemotherapy activities are reduced. Finally, one of the greatest challenges that will be faced in the coming decade will be to maintain commitments to disease-response efforts as the burden of disease is reduced. It is vital to sustain efforts to reach global elimination targets to avoid the risk of resurgence.

To use the language of the SDGs, the end of NTD "epidemics" will not be the end of NTD morbidity. Even if NTD elimination targets are attained by 2030, millions of people will continue to require clinical care and social support. Thus, it will be vital to strengthen health systems during the transition to UHC, which is called for in SDG 3.8, while developing and implementing effective and sustainable models of health-service delivery that can help reduce the impacts of the physical and mental disabilities caused by NTDs. The main challenge will be to persuade countries where these diseases are endemic to invest national resources in developing robust and dependable health-delivery systems to ensure that the gains from NTD control or elimination are translated into long-term progress in human development.

Given the scale of the challenges to be faced, and the lack of progress in this area in the past, it would be easy to become discouraged. However, it is important to remember how far the international community has come. It has been estimated (*93*) that 175 million DALYs (disability-adjusted life-years) have been averted during the 15 years of GPELF alone. If targets are met, a total of 600 million DALYs will be averted by 2030, largely due to the decline in morbidity from NTDs treated by preventive chemotherapy (*94*). Given that these figures do not take into account gains made in subtle morbidities through improved cognitive development and mental health and because only nine NTDs were used in the calculation (*35*), it is reasonable to suggest that overall gains in DALYs from all NTD programmes will be substantially greater. It is hoped that an increased focus on UHC, which is at the core of the SDG health target, will encourage new initiatives and increase investment. The next section discusses NTDs in the context of the SDGs.

References

1. Klepac P, Metcalf JE, McLean AR, Hampson K. Towards the endgame and beyond: complexities and challenges for the elimination of infectious diseases. Philos Trans R Soc Lond B Biol Sci. 2013;368:20120137. doi:10.1098/rstb.2012.0137.
2. Macpherson E, Adams ER, Bockarie MJ, Hollingsworth DT, Kelly-Hope LA, Lehane M et al. Mass drug administration and beyond: how can we strengthen health systems to deliver complex interventions to eliminate neglected tropical diseases? BMC Proc. 2015;9(Suppl 10):S7. doi:10.1186/1753-6561-9-S10-S7.
3. Investing to overcome the global impact of neglected tropical diseases: third WHO report on neglected diseases. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/152781/1/9789241564861_eng.pdf).
4. Global programme to eliminate lymphatic filariasis: progress report, 2015. Wkly Epidemiol Rec. 2016;39:441–56 (http://apps.who.int/iris/bitstream/10665/250245/1/WER9139.pdf).
5. Fürst T, Keiser J, Utzinger J. Global burden of human food-borne trematodiasis: a systematic review and meta-analysis. Lancet Infect Dis. 2012;12:210–21. doi:10.1016/S1473-3099(11)70294-8.
6. Cupp EW, Cupp MS. Impact of ivermectin community-level treatments on elimination of adult *Onchocerca volvulus* when individuals receive multiple treatments per year. Am J Trop Med Hyg. 2005;73:1159–61. PMID: 16354830.
7. Strategic and Technical Advisory Group for Neglected Tropical Diseases subgroup on disease-specific indicators. Integrating national programmes to eliminate lymphatic filariasis and onchocerciasis. Report of a meeting, Geneva, 7–8 February 2015. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/PCT/2016.4; http://apps.who.int/iris/bitstream/10665/246190/1/9789241511148-eng.pdf).
8. Provisional strategy for interrupting lymphatic filariasis transmission in loiasis-endemic countries. Report of a meeting on lymphatic filariasis, malaria and integrated vector management, Accra, Ghana, 5–9 March 2012. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/PCT/2012.6; http://apps.who.int/iris/bitstream/10665/75139/3/WHO_HTM_NTD_PCT_2012.6_eng.pdf).
9. Molyneux DH, Hopkins A, Bradley MH, Kelly-Hope LA. Multidimensional complexities of filariasis control in an era of large-scale mass drug administration programmes: a can of worms. Parasit Vectors. 2014;7:363. doi:10.1186/1756-3305-7-363.
10. Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification by WHO of elimination of transmission in Colombia. Wkly Epidemiol Rec. 2013;88:381–88. http://www.who.int/entity/wer/2013/wer8836.pdf

11. Taylor MJ, Hoerauf A, Townson S, Slatko BE, Ward SA. Anti-*Wolbachia* drug discovery and development: safe macrofilaricides for onchocerciasis and lymphatic filariasis. Parasitology.2014;141:119–27. doi:10.1017/S0031182013001108.
12. Geary TG, Mackenzie CD. Progress and challenges in the discovery of macrofilaricidal drugs. Expert Rev Anti Infect Ther. 2011;9:681–95. doi:10.1586/eri.11.76.
13. Barrett MP. Potential new drugs for human African trypanosomiasis: some progress at last. Curr Opin Infect Dis. 2010;23:603–8. doi:10.1097/QCO.0b013e32833f9fd0.
14. Guidelines for stopping mass drug administration and verifying elimination of human onchocerciasis: criteria and procedures. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/PCT/2016.1; http://apps.who.int/iris/bitstream/10665/204180/1/9789241510011_eng.pdf).
15. Helminth control in school-age children: a guide for managers of control programmes, 2nd edition. Geneva: World Health Organization; 2011 (http://apps.who.int/iris/bitstream/10665/44671/1/9789241548267_eng.pdf).
16. Assessing the epidemiology of soil-transmitted helminthiases during a transmission assessment survey in the global programme for the elimination of lymphatic filariasis. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/PCT/2015.2; http://apps.who.int/iris/bitstream/10665/153240/1/9789241508384_eng.pdf).
17. Four decades of achievements: highlights of the work of WHO. Geneva: World Health Organization; 1988 (http://apps.who.int/iris/bitstream/10665/40590/1/9241542349_eng.pdf).
18. Stanton MC, Bockarie MJ, Kelly-Hope LA. Geographical factors affecting bed net ownership, a tool for the elimination of *Anopheles*-transmitted lymphatic filariasis in hard-to-reach communities. PloS One. 2013;8:e53755. doi:10.1371/journal.pone.0053755.
19. Stanton MC, Molyneux DH, Kyelem D, Bougma RW, Koudou BG, Kelly-Hope LA. Baseline drivers of lymphatic filariasis in Burkina Faso. Geospat Health. 2013;8:159–73. doi:10.4081/gh.2013.63.
20. Kagbadouno MS, Camara M, Rouamba J, Rayaisse J-B, Traoré IS, Camara O et al. Epidemiology of sleeping sickness in Boffa (Guinea): where are the trypanosomes? PLoS Negl Trop Dis; 2012;6: e1949. doi:10.1371/journal.pntd.0001949.
21. Alonso LM, Alvar J. Stigmatizing neglected tropical diseases: a systematic review. Soc Med (Soc Med Publ Group). 2010;5:218–227.
22. Weiss MG. Stigma and the social burden of neglected tropical diseases. PLoS Negl Trop Dis. 2008;2:e237. doi:10.1371/journal.pntd.0000237.
23. Neglected tropical diseases: hidden successes, emerging opportunities. Geneva: World Health Organization; 2006 (http://apps.who.int/iris/bitstream/10665/69367/1/WHO_CDS_NTD_2006.2_eng.pdf).
24. Hofstraat K, van Brakel WH. Social stigma towards neglected tropical diseases: a systematic review. Int Health. 2016;8(suppl 1): i53-i70. doi:10.1093/inthealth/ihv071.
25. Coura JR, Viñas PA. Chagas disease: a new worldwide challenge. Nature. 2010;465:S6–7. doi:10.1038/nature09221.
26. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL et al. The global distribution and burden of dengue. Nature. 2013;496:504–7. doi:10.1038/nature12060.
27. Brady OJ, Gathing PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG et al. Refining the global spatial limits of dengue virus transmission by evidence-based consensus. PLoS Negl Trop Dis. 2012;6:e1760. doi:10.1371/journal.pntd.0001760.
28. Silva MMO, Rodrigues MS, Paploski IAD, Kikuti M, Kasper AM, Cruz JS et al. Accuracy of dengue reporting by national surveillance system, Brazil [letter to the Editor]. Emerg Infect Dis. 2016;22:336–9. doi:10.3201/eid2202.150495.
29. Global strategy for dengue prevention and control 2012–2020. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/75303/1/9789241504034_eng.pdf).

30. Dengue: guidelines for diagnosis, treatment, prevention and control, new edition. Geneva: World Health Organization; 2009 (WHO/HTM/NTD/DEN/2009.1; http://www.who.int/tdr/publications/documents/dengue-diagnosis.pdf).

31. Solomon AW, Kurylo E. The global trachoma mapping project. Community Eye Health / International Centre for Eye Health. 2014; 27:18 (http://researchonline.lshtm.ac.uk/1805380/1/jceh_27_85_018.pdf).

32. Solomon AW, Pavluck A, Courtright P, Aboe A, Adamu L, Alemayehu W et al. The global trachoma mapping project: methodology of a 34-country population-based study. Ophthalmic Epidemiol. 2015;22:214–5. doi:10.3109/09286586.2015.1037401.

33. Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification of elimination of transmission in Mexico. Wkly Epidemiol Rec. 2015;90:577–81 (http://www.who.int/wer/2015/wer9043.pdf).

34. Coura JR, Junqueira AC. Surveillance, health promotion and control of Chagas disease in the Amazon Region. Medical attention in the Brazilian Amazon Region: a proposal. Mem Inst Oswaldo Cruz. 2015;110: 825–30.

35. Molyneux DH, Savioli L, Engels D. Neglected tropical diseases: progress towards addressing the chronic pandemic. Lancet. 2017;389:312–25. doi.org/10.1016/S0140-6736(16)30171-4.

36. Lumbala C, Simarro PP, Cecchi G, Paone M, Franco JR, Mesu VKBK et al. Human African trypanosomiasis in the Democratic Republic of the Congo: disease distribution and risk. Int J Health Geogr. 2015;14: 20. doi:10.1186/s12942-015-0013-9.

37. Franco JR, Simarro PP, Diarra A, Ruiz-Postigo JA, Jannin JG. The journey towards elimination of gambiense human African trypanosomiasis: not far, nor easy. Parasitology. 2014;141:748–60. doi:10.1017/S0031182013002102.

38. Experiencia de países y herramientas para la declaración de áreas libres de rabia canina variantes 1 y 2 [Country experience and tools for the declaration of areas free of canine rabies variants 1 and 2]. "Experiencia de países y herramientas para la declaración de áreas libres de rabia canina variantes 1 y 2". Washington (DC): Pan American Health Organization; 2015 (in Spanish).

39. The Access to Medicine Index 2014. Haarlem (Netherlands): Access to Medicine Foundation; 2014 (http://apps.who.int/medicinedocs/documents/s21637en/s21637en.pdf).

40. Reimer LJ, Adams ER, Paine MJI, Ranson H, Coleman M, Thomsen EK et al. Fit for purpose: do we have the right tools to sustain NTD elimination? BMC Proc. 2015;9(Suppl 10):S5.

41. Thiele EA, Cama VA, Lakwo T, Mekasha S, Abanyie F, Sleshi M et al. Detection of *Onchocerca volvulus* in skin snips by microscopy and real-time polymerase chain reaction: implications for monitoring and evaluation activities. Am J Trop Med Hyg. 2016; 94:906–11. doi:10.4269/ajtmh.15-0695.

42. Converse PJ, Xing Y, Kim KH, Tyagi S, Li S-Y, Almeida DV et al. Accelerated detection of mycolactone production and response to antibiotic treatment in a mouse model of *Mycobacterium ulcerans* disease. PLoS Negl Trop Dis. 2014;8:e2618. doi:10.1371/journal.pntd.0002618.

43. Sakyi S, Aboagye SY, Otchere ID, Yeboah-Manu D. Clinical and laboratory diagnosis of Buruli ulcer disease: a systematic review. Can J Infect Dis Med Microbiol. 2016;5310718. doi:org/10.1155/2016/5310718.

44. Report of a WHO–FIND consultative meeting on diagnostics for Buruli ulcer. Geneva: World Health Organization; 2014 (WHO/HTM/NTD/IDM/2014.2; http://apps.who.int/iris/bitstream/10665/112669/1/WHO_HTM_NTD_IDM_2014.2_eng.pdf).

45. Geary TG. A step toward eradication of human filariases in areas where *Loa* is endemic. mBio. 2016;7:2e00456-16. doi:10.1128/mBio.00456-16.

46. Cooley GM, Mitjà O, Goodhwe B, Pillay A, Lammie PJ, Castro A et al. Evaluation of multiplex-based antibody testing for use in large-scale surveillance for yaws: a comparative study. J Clin Microbiol. 2016;54:1321–5. doi:10.1128/JCM.02572-15.

47. Health product research and development fund: a proposal for financing and operation. Geneva: World Health Organization on behalf of the Special Programme for Research and Training in Tropical Diseases; 2016 (http://www.who.int/tdr/publications/r_d_report/en/).

48. Wolstenholme AJ, Fairweather I, Prichard R, von Samson-Himmelstjerna G, Sangster NC. Drug resistance in veterinary helminths. Trends Parasitol. 2004;20:469–76.

49. Furtado LF, de Paiva Bello AC, Rabelo EM. Benzimidazole resistance in helminths: from problem to diagnosis. Acta Trop. 2016;162:95–102.

50. Hemingway J, Ranson H, Magill A, Kolaczinski J, Fornadel C, Gimnig J et al. Averting a malaria disaster: will insecticide resistance derail malaria control? Lancet. 2016;387:1785–8. doi.org/10.1016/S0140-6736(15)00417-1.

51. Global plan for insecticide resistance management in malaria vectors. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/44846/1/9789241564472_eng.pdf).

52. Thawer NG, Ngondi J; Mugalura FE, Emmanuel I, Mwalimu CD, Morou E et al. Use of insecticide quantification kits to investigate the quality of spraying and decay rate of bendiocarb on different wall surfaces in Kagera region, Tanzania. Parasit Vectors. 2015;8:242/doi:10.1186/s13071-015-0859-5.

53. Hanafy I, Kumar V, Singh RP, Williams C, Shivam P, Ghosh Q et al. Development of a simple dipstick assay for operational monitoring of DDT. PLoS Neg Trop Dis. 2016; 10: e0004324. doi:10.1371/journal.pntd.0004324.

54. Bass C, Nikou D, Vontas J, Donnelly MJ, Williamson MS, Field LM et al. The vector population monitoring tool (VPMT): high-throughput DNA-based diagnostics for the monitoring of mosquito vector populations. Malar Res Treat. 2010; 2010:190434. doi:10.4061/2010/190434.

55. Ismail HM, O'Neill PM, Hong DW, Finn RD, Henderson CJ, Wright AT et al. Pyrethroid activity-based probes for profiling cytochrome P450 activities associated with insecticide interactions. Proc Natl Acad Sci U S A. 2013;110:19766–71. doi:10.1073/pnas.1320185110.

56. Working Group II: Impacts, adaptation and vulnerability [website]. In: Intergovernmental Panel on Climate Change (http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=361; accessed 13 March 2017).

57. Naish S, Dale P, Mackenzie JS, McBride J, Mengersen K, Tong S. Climate change and dengue: a critical and systematic review of quantitative modelling approaches. BMC Infect Dis. 2014;14:167. doi:10.1186/1471-2334-14-167.

58. Boissier J, Moné H, Mitta G, Bargues MD, Molyneux D, Mas-Coma S. Schistosomiasis reaches Europe. Lancet Infect Dis 2015;15:757–8. doi:10.1016/S1473-3099(15)00084-5.

59. Tambo E, Ai L, Zhou X, Chen J-H, Hu W, Bergquist R et al. Surveillance-response systems: the key to elimination of tropical diseases. Infect Dis Poverty. 2014;3:17. doi:10.1186/2049-9957-3-17.

60. The 3rd Symposium of Surveillance Response System on Tropical Diseases [website]. Hope Hotel, Shanghai, People's Republic of China, 16–17 June 2016. (http://srs.ipd.org.cn:8080/srs/, accessed 13 March 2017).

61. Okorie PN, de Souza DK. Prospects, drawbacks and future needs of xenomonitoring for the endpoint evaluation of lymphatic filariasis elimination programs in Africa. Trans R Soc Trop Med Hyg. 2016;110:90–7. doi.org/10.1093/trstmh/trv104.

62. van den Berg H, Kelly-Hope LA, Lindsay SW. Malaria and lymphatic filariasis: the case for integrated vector management. Lancet Infect Dis. 2013;13:89–94. doi:10.1016/S1473-3099(12)70148-2.

63. Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification of elimination of transmission in Guatemala. Wkly Epidemiol Rec. 2016;91:505–514 (http://apps.who.int/iris/bitstream/10665/250643/1/WER9143.pdf).

64. Welburn SC, Beange I, Ducrotoy MJ, Okello AL. The neglected zoonoses – the case for integrated control and advocacy. Clin Microbiol Infect 2015;21:433–43. doi: 10.1016/j.cmi.2015.04.011.

65. Braae UC, Saarnak CFL, Mukaratirwa SM, Devleesschauwer B, Magnussen P, Johansen MV. *Taenia solium* taeniosis/cysticercosis and the co-distribution with schistosomiasis in Africa. Parasit Vectors. 201512;8:323. doi:10.1186/s13071-015-0938-7.

66. Tracking universal health coverage: first global monitoring report. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/174536/1/9789241564977_eng.pdf).

67. Bain R, Cronk R, Wright J, Yang H, Slaymaker T, Bartram J. Fecal contamination of drinking water in low- and middle-income countries: a systematic review and meta-analysis. PLoS Med 11:e1001644. doi:10.1371/journal.pmed.1001644.

68. WHO strengthens focus on water, sanitation and hygiene to accelerate elimination of neglected tropical diseases. In: WHO/Water, sanitation, hygiene [website]. Geneva: World Health Organization; 2015 (http://www.who.int/water_sanitation_health/events/wash-and-ntd-strategy/en/, accessed 13 March 2017).

69. Johnston EA, Teague J, Graham JP. Challenges and opportunities associated with neglected tropical disease and water, sanitation and hygiene intersectoral integration programs. BMC Public Health. 2015;15:547. doi:10.1186/s12889-015-1838-7.

70. Water sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/182735/1/WHO_FWC_WSH_15.12_eng.pdf).

71. Ventura-Garcia L, Roura M, Pell C, Posada E, Gascón, Aldasoro E et al. Socio-cultural aspects of Chagas disease: a systematic review of qualitative research. PLoS Negl Trop Dis. 2013;7:e2410. doi:10.1371/journal.pntd.0002410.

72. Lembo T, Attlan M, Bourhy H, Cleaveland S, Costa P, de Balogh K et al. Renewed global partnerships and redesigned roadmaps for rabies prevention and control. Vet Med Int. 2011;923149. doi:10.4061/2011/923149.

73. FAO, OIE and WHO unite to eliminate human rabies and control the disease in animals. Geneva: World Health Organization; 2013 (http://www.who.int/rabies/WRD_2013_Statement_Eng.pdf).

74. Global elimination of dog-mediated human rabies: report of the rabies global conference. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/NZD/2016.02; http://apps.who.int/iris/bitstream/10665/204621/1/WHO_HTM_NTD_NZD_2016.02_eng.pdf).

75. Report of the second WHO stakeholders meeting on gambiense human African trypanosomiasis elimination. Geneva, 21–23 March 2016. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/IDM/2016.4; http://apps.who.int/iris/bitstream/10665/254067/1/9789241511520-eng.pdf).

76. Vigilato MAN, Clavijo A, Knobl T, Silva HMT, Cosivi O, Schneider MC et al. Progress towards eliminating canine rabies: policies and perspectives from Latin America and the Caribbean. Phil. Trans. R. Soc. B. 2013;368:20120143. doi:10.1098/rstb.2012.0143.

77. Gyapong JO, Gyapong M, Yellu N, Anakwah K, Amofah, Bockarie M et al. Integration of control of neglected tropical diseases into health-care systems: challenges and opportunities. Lancet. 2010;375:160–5. doi.org/10.1016/S0140-6736(09)61249-6.

78. Progress report 2000–2009 and strategic plan 2010–2020 of the Global Programme to Eliminate Lymphatic Filariasis: halfway towards eliminating lymphatic filariasis. Geneva: World Health Organization; 2010 (WHO/HTM/NTD/PCT/2016.6 (http://www.searo.who.int/entity/vector_borne_tropical_diseases/topics/lymphatic_filariasis/LFREP.pdf).

79. Brantus P. Ten years of managing the clinical manifestations and disabilities of lymphatic filariasis. Ann Trop Med Parasitol. 2009;103 (Suppl 1): S5–10. doi:10.1179/00034980 9X12502035776432.

80. Rabies: rationale for investing in the global elimination of dog-mediated human rabies. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/NZD/2015.2; http:// apps.who.int/iris/bitstream/10665/185195/1/9789241509558_eng.pdf).

81. Zinsstag J, Dürr S, Penny MA, Mindekem R, Roth F, Menendez Gonzalez S et al. Transmission dynamics and cost-effectiveness of rabies control in dogs and humans in an African city. Proc Natl Acad Sci U S A. 2009. 2011; 106:14996–5001. doi:10.1073/pnas.0904740106.

82. Mahler H. The tuberculosis programme in the developing countries. Bull Int Union Tuberc Lung Dis. 1966;37:77–82.

83. Collaborative framework for care and control of tuberculosis and diabetes. Geneva: World Health Organization/International Union Against Tuberculosis and Lung Disease; 2011 (WHO/HTM/TB/2011.15).

84. Public–private mix for TB care and control: a toolkit. Geneva: World Health Organization, 2010 (WHO/HTM/TB/2010.12; http://www.who.int/tb/careproviders/ppm/ PPMToolkit.pdf).

85. WHO recommendations on the management of diarrhoea and pneumonia in HIV-infected infants and children: integrated management of childhood illness (IMCI). Geneva: World Health Organization; 2010 (http://apps.who.int/iris/ bitstream/10665/44471/1/9789241548083_eng.pdf).

86. Atun RA, Bennett S, Duran A. When do vertical (stand-alone) programmes have a place in health systems? Copenhagen: World Health Organization; 2008 (http://www.who.int/ management/district/services/WhenDoVerticalProgrammesPlaceHealthSystems.pdf).

87. WHO Maximizing Positive Synergies Collaborative Group. An assessment of interactions between global health initiatives and country health systems. Lancet. 2009;373:2137–69. doi:10.1016/S0140-6736(09)60919-3.

88. Hotez PJ, Mistry N, Rubinstein J, Sachs JD. Integrating neglected tropical diseases into AIDS, tuberculosis, and malaria control. N Engl J Med. 2011;364:2086–9. doi:10.1056/ NEJMp1014637.

89. Lymphatic filariasis: managing morbidity and preventing disability: an aide-mémoire for national programme managers. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/ PCT/2013.7; http://apps.who.int/iris/bitstream/10665/85347/1/9789241505291_ eng.pdf).

90. Dye C, Mertens T, Hirnschall G, Mpanju-Shumbusho W, Newman RD, Raviglione MC et al. WHO and the future of disease control programmes. Lancet. 2013;381:413-8. doi:10.1016/S0140-6736(12)61812-1.

91. Accelerating progress on HIV, tuberculosis, malaria, hepatitis and neglected tropical diseases: a new agenda for 2016–2030. Geneva: World Health Organization; 2015 (http://apps. who.int/medicinedocs/documents/s22340en/s22340en.pdf).

92. Rebollo M P, Bockarie MJ. Toward the elimination of lymphatic filariasis by 2020: treatment update and impact assessment for the endgame. Expert Rev Anti Infect Ther. 2013;11:723–31. doi:10.1586/14787210.2013.811841.

93. Turner HC, Bettis AA, Chu BK, McFarland DA, Hooper PJ, Ottesen EA et al. The health and economic benefits of the Global Programme to Eliminate Lymphatic Filariasis (2000–2014). Infect Dis Poverty. 2016;5:54. doi:10.1186/s40249-016-0147-4.

94. de Vlas SJ, Stolk WA, le Rutte EA, Hontelez JAC, Bakker R, Block DJ et al. Concerted efforts to control or eliminate neglected tropical diseases: how much health will be gained? PLoS Negl Trop Dis. 2016;10:e000386. doi:10.1371/journal.pntd.0004386.

NTDs & SDGs

NTDs affect the 1 billion poorest people in the world, and they stand in the way of achieving the SDGs. NTDs are most relevant to the goal to "ensure healthy lives and ensure well-being for all at all ages" (SDG 3), but they also affect and are affected by many of the other development areas covered by the 2030 Agenda for Sustainable Development. NTDs proliferate in underdeveloped areas in countries across the income spectrum, settings where large numbers of people have little or no access to adequate health care, clean water, sanitation, housing, education and information. As this section shows, tackling NTDs significantly improves the prospects of attaining all of the SDGs, from reducing poverty and malnutrition to improving water and sanitation, gender equality and education.

The NTD agenda, with its focus on equity and its commitment to reaching people in need of health services wherever they may live and whatever their circumstances, is fundamentally aligned with the SDG commitment to leave no one behind. This section explores the extent and depth of that alignment.

- Integrating NTDs into global health and development
- Mainstreaming on NTDs in the context of UHC
- Monitoring NTDs within the sutainable development Goals
- Financing NTDs in the context of SDGs

Children are especially vulnerable, accounting for more than two thirds of global NTD deaths.

4. Integrating NTDs into global health and development

4.1 "Ending" NTDs in efforts to achieve the Sustainable Development Goals

4.1.1 Introduction

NTDs affect the 1 billion poorest people in the world (*1*), and they stand in the way of achieving the SDGs. NTDs are most relevant to the goal to "ensure healthy lives and ensure well-being for all at all ages" (SDG 3), but they also affect and are affected by many of the other development areas covered by the 2030 Agenda for Sustainable Development (*2*). NTDs proliferate in underdeveloped areas in countries across the income spectrum, settings where large numbers of people have little or no access to adequate health care, clean water, sanitation, housing, education and information. As this section shows, tackling NTDs significantly improves the prospects of attaining all of the SDGs, from reducing poverty and malnutrition to improving water and sanitation, gender equality and education (*3*).

Enmeshed and interrelated, the SDGs call for an integrated response, with the type of integration that has defined efforts to address NTDs during the past decade and given rise to strategies such as MDA and the programmatic integration of NTD and WASH activities. Effective integrated responses will require far greater intersectoral collaboration than has hitherto been in evidence. Critical to achieving this will be a revitalization of global partnerships for sustainable development. Here, too, national programmes and initiatives have much to contribute, not least in terms of experience, having collaborated in strong global partnerships for more than a decade, partnerships that have brought together a range of stakeholders, including governments in countries where NTDs are endemic, international agencies, pharmaceutical companies, international NGOs, and professionals from academia, civil society and United Nations agencies (*4*).

The NTD agenda, with its focus on equity and its commitment to reaching people in need of health services wherever they may live and whatever their circumstances, is fundamentally aligned with the SDG commitment to leave no one behind. This section explores the extent and depth of that alignment.

4.1.2 The Sustainable Development Goals

The 17 goals comprising the SDG agenda (Table 4.1) integrate all three dimensions of sustainable development –the economic, the social and the environmental – around the themes of people, planet, prosperity, peace and partnership. Following on from the Millennium Development Goals, they continue to prioritize the fights against poverty and hunger, and also focus on human rights for all and the empowerment of women and girls as part of global efforts to achieve gender equality. The SDGs recognize that eradicating poverty and inequality, creating inclusive economic growth and preserving the planet are inextricably linked, not only to one another but also to the health of populations. They also acknowledge that the relationships among each of these elements are dynamic and reciprocal. For example, a fundamental assumption of the SDGs is that health is a major contributor to and beneficiary of sustainable development policies (*5*).

4.1.3 NTDs and the Sustainable Development Goals

Although it is clear that the NTDs and the responses to them have the most direct relevance for SDG 3 (known as the health goal), they also have specific relevance for the SDGs aimed at ending poverty (SDG 1), ending hunger (SDG 2), ensuring equal educational opportunities (SDG 4), ensuring the availability and sustainable management of water and sanitation (SDG 6) and ensuring that cities are sustainable, safe, resilient and inclusive (SDG 11). The relevance of NTDs to the other SDGs is more subtle, and in some cases the areas of alignment are limited to single targets, but, nonetheless, there are alignments and potential synergies to be developed. Thus, efforts to mitigate the impact of NTDs will have a direct influence on the overall progress made towards achieving the SDGs.

Goal 1. End poverty in all its forms everywhere

The first SDG is among the most ambitious of the 17 goals. Rates of extreme poverty have declined by more than half since 1990, in part as a result of the rebalancing of global trade towards Asia. However, 1 in 5 people in developing regions still lives on less than US$ 1.25 per day, and there are millions more who exist on little more than this. According to the 2030 Agenda, ending poverty requires not only raising incomes but also increasing access to basic resources and services, and supporting communities affected by conflict and climate-related disasters.

The NTDs are diseases of the poor and they drive impoverishment in a variety of ways. For example, the disabling and debilitating effects of NTDs prevent adults from providing for their families and contributing to the economic development of their countries. They also generate health care costs, notably in the form of out-of-pocket costs incurred when seeking care and treatment. In Ghana, the cost of care per patient with Buruli ulcer in a household in the poorest-earning quartile has been reported to be as high as 315% of annual earnings (*6*). Such costs can result in generations being caught in the so-called medical poverty trap. The costs of medical care affect people worldwide; for examples, in Cambodia, 50–67% of affected households have incurred debt as a result of treatment for dengue (*7*); in Bangladesh (*8*) and Nepal (*9*), 25–75% of households that are affected by visceral leishmaniasis experience some type of financial catastrophe

Table 4.1 The 17 Sustainable Development Goals

Goals	
	1. End poverty in all its forms everywhere
	2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
	3. Ensure healthy lives and promote well-being for all at all ages
	4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
	5. Achieve gender equality and empower all women and girls
	6. Ensure availability and sustainable management of water and sanitation for all
	7. Ensure access to affordable, reliable, sustainable and modern energy for all
	8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
	9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
	10. Reduce inequality within and among countries
	11. Make cities and human settlements inclusive, safe, resilient and sustainable
	12. Ensure sustainable consumption and production patterns
	13. Take urgent action to combat climate change and its impacts
	14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
	15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
	16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
	17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

Source: reference *2*

when obtaining a diagnosis and treatment. Even when tests and medicines are provided free of charge, NTDs impose a financial burden on patients (*10,11*). Their economic impact is also felt in lost productivity, as demonstrated by the chikungunya outbreak on Réunion island, where an additional 112 400 days of absence from work was recorded from 12 800 subjects, costing an estimated at €17.4 million (*12*).

The cost of NTDs is not limited to human infections. Pigs are frequently kept as a cash reserve to be used whenever there is an emergency, such as medical needs. A study in the United Republic of Tanzania measuring the impact of cysticercosis infections on these reserves found a significant economic burden resulting from the reduced value or condemnation of pigs harbouring cysticercosis (*13*).

Although the links between NTDs and poverty are clear, it is important to note that NTDs are diseases of poverty rather than diseases of poor countries. In 2015, 960 million of the 1.59 billion people requiring mass or individual treatment and care for NTDs were living in lower-middle- rather than low-income countries. Indeed, many of the NTDs that cause the highest burden of disease (just five NTDs represent 71% of the total NTD burden (*14*) occur predominantly in the largest emerging-market economies in the Group of 20 nations (G20) plus Nigeria, which also has one of the world's largest economies (*15*). Brazil, China, India, Indonesia and Nigeria have the highest prevalence of NTDs, but even very wealthy nations have a hidden burden of NTDs, such as the United States, where it is mostly concentrated in the southern states (*16*), and Australia, where blinding trachoma and scabies remain major public health problems in many Aboriginal communities (*17*). In Europe, leishmaniasis is considered to be endemic in the Mediterranean basin (*18*). Additionally, autochthonous outbreaks of dengue have been reported in the high-income countries of Australia, France (*19*), Portugal (*20*), Singapore, Chinese Taipei (*21*) and the United States; recently, a focus of urogenital schistosomiasis transmission (due to *Schistosoma haematobium*) was found in Corsica (*22*).

NTD programmes have an important role in reducing the financial burden on families seeking care, both in the way interventions are delivered (that is, free of charge and often through community-directed interventions) and in their emphasis on preventive care. NTD programmes, simply by preventing diseases, reduce exposure to the debilitating physical and mental health effects (*22*) that give rise to catastrophic and impoverishing costs (*23*). Clearly, that making progress on NTDs is a prerequisite for making progress towards ending poverty in all its forms (SDG 1).

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

The second SDG emphasizes the importance of ensuring that children and other vulnerable people have access to sufficient, nutritious food year round, thereby ensuring food security. Achieving this goal requires promoting sustainable agricultural practices, improving the livelihoods and capacities of small-scale famers, and allowing equal access to land, technology and markets. Also, international cooperation is required to ensure that investments are made in infrastructure and technology to improve agricultural

productivity. The targets for this goal also address the food trade and food commodity trading issues, emphasizing the need to correct and prevent trade restrictions and distortions in world agricultural markets and also calling for the adoption of measures to ensure the proper functioning of food commodity markets and the financial derivatives trading that is based on them to help limit extreme food-price volatility.

NTDs have both direct and indirect impacts on nutrition in that anaemia and malnutrition are common side effects of several NTDs (*25*). Direct impacts include the effects of parasites such as soil-transmitted helminths, which consume the nutrients required to keep people healthy (*26*). Soil-transmitted helminths compete for nutrients within the host, thereby reducing the impact of food aid and other forms of nutritional transfer. The nutritional impairment caused by schistosomes and soil-transmitted helminths during childhood has been shown to have an impact on children's growth and development (*27*). Food animals are also affected, such as ruminants who fail to put on weight as a result of helminth infections (*28*) and cows that produce up to 15% less milk as a result of nematode infections (*29*). Trypanosomiasis in domestic animals, particularly in cattle, causes serious economic losses in livestock from anaemia, loss of condition and emaciation (*30*). Also notable are the frequently fatal outbreaks of Chagas disease caused by fruit juices contaminated with *T. cruzi*, the causative parasite; these outbreaks have directly affected food security in the Bolivarian Republic of Venezuela (*31*).

The indirect impacts of NTDs include the debilitating effects on those living with disease, such as farmers who are less able to work and, thus, are less able to produce the crops needed to feed themselves and their families, and impoverished consumers who are less able to pay for the food they need. Such impacts are reflected in a term used in Mali for dracunculiasis that translates to "the disease of the empty granary"; the peak transmission period for dracunculiasis often coincides with the agricultural season (*32*). Other examples of the indirect impact of NTDs are trichiasis and onchocerciasis, both of which prevent women from working due to visual impairment, including fulfilling their traditional role as primary food providers (*33*), as well as making it difficult to work, weed, collect firewood, socialize and even to walk outside (*34*).

Thus, controlling and eliminating NTDs contributes to improving agricultural productivity, increasing food security and improving the nutritional status of affected communities. Cost–effective interventions of proven efficacy include periodically deworming children (*35*) together with making improvements to water and sanitation services (*36*) and providing health education (*37*), all of which have been shown to reduce the transmission of schistosomes and soil-transmitted helminths (*38–40*).

With regard to agriculture, the evidence of the beneficial impact of NTD interventions on nutrition includes a study carried out in 2014 showing that the 600 million people who depend on healthy livestock that might be affected by zoonotic NTDs, such as cysticercosis, would derive multiple benefits by integrating the sustainable management of helminth infections into the whole-farm economic context using a combination of laboratory diagnostics and animal health economics. The study concluded that benefits from this integration would include increases in the safety and quality of food and an increased return on the investment in food security (*28*).

Goal 3. Ensure healthy lives and promote well-being for all at all ages

The health goal of the SDGs has 13 targets, several of which are more or less direct transfers from the MDGs, but the target for infectious diseases (3.3) has been expanded to include hepatitis, waterborne infections, and NTDs. Passed over in the MDGs as "other diseases", NTDs have now been accorded a specific target, reflecting their importance in terms of their global prevalence and their social, economic and developmental consequences.

Another important addition to the health goal is the inclusion of a target (3.8) for UHC. This is the only target that cuts across all of the other targets for the health goal and that also addresses linkages with health-related targets in the other goals. Ensuring that essential services reach all those who need them (a core UHC imperative) is at the heart of the NTD response and is a fundamental component of WHO's Roadmap for implementing the 2012 NTD strategy (*41*), endorsed by Resolution WHA66.12 on neglected tropical diseases adopted by the Sixty-sixth World Health Assembly in 2013 (*42*).

NTD programmes and interventions are closely aligned with goals for UHC or have components that have relevance for UHC (discussed in detail in **section 4.2**). These UHC goals include defining and delivering an essential package of high-quality interventions across the full continuum of services, expanding the coverage of services to ensure they reach all who need them, and providing financial protection to minimize out-of-pocket payments and financial hardship. The notion of equitable access is woven into the fabric of the NTD agenda, serving as a constant reminder that cost–effectiveness is not the sole criterion for prioritizing services and that explicit consideration must be given to the most disadvantaged groups, including the low-income, rural and marginalized communities that are most at risk of NTDs. By preventing NTDs, programmes reduce the physical and mental health effects of these diseases and their catastrophic and impoverishing costs (*24*).

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Since 2000, there has been significant progress in achieving the target of universal primary education. The total enrolment rate in developing regions reached 91% in 2015, and the number of children out of school worldwide has dropped by almost half. There has also been a dramatic increase in literacy rates, and many more girls are in school now than ever before. However, despite these advances, challenges remain and, going forward, progress will depend on all girls and boys having access to free, high-quality primary and secondary education, as well as equal access to affordable vocational training. It also requires equal access to all levels of education and vocational training for those who are vulnerable, including people living with disabilities, indigenous peoples and children in difficult circumstances. This goal's focus on achieving high-quality education for all reaffirms the belief that education is one of the most powerful drivers of sustainable development.

That NTDs have a direct impact on school attendance and students' performance is well established. For example, multiple studies have described the impact of soil-transmitted helminth and schistosome infections on children, reducing both their performance in

school and their attendance rates (*43*,*44*,*45*). As many as 2 billion people are estimated to suffer from intestinal worms, such as roundworm, hookworm or whipworm (*46*), with the largest burden of disease being found in sub-Saharan Africa and in South Asia. Soil-transmitted helminthiases continue to have a significant impact on public health, particularly in rural communities and particularly on children's school participation (*47*) and cognitive ability (*48*). The indirect effects of NTDs on education include the stigma and exclusion that are associated with disfiguring diseases (*49*).

A single dose of the inexpensive, safe and easily administered medicines albendazole and mebendazole is effective in treating worms. The fact that these medicines have no significant side effects for uninfected children (and the fact that screening children for infection is significantly more expensive than treating them) has pointed global health policy-makers towards mass treatment for populations in which there is a high prevalence, including school-aged children (*50*). Increases in school attendance associated with deworming occur for several reasons, some of which are direct and related to morbidity. For example, deworming has been shown to improve cognition both in the short- and long-term (that is, in communities *7*–10 years after treatment) (*51*,*52*).

The school-based delivery of anthelminthic medicines is one of the most cost–effective interventions that can be used to increase school attendance and performance, as evidenced by a number of studies highlighting its positive impacts on children's health, nutritional status, cognitive function and educational achievement (*53*). A notable success story is the school-based deworming programme in Kenya: it has reduced absenteeism by 25% and added 1 year to the average duration of a child's education (*44*). A long-term study of the impacts of school-based deworming after 10 years revealed that males stayed enrolled for more years of primary school, worked 17% more hours each week, spent more time in non-agricultural self-employment, were more likely to hold manufacturing jobs, and missed one fewer meal per week (*54*). The same study showed that women were approximately one quarter more likely to have attended secondary school, thus halving the gender education gap (*54*).

The verdict from this body of evidence is clear: deworming treatment is not only highly effective and inexpensive, but it is easy to administer through public schools and brings benefits to children years after treatment. Although studies are expensive and logistically difficult to undertake, there is a need to measure these benefits using robust clinical trials to provide high-quality evidence for systematic reviews (*55*). Nevertheless, with hundreds of millions of children still at risk of worm infections worldwide, providing free school-based deworming treatment is an easy policy win for health, education and development.

Goal 6. Ensure availability and sustainable management of water and sanitation for all

During recent decades, the progress made on improving water and sanitation has been remarkable, with an estimated 2.1 billion people gaining access to an improved water source since 1990. According to data from 2015, nearly 90% of people worldwide have access to an improved water source, which means water is piped into a dwelling, plot or yard; obtained from a public tap or well; or collected from a protected spring or rainwater (*56*). Unfortunately, this still means that around 633 million people do not

have access to an improved drinking-water source and that access to such a source does not mean that the water is necessarily clean. In 2014, a literature review reported that in 38% of 191 studies about 25% of samples from improved sources contained faecal contamination (*57*). Additionally, an estimated 40% of people around the world are affected by water scarcity, a number that is projected to increase with the rise of average global temperatures. The progress made on improving sanitation has been even less impressive, with 36% of the world's population, or nearly 2.5 billion people, lacking access to improved sanitation facilities, putting them at risk of enteric diseases, including dysentery, cholera, typhoid, schistosomiasis and intestinal worms (*56*).

Ensuring universal access to safe and affordable drinking–water by 2030 not only requires making investments in infrastructure to support the provision of sanitation facilities but also making investments in efforts to support behavioural change, in particular to discourage the widespread practice of open defecation. It also requires protecting and restoring water-related ecosystems, such as forests, mountains and wetlands. Additionally, greater international cooperation is needed to encourage moves towards water efficiency and to support the use of treatment technologies in developing countries (*58*).

NTD programmes and initiatives have a particularly important role in achieving the goals associated with water, sanitation and hygiene because of the prime importance of safe water in reducing exposure to many of the pathogens that cause NTDs. Many of these pathogens thrive where water and sanitation are inadequate; for example, water contaminated with faeces and urine may contain worm eggs that can contaminate surface water and lead to the transmission of schistosomiasis. These eggs may come from the faeces and urine of humans and reservoir hosts, such as cows and buffalos, making it important to protect fresh water from animals and their waste. Poorly constructed latrines facilitate the breeding of the *Culex* mosquito, which transmits the filarial parasites that cause lymphatic filariasis in humans (*59*). Similarly, *Ae. aegypti*, the major vector of arboviruses, breeds in water found, for example, in discarded tyres, containers and plant pots (*60*). In some cases, water may be clean but because of the way it is stored it becomes a larval habitat for the *Ae. aegypti* and *Ae. albopictus* mosquitoes, which transmit the dengue, Zika and chikungunya viruses to humans (*24*). (Zika virus disease has not been formally recognized as an NTD, but its inclusion is being discussed.)

Access to clean water is essential for tackling some diseases; for example, trachoma, a preventable cause of blindness, is spread not only by an eye-seeking fly (*Musca sorbens*, which breeds primarily in human faeces) that transmits the *Chlamydia trachomatis* bacterium, but also by dirty fingers and fomites. Maintaining facial cleanliness, which requires clean water, and making environmental improvements are the primary prevention components of WHO's SAFE strategy for trachoma elimination (*61*); SAFE refers to surgery for trichiasis, antibiotics, facial cleanliness and environmental improvement. Unfortunately, the people affected by NTDs are often stigmatized and may be excluded from accessing water and sanitation facilities, thus increasing their risk of poverty and severe illness (*49*).

Interventions to improve water, sanitation and hygiene (known as WASH interventions) are essential in preventing many NTDs. The global dracunculiasis eradication programme has assisted in providing increased access to safe water through bore holes and protected wells (*62*). And studies have concluded that developing and managing water resources is vital to control schistosomiasis (*63*); also, having latrines for individual households is

associated with lower rates of infection with soil-transmitted helminths compared with sharing sanitation facilities (*64*).

Systematic reviews have found that having access to safe water was associated with a significantly reduced chance of *Schistosoma* infection and that access to adequate sanitation was associated with significantly lower odds of infection with both *S. mansoni* and *S. haematobium* (*65*). Another systematic review found that better hygiene in children was associated with lower odds of developing trachoma and that access to sanitation was associated with 15% lower odds of having active trachoma and 33% lower odds of having *C. trachomatis* infection of the eyes (*66*). Also, access to safe water, sanitation and hygiene and better hygiene practices were associated with 33–70% lower odds of infection with soil-transmitted helminths (that is, people who washed their hands after defecating were less than half as likely to be infected as those who did not) (*67*).

In August 2015, WHO launched a global strategy and action plan to integrate WASH with other public health interventions, reflecting the cross-sectoral nature of the challenges to accessing safe water and sanitation and improved hygiene, and the fact that this component of the NTD strategy had not received attention commensurate with its importance (*68*). The expectation is that integrating approaches to NTDs and WASH efforts will increase efficiencies and, thus, sustainability. It will also ensure that investments in WASH reach those who need them most (this is discussed in more detail in **section 4.3**).

Achieving universal access to safe water and sanitation and improving hygiene requires focusing on those who are the poorest and hardest to reach: these are the same groups most affected by NTDs. However, the target date for the Roadmap is 2020, which is 10 years earlier than the SDG targets for ensuring access to water, sanitation and improved hygiene in communities, schools and health care facilities. Thus, integration may add impetus to the WASH agenda that targets the most vulnerable people. Only by achieving the targets for water, sanitation and hygiene will a sustained reduction of transmission in those NTDs associated with water and sanitation be ensured. Thus, making progress on certain NTDs can also serve as a proxy for equity and the effective targeting of WASH programmes. The joint NTD–WASH strategy has the potential to make an important contribution to global efforts to achieve the SDGs, most notably in regard to achieving UHC while addressing some of the key determinants of human health.

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

It is estimated that more than half of the world's population lives in urban areas, and by 2050, it is expected that 6.5 billion people will live in cities, accounting for two thirds of humanity. The growth of cities in the developing world, driven in part by increasing migration from rural to urban areas, has led to the development of megacities. In 1990, there were 10 megacities that each had 10 million inhabitants or more. In 2014, there were 28 megacities, home to a total of 453 million people. Given the strains already apparent in urban centres, it is clear that sustainable development cannot be achieved without significantly transforming the way that urban spaces are built and managed. To make such cities safe and sustainable requires ensuring access to safe and affordable housing, which will require upgrading slum settlements. It will also involve investing in

mass transport systems, creating green spaces, and engaging in urban planning and management that is both participatory and inclusive.

Although NTDs are often thought to concern solely remote rural areas, several are profoundly rooted in the urban environment. This is partly because of the conditions in which the urban poor often live and partly because of the affinity of certain NTD vectors for urban areas. Mosquitoes such as *Ae. aegypti* – the world's most efficient vector of viruses, including the dengue, Zika, chikungunya and yellow fever viruses – thrive in urban areas. In part, this is due to the ideal breeding grounds provided by the urban environment, as demonstrated in a study undertaken in Dar es Salaam, where more than 70% of larval habitats for *Anopheles* were found to be manmade (*59*). Leishmaniasis is also transmitted in urban and periurban settings and has been reported in Afghanistan (in Khabul) (*69*), Brazil (in Fortaleza) (*70*) and the Syrian Arab Republic (in Aleppo) (*71,72,73*). The disease's spread in Europe (*74*) led to an outbreak in Madrid (*75*). The movement of people also increases the risk of NTDs becoming established in cities that were previously unaffected; for example, the 2013 outbreak of chikungunya in the Caribbean led to a sevenfold increase in infections imported to Spanish cities where the vector was present, thereby posing the threat of autochthonous transmission (*76*).

The global incidence of dengue has grown dramatically in recent decades, partly due to urban growth, with the result that roughly half of the world's population is now at risk of infection (*77*). Dengue thrives in urban slums: community-based surveillance in a slum in Salvador, Brazil, found that of 2962 patient with acute febrile illness, 651 (22%) had laboratory evidence of dengue infection (*78*). The study also suggested that socioeconomic development could potentially mitigate risk factors for both dengue and non-dengue cases of acute febrile illness and that residential proximity to a health care facility was associated with improved case detection (*78*).

WHO's guidelines on preventing or reducing transmission of the dengue virus focus on controlling the mosquito vectors or interrupting human–vector contact. Activities to control transmission are directed at removing the habitats of the immature and adult stages of mosquitoes from the household and immediate vicinity as well as from other settings where human–vector contact occurs (for example, schools, hospitals and workplaces), unless there is sound evidence that *Ae. albopictus* or other mosquito species are the local vectors of dengue. Additional emphasis is being placed on community-based vector-control strategies that include environmental management (*79*).

The triatomine bug, a vector for Chagas disease, is another cause for concern because it is associated with poor-quality housing in urban areas (*80*). In the Southern Cone countries of Latin America the disease has resurged despite previous successes in controlling domestic transmission in urban settings with indoor residual spraying (*81,82*). The control measures for Chagas disease have tended to rely on indoor residual spraying, but improving the quality of housing is also important to reduce the number of sites within houses where vectors can live and breed (such as cracks in walls or spaces behind pictures, and in poor roofing materials); these improvements are usually implemented as part of integrated approaches that combine spraying, environmental management and improvement, as well as community mobilization. Because of the focus on domestic

transmission, there has been a tendency to neglect peridomestic transmission. As with so many NTD-related endeavours, community participation and ownership of control efforts is crucial (*83*).

Initiatives to control dengue and Chagas disease and their targets are closely aligned with the targets set out in this SDG. The effective prevention of NTDs addresses many of the social factors that produce unequal health outcomes for slum residents, in addition to improving sanitation through integrated NTD–WASH interventions. Environmental health strategies, in particular those recognizing the need to control vectors, should be incorporated into future planning within cities. In Spain, for example, an unusual urban outbreak of leishmaniasis was attributed to the conversion of agricultural land to urban parkland, which may have brought a transmission cycle formerly in the wild into contact with people (*75*). This outbreak could have been prevented if vector-borne diseases had been considered during the planning stage.

4.1.4 Other alignments among the Sustainable Development Goals and the Roadmap targets for NTDs

The preceding SDGs have the most obvious relevance for NTDs and vice versa, and they will be used to track the progress made towards achieving NTD goals (discussed in section 4.3). However, there are many other areas of alignment among the responses to NTDs and the remaining SDGs. A full exploration of the ways in which the NTDs interact with all of the SDGs is discussed in more detail elsewhere (*84*).

In some cases, this alignment reflects the close connections among the SDGs themselves. For example, the anti-poverty goal (SDG 1) is closely related to the goal to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" (SDG 8). The direct impact of NTDs is enormous, especially when taken together with the social and psychological burdens they impose (*6*,*43*,*85*). The disabilities, disfigurement and debilities of NTDs, including the mental health impacts (23,*86*), coupled with secondary impacts, such as exclusion and prejudice, prevent adults from working and providing for their families, as well as from contributing to the economic development of their countries.

The goal to "reduce inequality within and among countries" (SDG 10) also focuses on alleviating poverty. Target 10.1 explicitly calls for sustained income growth for the bottom 40% of the population in every country at a rate higher than the national average. Target 10.2 calls for efforts "to empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status". Here, too, NTD programmes and initiatives have an important role in reducing the discrimination, exclusion and stigmatization of those living with NTDs.

Stigmatization is also a core concern of the goal to "promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels" (SDG 16). Just and inclusive societies are incompatible with excluding or stigmatizing groups of people or communities. A number of NTD programmes focus on reducing stigmatization, including those aimed at

controlling leprosy (*87*), onchocerciasis (*88*), lymphatic filariasis (86), Buruli ulcer (*89*), leishmaniasis (*90*), schistosomiasis (*91*) and Chagas disease (*92*).

Aiming to "strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development" (SDG 17) stands somewhat apart from the other SDGs, having overarching significance for the mobilization of resources and for capacity strenghtening for all SDGs. The SDGs can be realized only through strong commitments to building global partnerships and cooperation, including partnerships among governments, the private sector and civil society.

The NTD agenda has been characterized by strong global partnerships from the beginning. Generally under the guidance or leadership of WHO, these have proven key to tackling the diseases effectively and have helped to mobilize resources (*1*). Examples abound, dating back to 1966, with the founding of the International Federation of Anti-Leprosy Associations, and later with other partnerships established throughout the 1990s. Recent partnerships include the NTD NGDO Network, established in October 2009 to provide a global forum for nongovernmental development organizations and a range of other partners, and Uniting to Combat Neglected Tropical Diseases, a group of dedicated partners who are working to meet the challenges of the London Declaration.

Such partnerships have brought together a broad range of actors, including governments and other stakeholders in countries where NTDs are endemic, international agencies and nongovernemental organizations, professionals in academia and civil society, and United Nations agencies and pharmaceutical companies (*4*). Many of these partners have come together as a result of the more integrated approaches being taken to address prevention and control, which have coalesced around WHO's *Global plan to combat neglected tropical diseases 2008–2015* (*93*) and the Roadmap (*41*).

4.1.5 Conclusions

As this section has shown, NTDs and the responses developed for their control or elimination are woven into the fabric of the 2030 Agenda for Sustainable Development (*2*). Not only are there many areas of alignment, but many NTD programmes and interventions have implications for multiple goals. This is true, for example, of preventive chemotherapy, the delivery of which has a bearing on poverty, nutrition, education, employment and gender equality. Combating vector-borne diseases by providing piped water or ensuring water is stored safely has an impact on keeping populations healthy. It is also clear that many of the challenges presented by NTDs require the kind of multisectoral responses encouraged by the 2030 SDG agenda, as shown by the numerous alliances of partners working to end NTDs. Nowhere is the issue of integration more pertinent than in regard to the health goal (SDG 3), which requires the alignment of multiple programmes and initiatives to move towards the overarching goal of UHC. Section 4.2 discusses UHC.

References

1. Working to overcome the global impact of neglected tropical disease: first WHO report on neglected tropical diseases. Geneva: World Health Organization; 2010 (WHO/HTM/NTD/2010.1 (http://apps.who.int/iris/bitstream/10665/44440/1/9789241564090_eng.pdf).
2. Transforming our world: the 2030 Agenda for Sustainable Development [Resolution A/RES/70/1 adopted by the General Assembly on 25 September 2015). New York (NY): United Nations; 2015 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).
3. Samuels F, Rodríguez Pose R. Why neglected tropical diseases matter in reducing poverty [Working paper 03). ODI Development Progress; 2013 (http://www.developmentprogress.org/sites/developmentprogress.org/files/resource-document/why_neglected_tropical_diseases_matter_in_reducing_poverty.pdf).
4. Molyneux DH. The "Neglected Tropical Diseases": now a brand identity; responsibilities, context and promise. Parasit Vectors. 2012;5:23. doi:10.1186/1756-3305-5-23.
5. Health in 2015: from MDGs, Millennium Development Goals, to SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf).
6. Conteh L, Engels T, Molyneux DH. Socioeconomic aspects of neglected tropical diseases. Lancet. 2010;16:239–47. doi:10.1016/S0140-6736(09)61422-7.
7. Huy R, Wichmann O, Beatty M, Ngan C, Duong S, Margolis HS et al. Cost of dengue and other febrile illnesses to households in rural Cambodia: a prospective community-based case-control study. BMC Public Health. 2009;9:155. doi:10.1186/1471-2458-9-155.
8. Anoopa Sharma D, Bern C, Varghese B, Chowdhury R, Hague R, Ali M et al. The economic impact of visceral leishmaniasis on households in Bangladesh. Trop Med Int Health. 2006;11:757–64. https://www.ncbi.nlm.nih.gov/pubmed/16640630.
9. Uranw S, Meheus F, Baltussen R, Rijal S, Boelaert M. The household costs of visceral leishmaniasis care in south-eastern Nepal. PLoS Negl Trop Dis. 2013;7:e2062. doi.org/10.1371/journal.pntd.0002062.
10. Perera M, Whitehead M, Molyneux D, Weerasooriya M, Gunatilleke G. Neglected patients with a neglected disease? A qualitative study of lymphatic filariasis. PLoS Negl Trop Dis. 2007;1:e128. doi.org/10.1371/journal.pntd.0000128.
11. Boelaert M, Meheus F, Robays J, Lutumba P. Socio-economic aspects of neglected diseases: sleeping sickness and visceral leishmaniasis. Ann Trop Med Parasitol. 2010;104:535–42. doi:10.1179/136485910X12786389891641.
12. Soumahoro M-K, Boelle P-Y, Gaüzere B-A, Atsou K, Pelat C, Lambert B et al. The Chikungunya epidemic on La Réunion island in 2005–2006: a cost-of-illness study. PLoS Negl Trop Dis. 2011;5:e1197. doi.org/10.1371/journal.pntd.0001197.
13. Nkwengulila G. The financial costs associated with porcine cysticercosis and epilepsy in Iringa rural district. Health (NY). 2014;6:2959–65. doi:10.4236/health.2014.621334.
14. Estimates for 2000–2012. In: Health statistics and information systems [website). Geneva: World Health Organization; 2017 (http://www.who.int/healthinfo/global_burden_disease/estimates/en, accessed 13 March 2017).
15. Hotez PJ. NTDs V.2.0: "blue marble health"–neglected tropical disease control and elimination in a shifting health policy landscape. PLoS Negl Trop Dis. 2013;7:e2570. doi.org/10.1371/journal.pntd.0002570.
16. Hotez PJ. Fighting neglected tropical diseases in the southern United States. BMJ. 2012;345:e6112. doi:10.1136/bmj.e6112.
17. Taylor HR, Fox SS, Xie J, Dunn RA, Arnold A-LMR, Keeffe JE. The prevalence of trachoma in Australia: the National Indigenous Eye Health Survey. Med J Aust. 2010;192:248–53 (PMID:20201757).

18. Ready PD. Leishmaniasis emergence in Europe. Euro Surveill Bull Eur Sur Mal Transm Eur Commun Dis Bull. 2010;15:19505. https://www.ncbi.nlm.nih.gov/pubmed/20403308.
19. Succo T, Leparc-Goffart I, Ferré J-B, Roiz D, Broche B, Maquart M et al. Autochthonous dengue outbreak in Nîmes, South of France, July to September 2015. Eurosurveillance. 2016;21. doi:10.2807/1560-7917.ES.2016.21.21.30240.
20. Lourenço J, Recker M. The 2012 Madeira dengue outbreak: epidemiological determinants and future epidemic potential. PLoS Negl Trop Dis. 2014;8:e3083. http://dx.doi.org/10.1371/journal.pntd.0003083.
21. Viennet E, Ritchie SA, Williams CR, Faddy HM, Harley D. Public health responses to and challenges for the control of dengue transmission in high-income countries: four case studies. PLoS Negl Trop Dis. 2016;10:e0004943. doi:10.1371/journal.pntd.0004943.
22. Boissier J, Grech-Angelini S, Webster BL, Allienne J-F, Huyse T, Mas-Coma S et al. Outbreak of urogenital schistosomiasis in Corsica (France): an epidemiological case study. Lancet Infect Dis. 2016;16:971–9. doi:10.1016/S1473-3099(16)00175-4.
23. Litt E, Baker MC, Molyneux D. Neglected tropical diseases and mental health: a perspective on comorbidity. Trends Parasitol. 2012;28:195–201. doi:10.1016/j.pt.2012.03.001.
24. Investing to overcome the global impact of neglected tropical diseases: third WHO report on neglected tropical diseases. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/2015.1; http://apps.who.int/iris/bitstream/10665/152781/1/9789241564861_eng.pdf).
25. Hotez PJ, Molyneux DH. Tropical anemia: one of Africa's great killers and a rationale for linking malaria and neglected tropical disease control to achieve a common goal. PLoS Negl Trop Dis. 2008;2:e270. doi.org/10.1371/journal.pntd.0000270.
26. Crompton DWT, Nesheim MC. Nutritional impact of intestinal helminthiasis during the human life cycle. Annu Rev Nutr. 2002;22:35–59. doi:10.1146/annurev.nutr.22.120501.134539.
27. Hall A, Hewitt G, Tuffrey V, de Silva N. A review and meta-analysis of the impact of intestinal worms on child growth and nutrition. Matern Child Nutr. 2008;4 Suppl 1:118–236. doi:10.1111/j.1740-8709.2007.00127.
28. Charlier J, van der Voort M, Kenyon F, Skuce P, Vercruysse J. Chasing helminths and their economic impact on farmed ruminants. Trends Parasitol. 2014;30:361–7. doi:10.1016/j.pt.2014.04.009.
29. Perri AF, Mejía ME, Licoff N, Lazaro L, Miglierina M, Ornstein A et al. Gastrointestinal parasites presence during the peripartum decreases total milk production in grazing dairy Holstein cows. Vet Parasitol. 2011;178:311–8. doi:10.1016/j.vetpar.2010.12.045.
30. Achukwi MD, Tanya VN, Hill EW, Bradley DG, Meghen C, Sauveroche B et al. Susceptibility of the namchi and kapsiki cattle of Cameroon to trypanosome infection. Trop Anim Health Prod. 1997;29:219–26. doi:10.1007/BF02632308.
31. Noya BA de, Díaz-Bello Z, Colmenares C, Ruiz-Guevara R, Mauriello L, Muñoz-Calderón A et al. Update on oral Chagas disease outbreaks in Venezuela: epidemiological, clinical and diagnostic approaches. Mem Inst Oswaldo Cruz. 2015;110:377–86. doi:10.1590/0074-02760140285.
32. Biswas G, Sankara DP, Agua-Agum J, Maiga A. Dracunculiasis (guinea worm disease): eradication without a drug or a vaccine. Philos Trans R Soc B Biol Sci. 2013;368:20120146–20120146. doi:10.1098/rstb.2012.0146.
33. Palmer SL, Winskell K, Patterson AE, Boubacar K, Ibrahim F, Namata I et al. "A living death": a qualitative assessment of quality of life among women with trichiasis in rural Niger. Int Health. 2014;6:291–7. doi:10.1093/inthealth/ihu054.
34. Frick KD, Melia BM, Buhrmann RR, West SK. Trichiasis and disability in a trachoma-endemic area of Tanzania. Arch Ophthalmol Chic Ill 1960. 2001;119:1839–44. https://www.ncbi.nlm.nih.gov/pubmed/11735797.

35. Turner HC, Truscott JE, Hollingsworth TD, Bettis AA, Brooker SJ, Anderson RM. Cost and cost-effectiveness of soil-transmitted helminth treatment programmes: systematic review and research needs. Parasit Vectors. 2015;8:355. doi:10.1186/s13071-015-0885-3.

36. Campbell SJ, Savage GB, Gray DJ, Atkinson J-AM, Soares Magalhães RJ, Nery SV et al. Water, sanitation, and hygiene (WASH): a critical component for sustainable soil-transmitted helminth and schistosomiasis control. PLoS Negl Trop Dis. 2014;8:e2651. doi:10.1371/journal.pntd.0002651.

37. Ndeffo Mbah ML, Kjetland EF, Atkins KE, Poolman EM, Orenstein EW, Meyers LA et al. Cost-effectiveness of a community-based intervention for reducing the transmission of *Schistosoma haematobium* and HIV in Africa. Proc Natl Acad Sci. 2013;110:7952–7. doi:10.1073/pnas.1221396110.

38. Guanghan H, Dandan L, Shaoji Z, Xiaojun Z, Zenghua K, Guojun C. The role of health education for schistosomiasis control in heavy endemic area of Poyang Lake region, People's Republic of China. Southeast Asian J Trop Med Public Health. 2000;31:467–72. https://www.ncbi.nlm.nih.gov/pubmed/11289003.

39. Doenhoff MJ, Hagan P, Cioli D, Southgate V, Pica-Mattoccia L, Botros S et al. Praziquantel: its use in control of schistosomiasis in sub-Saharan Africa and current research needs. Parasitology. 2009;136:1825. doi:10.1017/S0031182009000493.

40. van Secor W. Water-based interventions for schistosomiasis control. Pathog Glob Health. 2014;108:246–54. doi:10.1179/2047773214Y.0000000149.

41. Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation [Roadmap approved by the Strategic and Technical Advisory Group for Neglected Tropical Diseases in 2011]. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/2012.2; http://www.who.int/neglected_diseases/NTD_RoadMap_2012_Fullversion.pdf).

42. Resolution WHA66.12. Neglected tropical diseases. In: Sixty-sixth World Health Assembly. Geneva: 20–28 May 2013. Resolutions and decisions, annexes. Geneva: World Health Organization; 2013 (http://apps.who.int/gb/ebwha/pdf_files/WHA66-REC1/A66_REC1-en.pdf#page=25).

43. Hotez PJ, Fenwick A, Savioli L, Molyneux DH. Rescuing the bottom billion through control of neglected tropical diseases. Lancet. 2009;373:1570–5. doi:10.1016/S0140-6736(09)60233-6.

44. Miguel E, Kremer M. Worms: identifying impacts on education and health in the presence of treatment externalities. Econometrica. 2004;72:159–217. doi:10.1111/j.1468-0262.2004.00481.

45. Sakti H, Nokes C, Hertanto WS, Hendratno S, Hall A, Bundy DA et al. Evidence for an association between hookworm infection and cognitive function in Indonesian school children. Trop Med Int Health. 1999;4:322–34. https://www.ncbi.nlm.nih.gov/pubmed/10402967?dopt=Abstract.

46. Bundy DAP, Kremer M, Bleakley H, Jukes MCH, Miguel E. Deworming and development: asking the right questions, asking the questions right. PLoS Negl Trop Dis. 2009;3:e362. doi.org/10.1371/journal.pntd.0000362.

47. Ahmed A, Al-Mekhlafi HM, Azam MN, Ithoi I, Al-Adhroey AH, Abdulsalam AM et al. Soil-transmitted helminthiasis: a critical but neglected factor influencing school participation of Aboriginal children in rural Malaysia. Parasitology. 2012;139:802–8. doi:10.1017/S003118201100237X.

48. Liu C, Luo R, Yi H, Zhang L, Li S, Bai Y et al. Soil-transmitted helminths in southwestern China: a cross-sectional study of links to cognitive ability, nutrition, and school performance among children. PLoS Negl Trop Dis. 2015;9:e0003877. doi:10.1371/journal.pntd.0003877.

49. Weiss MG. Stigma and the social burden of neglected tropical diseases. PLoS Negl Trop Dis. 2008;2:e237. doi.org/10.1371/journal.pntd.0000237.

50. Preventive chemotherapy in human helminthiasis: coordinated use of anthelminthic drugs in control interventions; a manual for health professionals and programme managers. Geneva: World Health Organization; 2006 (http://apps.who.int/iris/bitstream/10665/43545/1/9241547103_eng.pdf).

51. Nokes C, Grantham-McGregor SM, Sawyer AW, Cooper ES, Bundy DA. Parasitic helminth infection and cognitive function in school children. Proc Biol Sci. 1992;247:77–81. https://www.ncbi.nlm.nih.gov/pubmed/1349184.

52. Grigorenko EL, Sternberg RJ, Jukes M, Alcock K, Lambo J, Ngorosho D et al. Effects of antiparasitic treatment on dynamically and statically tested cognitive skills over time. J Appl Dev Psychol. 2006;27:499–526.

53. Jukes MCH, Drake LJ, Bundy DAP. School health, nutrition and education for all: levelling the playing field. Wallingford (UK); Cambridge (MA): CABI Pub; 2008.

54. Baird S, Kremer M, Hicks J, Miguel E. Worms at work: long-run impacts of child health gains. 2011 (http://cega.berkeley.edu/assets/cega_research_projects/35/Worms_at_Work_-_Long_Run_Impacts_on_Child_Health_Gains.pdf).

55. Taylor-Robinson DC, Maayan N, Soares-Weiser K, Donegan S, Garner P. Deworming drugs for soil-transmitted intestinal worms in children: effects on nutritional indicators, haemoglobin, and school performance. In: Cochrane Database of Systematic Reviews. The Cochrane Collaboration, editor. Chichester (UK): John Wiley & Sons, Ltd; 2015. doi.wiley.com/10.1002/14651858.CD000371.pub6.

56. Tracking universal health coverage: first global monitoring report. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/174536/1/9789241564977_eng.pdf).

57. Bain R, Cronk R, Wright J, Yang H, Slaymaker T, Bartram J. Fecal contamination of drinking-water in low- and middle-income countries: a systematic review and meta-analysis. PLoS Med. 2014;11:e1001644. doi:10.1371/journal.pmed.1001644.

58. Kar K, Chambers R, Plan UK. Handbook on community-led total sanitation. London: Plan UK; 2008.

59. Castro MC, Kanamori S, Kannady K, Mkude S, Killeen GF, Fillinger U. The importance of drains for the larval development of lymphatic filariasis and malaria vectors in Dar es Salaam, United Republic of Tanzania. PLoS Negl Trop Dis. 2010;4:e693. doi.org/10.1371/journal.pntd.0000693.

60. Chitolina RF, Anjos FA, Lima TS, Castro EA, Costa-Ribeiro MCV. Raw sewage as breeding site to *Aedes (Stegomyia) aegypti* (Diptera, culicidae). Acta Trop. 2016;164:290–6. doi:10.1016/j.actatropica.2016.07.013.

61. Emerson PM, Burton M, Solomon AW, Bailey R, Mabey D. The SAFE strategy for trachoma control: using operational research for policy, planning and implementation. Bull World Health Organ. 2006;84:613–9. https://www.ncbi.nlm.nih.gov/pubmed/16917648.

62. Sangodoyin AY, Ayotamuno MJ. Guinea worm control: assessing the effectiveness of drum-lined water holes. The Environmentalist. 1990;10:165–76. doi:10.1007/BF02240352.

63. Steinmann P, Keiser J, Bos R, Tanner M, Utzinger J. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. Lancet Infect Dis. 2006;6:411–25. doi:10.1016/S1473-3099(06)70521-7.

64. Heijnen M, Cumming O, Peletz R, Chan GK-S, Brown J, Baker K et al. Shared sanitation versus individual household latrines: a systematic review of health outcomes. PloS One. 2014;9:e93300. doi.org/10.1371/journal.pone.0093300.

65. Grimes JET, Croll D, Harrison WE, Utzinger J, Freeman MC, Templeton MR. The relationship between water, sanitation and schistosomiasis: a systematic review and meta-analysis. PLoS Negl Trop Dis. 2014;8:e3296. doi.org/10.1371/journal.pntd.0003296.

66. Stocks ME, Ogden S, Haddad D, Addiss DG, McGuire C, Freeman MC. Effect of water, sanitation, and hygiene on the prevention of trachoma: a systematic review and meta-analysis. PLoS Med. 2014;11:e1001605. doi:10.1371/journal.pmed.1001605.

67. Strunz EC, Addiss DG, Stocks ME, Ogden S, Utzinger J, Freeman MC. Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis. PLoS Med. 2014;11:e1001620. doi.org/10.1371/journal.pmed.1001620.

68. Water, sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/182735/1/WHO_FWC_WSH_15.12_eng.pdf).

69. Reithinger R, Mohsen M, Aadil K, Sidigi M, Erasmus P, Coleman PG. Anthroponotic cutaneous leishmaniasis, Kabul, Afghanistan. Emerg Infect Dis. 2003; 9:727–9. doi:10.3201/eid0906.030026.

70. Albuquerque PLMM, Silva Júnior GB da, Freire CCF, Oliveira SB de C, Almeida DM, Silva HF da et al. Urbanization of visceral leishmaniasis (kala-azar) in Fortaleza, Ceará, Brazil. Rev Panam Salud Pública. 2009;26:330–3.

71. Postigo JAR. Leishmaniasis in the World Health Organization Eastern Mediterranean Region. Int J Antimicob Agents. 2010;36(Suppl 1):S62–5. doi:10.1016/j.ijantimicag.2010.06.23.

72. Douba MD, Abbas O, Wali A, Nassany J, Aouf A, Tibbi MS. Chronic cutaneous leishmaniasis, a great mimicker with various clinical presentations: 12 years' experience from Aleppo. J Eur Acad Dermatol Venereol. 2012;26:1224–9. doi:10.1111/j.1468-3083.2011.04266.

73. Ashford RW, Rioux JA, Jalouk L, Khiami A, Dye C. Evidence for a long-term increase in the incidence of *Leishmania tropica* in Aleppo, Syria. Trans R Soc Trop Med Hyg. 1993;87:247–9.

74. Neiderud C-J. How urbanization affects the epidemiology of emerging infectious diseases. Infect Ecol Epidemiol. 2015;5. doi:10.3402/iee.v5.27060.

75. Carrillo E, Moreno J, Cruz I. What is responsible for a large and unusual outbreak of leishmaniasis in Madrid? Trends Parasitol. 2013;29:579–80. doi:10.1016/j.pt.2013.10.007.

76. Fernandez-Garcia MD, Bangert M, de Ory F, Potente A, Hernandez L, Lasala F et al. Chikungunya virus infections among travellers returning to Spain, 2008 to 2014. Eurosurveillance. 2016;21. doi:10.2807/1560-7917.ES.2016.21.36.30336.

77. Galvan JM. Growing burden of dengue in Latin America: A public health challenge. Int J Infect Dis. 2010;14:e169.

78. Kikuti M, Cunha GM, Paploski IAD, Kasper AM, Silva MMO, Tavares AS et al. Spatial distribution of dengue in a Brazilian urban slum setting: role of socioeconomic gradient in disease risk. PLoS Negl Trop Dis. 2015;9:e0003937.

79. Sommerfeld J, Kroeger A. Innovative community-based vector control interventions for improved dengue and Chagas disease prevention in Latin America: introduction to the special issue. Trans R Soc Trop Med Hyg. 2015;109:85–8. doi.org/10.1093/trstmh/tru176.

80. Levy MZ, Barbu CM, Castillo-Neyra R, Quispe-Machaca VR, Ancca-Juarez J, Escalante-Mejia P et al. Urbanization, land tenure security and vector-borne Chagas disease. Proc R Soc B Biol Sci. 2014;281:20141003–20141003. doi:10.1098/rspb.2014.1003.

81. Dias JCP. Southern Cone Initiative for the elimination of domestic populations of *Triatoma infestans* and the interruption of transfusional Chagas disease. Historical aspects, present situation, and perspectives. Mem Inst Oswaldo Cruz. 2007;102 Suppl 1:11–8. https://www.ncbi.nlm.nih.gov/pubmed/17891281.

82. Dias JCP, Silveira AC, Schofield CJ. The impact of Chagas disease control in Latin America: a review. Mem Inst Oswaldo Cruz. 2002;97:603–12. https://www.ncbi.nlm.nih.gov/pubmed/12219120.

83. Rojas-De-Arias A. Chagas disease prevention through improved housing using an ecosystem approach to health. Cad Saude Publica. 2001;17 Suppl:89–97. https://www.ncbi.nlm.nih.gov/pubmed/11426269.

84. Bangert M, Molyneux DH, Lindsay SW, Fitzpatrick C, Engels D. The cross-cutting contribution of the end of neglected tropical diseases to the Sustainable Development Goals. Infect Dis Poverty. 2017;6:73. doi:10.1186/s40249-017-0288-0.

85. Hotez PJ. Stigma: the stealth weapon of the NTD. PLoS Negl Trop Dis. 2008;2:e230. doi.org/10.1371/journal.pntd.0000230.

86. Ton TGN, Mackenzie C, Molyneux DH. The burden of mental health in lymphatic filariasis. Infect Dis Poverty. 2015;4. doi:10.1186/s40249-015-0068-7.

87. Tsutsumi A, Izutsu T, Md Islam A, Maksuda AN, Kato H, Wakai S. The quality of life, mental health, and perceived stigma of leprosy patients in Bangladesh. Soc Sci Med. 2007;64:2443–53. doi:10.1016/j.socscimed.2007.02.014.

88. Vlassoff C, Weiss M, Ovuga EB., Eneanya C, Nwel PT, Babalola SS et al. Gender and the stigma of onchocercal skin disease in Africa. Soc Sci Med. 2000;50:1353–68. https://www.ncbi.nlm.nih.gov/pubmed/10741573.

89. Debacker M, Aguiar J, Steunou C, Zinsou C, Meyers WM, Portaels F. Buruli ulcer recurrence, Benin. Emerg Infect Dis. 2005;11:584–9. doi:10.3201/eid1104.041000.

90. Kassi M, Kassi M, Afghan AK, Rehman R, Kasi PM. Marring leishmaniasis: the stigmatization and the impact of cutaneous leishmaniasis in Pakistan and Afghanistan. PLoS Negl Trop Dis. 2008;2:e259. doi.org/10.1371/journal.pntd.0000259.

91. Takougang I, Meli J, Fotso S, Angwafo F, Kamajeu R, Ndumbe PM. Some social determinants of urinary schistosomiasis in Northern Cameroon : implications for schistosomiasis control. Afr J Health Sci. 2005;11. doi:10.4314/ajhs.v11i3.30788.

92. Ventura-Garcia L, Roura M, Pell C, Posada E, Gascón J, Aldasoro E et al. Socio-cultural aspects of Chagas disease: a systematic review of qualitative research. PLoS Negl Trop Dis. 2013;7:e2410. doi.org/10.1371/journal.pntd.0002410.

93. The Global plan to combat neglected tropical diseases, 2008–2015. Geneva: World Health Organization; 2007 (WHO/CDS/NTD/2007.3; http://apps.who.int/iris/bitstream/10665/69708/1/WHO_CDS_NTD_2007.3_eng.pdf).

4.2 Mainstreaming NTDs in the context of universal health coverage

4.2.1 Introduction

The previous section considered at the various ways in which NTD programmes and interventions align with and contribute to the SDGs and their targets. This section focuses on NTD programmes and interventions in the context of the health goal (SDG 3), which aims to "ensure healthy lives and promote well-being for all at all ages", particularly the target for UHC (target 3.8). The health goal covers a wide range of topics, with no fewer than 13 targets designed to orient efforts towards achieving the overall goal. Table 4.2 shows that many of the MDGs have been retained and also augmented by new and more ambitious targets for 2030. The infectious disease target (3.3) retains the MDG focus on HIV and AIDS, tuberculosis and malaria, but adds specific references to NTDs, hepatitis, waterborne diseases and other communicable diseases. The SDGs also include new targets addressing noncommunicable diseases, mental health, substance abuse, injuries, health impacts from hazardous chemicals, and water and soil pollution and contamination. Implementation of the *WHO framework convention on tobacco control* (*1*) has also become a target, as has the achievement of UHC.

The order in which the targets are listed gives no sense of their relationship to one another, and the target for UHC is 3.8. In the agenda that was endorsed by heads of government as a statement of intent regarding the SDGs, the importance of UHC is emphasized: "To promote physical and mental health and well-being, and to extend life expectancy for all, we must achieve universal health coverage and access to quality health care. No one must be left behind" (*2*). In other words, achieving the health goal depends on making progress towards UHC. Since the adoption of the SDGs, it has been pointed out that UHC is the only target that binds all of the targets of the health goal, as well as addressing linkages with health-related targets in the other goals (*3*).

The strategies, programmes and interventions used to address NTDs are closely aligned with the goals for achieving UHC. The goals for UHC include delivering essential high-quality interventions across the full spectrum of services, increasing the coverage of services to ensure that they reach all who need them and ensuring financial protection that minimizes out-of-pocket payments and financial hardship. The progress made by NTD programmes during the past decade, notably through MDA of preventive chemotherapy, has led to the development of capacities and the accumulation of experience that have the potential to drive progress towards UHC and, by extension, towards achieving the health goal of the SDGs.

4.2.2 Universal health coverage within the Sustainable Development Goals

UHC is at the core of the health goal, and health-system strengthening is at the core of the UHC agenda. The delivery of high-quality, people-centred health services to all depends on the existence of robust health systems. Reflecting its importance perhaps, specific targets for health-system strengthening are also included within the health goal, namely targets 3.B–D (Table 4.2), which touch on the key issues of medicines and vaccines, the health workforce, and outbreak surveillance and response.

Table 4.2 Primary health targets for Sustainable Development Goal 3 (the health goal)

Goals	
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births
3.2	By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births
3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, waterborne diseases and other communicable diseases
3.4	By 2030, reduce by one third premature mortality from noncommunicable diseases through prevention and treatment and promote mental health and well-being
3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol
3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents
3.7	By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes
3.8	Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
3.a	Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate
3.b	Support the research and development of vaccines and medicines for the communicable and noncommunicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all
3.c	Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least-developed countries and small island developing States
3.d	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

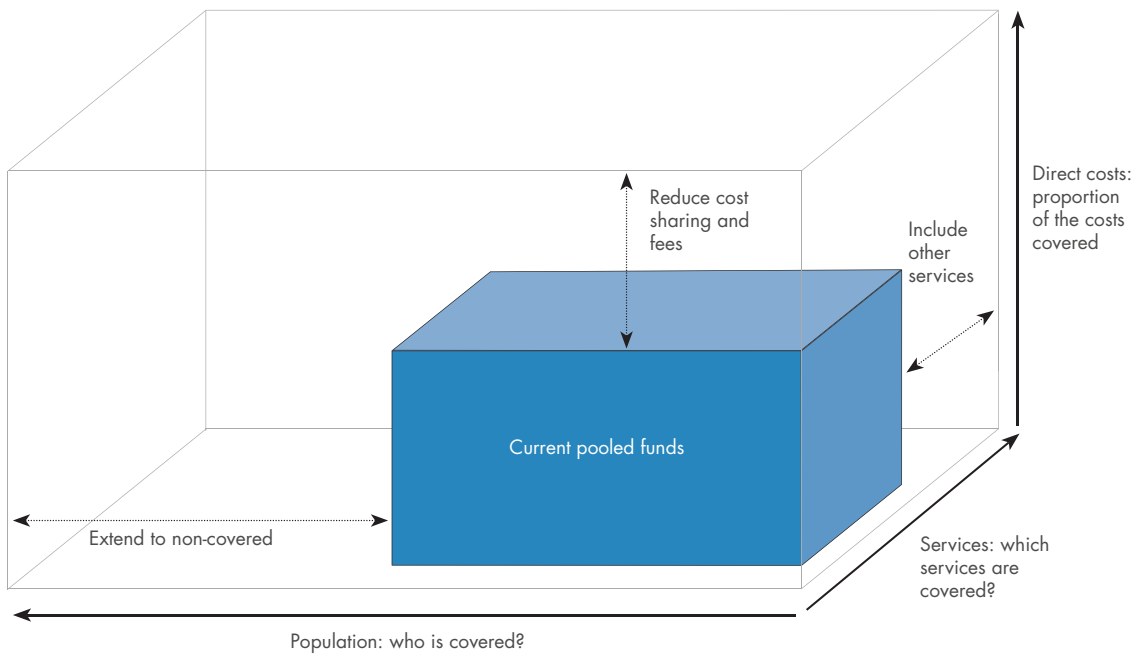
There are also a number of non-health-related SDG targets that have important implications for health and, thus, relevance for UHC (3). (These are discussed in **section 4.1**) The anti-poverty goal (SDG 1) also relates to the UHC target, which includes a component aimed at protecting people from financial risk (**Box 4.1**). Because UHC has links with all of the health-related SDG targets, it could serve as a platform for integrating all health-related activities and when combined with a Health in All Policies approach, become a powerful tool for policy development (*3*).

Box 4.1. The universal health coverage cube

WHO defines universal health coverage as "ensuring that all people have access to needed promotive, preventive, curative and rehabilitative health services, of sufficient quality to be effective, while also ensuring that people do not suffer financial hardship when paying for these services" (*4*). UHC comprises two components: coverage of health services and financial protection; both of these need to be assessed at the population level. Thus, three dimensions – health services, finance and population – are typically represented in what has come to be known as the UHC cube. (**Fig. 4.1**)

Every country strives to fill the cube, including high-income countries with long-established institutional arrangements for health systems that may, for example, be fighting to maintain their levels of coverage in the face of rising costs driven by ageing populations, an epidemiological shift towards chronic diseases, and technological advances. It is for this reason that the UHC endeavour is generally referred to as a journey rather than a destination, as a dynamic, continuing process rather than a permanent solution or state that can be achieved.

Fig. 4.1. The dimensions of the universal health coverage cube



Source: reference *3*

4.2.3 NTDs and universal health coverage

In addressing the question of how strategies for NTDs and UHC align and how NTD programmes and initiatives might be integrated into broader health systems, it is important to consider the five key interventions within the overall NTD response: innovative and intensified disease management (known as IDM), preventive chemotherapy, vector ecology and management, veterinary public health services, and the provision of safe water, sanitation and hygiene (**Box 4.2**). (See **section 2** for more detail.) Each of these interventions has a bearing on UHC imperatives and on health-system functions.

4.2.4 NTDs and the coverage of universal health services

Ensuring that essential services reach all who need them is at the heart of efforts to respond to NTDs. WHO's Roadmap for implementing the NTD strategy, launched in 2012, set clear targets for ensuring universal access to the interventions required for the eradication, elimination or control of selected NTDs by 2020 (*7*). Many countries have begun to implement the strategy, building on their local health systems and often drawing on community health workers to deliver the services required. Also, the *London declaration on neglected tropical diseases* (*9*) encouraged partners, such as the pharmaceutical industry, to provide the resources necessary to implement the Roadmap. As reported to WHO, in 2015, about 986.5 million people received preventive chemotherapy for at least 1 disease. The coverage trajectory for preventive chemotherapy continues to accelerate, increasing from 35.4% in 2008 to 62.3% in 2015 (*10*).

NTD programmes are at the forefront of efforts to ensure access to necessary services. NTDs predominantly affect poor people, but they are not solely the concern of poor countries. In 2015, 960 million of the 1.59 billion people requiring mass or individual treatment and care for NTDs were in lower-middle-income countries rather than in low-income countries (see **section 4.3**). Thus, NTDs affect those parts of populations that UHC must reach in order to be meaningful. Often, reaching these communities involves extending the concept of value for money beyond cost–effectiveness alone (see **section 4.4**). The notion of equity is woven into the fabric of the NTD agenda, serving as a constant reminder that cost–effectiveness is not the only criterion that should be used to prioritize services and that the needs of the most disadvantaged groups of people must be explicitly considered (*11*).

In some instances, the communities passed over by health systems are geographically isolated and getting treatment to them is largely a question of reaching beyond the fixed assets of health systems, such as health facilities. This kind of outreach is integral to many NTD interventions, including total community treatment, which has been used for yaws, a disabling and disfiguring disease that "begins where the road ends" (*12*). In other cases, the barriers to reaching communities that have been excluded may be sociobehavioural, and the initiatives required to overcome them may call for community-wide health education. The effects of stigmatization associated with disfiguring skin NTDs – such as Buruli ulcer, leprosy, onchocerciasis, lymphatic filariasis and cutaneous leishmaniasis – have been well documented and may discourage those living with one of these diseases from seeking care or adhering to treatment regimens (*13,14*).

Box 4.2. The five NTD interventions that are consistent with universal health coverage

Preventive chemotherapy. This refers to delivering a single dose of medication once or twice a year, usually through the widespread distribution of medicines known as MDA. For MDA to be successful, at least 65% of the population living in an endemic area must swallow the medicine. As such, the treatment is often administered by community volunteers and teachers, which enables it to be delivered to large numbers of people, including people in remote areas (*5*). This is the core intervention recommended by WHO for reducing morbidity from and the transmission of diseases for which tools exist, including safe and effective medicines that make it feasible to implement MDA. The diseases amenable to treatment with chemotherapy include lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma. Some diseases require preventive chemotherapy to be delivered with other interventions; for example, efforts to control trachoma combine medicine with strategies to improve hygiene and the environment (known as the SAFE strategy). The response to lymphatic filariasis requires not only preventive treatment but also management for people with chronic disease.

Innovative and intensified disease management. This strategy uses a variety of medical interventions, ranging from medicines to surgery, to address the symptoms of NTDs for which no effective control tools exist or in situations in which the widespread use of tools is limited. Six NTDs are targeted: three vector-borne diseases (Chagas disease, cutaneous and visceral leishmaniasis, and human African trypanosomiasis), two caused by bacteria (Buruli ulcer and yaws), and mycetoma (a fungal and bacterial infection that was added to the list of NTDs after the World Health Assembly adopted resolution WHA69.21 on addressing the global burden of mycetoma in 2016). These diseases are difficult to diagnose and treat, and they are costly to manage. Moreover, the burden they impose is poorly understood, partly as a result of inadequate investment in research. The people affected by these diseases often live in remote rural areas where they have limited access to diagnosis and treatment. The main focus of efforts has been to ensure that these diseases are managed within the primary health care systems in the affected countries, although the overall goal is to eliminate them as a public health problem. To achieve this, it is imperative that national health systems and national control programmes intensify disease management and push for new tools to be developed.

Vector ecology and management. This intervention aims to develop and promote strategies and guidelines based on the principles and approaches of integrated vector management, including the judicious use of pesticides. Vector control is important in preventing and controlling vector-borne diseases, specifically for controlling transmission. The vector-borne NTDs include dengue, lymphatic filariasis, onchocerciasis, Chagas disease, leishmaniasis and human African trypanosomiasis, but it is important to note that vectors for NTDs also carry other pathogens. For example, dengue is carried by the *Ae. aegypti* mosquito (and to a lesser extent by *Ae. albopictus*), which also carries the Zika and chikungunya viruses as well as other arboviruses. Vector ecology and management relies on national and regional coordination, and on capacity building, as emphasized in the draft *Global vector control response 2017–2030* (*6*), which calls for the realignment of vector-control programmes to be supported by increasing technical capacity, strengthening monitoring and surveillance systems, and improving infrastructure.

Veterinary public health services. This intervention addresses neglected zoonotic diseases, a subset of NTDs that are naturally transmitted from vertebrate animals to humans and vice versa. The neglected zoonotic diseases targeted in the Roadmap (*7*) are rabies, cystic and alveolar echinococcosis, *T. solium* taeniasis and cysticercosis, and foodborne trematodiases. Their management requires collaborative, cross-disciplinary and cross-sectoral efforts that reflect the complexities of the ecosystems in which humans and animals coexist. Preventing these diseases and mitigating their impacts on humans requires controlling and, when technically feasible, eliminating the diseases in their animal reservoirs. WHO is working with partner organizations to address some of these diseases, including rabies and cysticercosis, and to promote a One Health approach to tackle the spread of these diseases among people, animals and the environment.

Water, sanitation and hygiene. Interventions to provide safe water, sanitation and hygiene (known as WASH strategies) are a key component of the global NTD strategy and are critical for preventing most of these diseases, as well for caring for people with an NTD. WASH interventions are especially needed for NTDs in which transmission is closely linked to a lack of access to safe water and sanitation, such as the soil-transmitted helminthiases, schistosomiasis and trachoma. The joint NTD–WASH strategy for 2015–2020 (*8*) aims to intensify the control of or eliminate certain NTDs in specific regions by 2020. It has four objectives: improving awareness of the benefits of implementing joint WASH and NTD activities; monitoring WASH and NTD activities to track their progress; strengthening the evidence about how to deliver effective WASH interventions; and involving all stakeholders in planning, delivering and evaluating WASH and NTD programmes. (See **section 2.6** for more information.)

Often, isolation is also related to social status. Poverty is an obvious risk factor, but more specific factors may come into play. Undocumented migrant workers may be unable to access the services they need because of their legal status; for example, undocumented migrant workers may develop Chagas disease and be reluctant to seek treatment owing to their status. Chagas disease was once confined to Latin America; however, it is now present in Canada and the United States of America, and in WHO's European and Western Pacific Regions, having spread during the 20th century, partly as a result population movement driven by economic necessity. Migrants may lack access to medical attention and social security, problems complicated for thousands of Latin American migrants not only by their status but also by a lack of medical expertise in countries where the disease is not endemic (*15,16*). WHO's strategy for Chagas disease recognizes the importance of providing services to immigrants from countries where it is endemic regardless of their immigration status, and also acknowledges the difficulty of providing such care (*5*).

Reaching populations and subgroups that have been underserved by efforts to improve services and coverage in the past is an ethical imperative, but it should also be borne in mind that during the latter stages of elimination campaigns, focusing on specific locations or populations may also ensure the best use of limited resources.

NTD programmes are so closely aligned with UHC targets for population coverage that the coverage targets for 2020 in the Roadmap are considered important steps on the path towards achieving UHC by 2030. The coverage of preventive chemotherapy for NTDs has been proposed as a tracer intervention for monitoring equity in the progress being made towards UHC across population groups because this represents contributions made by the NTD community towards ensuring the fairest use of whatever financing is available for UHC (*17*). (See **section 4.3** for more information.)

4.2.5 Specific NTD-related contributions to health systems

Preventive chemotherapy is a good example of an NTD-related intervention that can have a beneficial impact on broader health systems and that can play an important part in accelerating progress towards achieving the key objectives of UHC. Before 2007, diseases were addressed by preventive chemotherapy through control programmes that operated independently and had varying degrees of success. Integrated approaches use data from disease mapping to deliver combinations of medicines to meet the needs of individual districts. Optimal population coverage – a core UHC imperative – is integral to the effectiveness of preventive chemotherapy, which depends on people in endemic and often remote areas receiving the medicines they need in the places where they live at appropriate, regular intervals. In some cases, preventive chemotherapy programmes target a subset of individuals living in a specific endemic area (for example, school-aged children), but in others, a subset may be excluded owing to the medicine being used (such as pregnant women); nonetheless, these programmes have the capacity to reach almost everyone (*18*).

One of the key reasons for the success of preventive chemotherapy programmes is the ease with which they can be implemented. Most of the medicines used for preventive chemotherapy[1] are tablets, so they are relatively easy to administer and safe for use;

1. The main medicines used in preventive chemotherapy are azithromycin, benzimidazoles, diethylcarbamazine, ivermectin and praziquantel.

adverse reactions are generally mild and self-limiting, especially when the medicine is given as a single dose (*19*). This means that delivery systems can be set up using people in the community who do not have medical qualifications, such as schoolteachers, traditional healers and community volunteers, and who will require only basic training and supervision to become effective distributors of preventive chemotherapy (*20,21*). This is immensely important in contexts in which the public health system lacks resources, as is the case in many countries where NTDs are endemic.

Although drawing on the community to administer preventive chemotherapy certainly fills important gaps in health-system capacity, the effect of community-directed distribution – the principal delivery system for preventive chemotherapy – goes far beyond that. Community-directed distribution (also referred to as community-directed intervention) has several beneficial impacts, including empowering communities and activating local health systems.

The implementation of community-directed distribution varies, but the focus is on empowering communities to take responsibility for delivering the treatment by deciding how, when and by whom it should be administered. In particular, the strategy seeks to empower the people most affected by the disease to assume specific roles and responsibilities, and to make critical decisions about the interventions that address their needs. This distribution scheme has been successfully deployed in a number of countries, most notably by the African Programme for Onchocerciasis Control (**Box 4.3**), which was started in the mid-1990s, and by using this distribution strategy has helped to ensure and sustain the delivery of annual ivermectin treatment to more than 100 million Africans, many of them living in remote areas.

Box 4.3. The African Programme for Onchocerciasis Control: the journey from control to elimination

The African Programme for Onchocerciasis Control was launched in December 1995, covering 20 African countries (*22*). By starting with epidemiological surveys, the programme found that more than 100 million people in the programme's area were at risk of onchocerciasis and needed ivermectin treatment and an estimated 37 million people were already infected (*23*). In 1997, in response to the immense coverage challenge it faced, and based on a realistic assessment of what national health systems could deliver, the programme adopted as its core strategy community-directed treatment with ivermectin. As a result, the coverage of ivermectin treatment increased from 1.5 million people covered in 1997 to more than 100 million in 2013 (*22*).

One modelled estimate suggested that by the end of 2015 the programme had saved 17.4 million disability-adjusted life-years (DALYs) during its 20-year existence, at a cost of US$ 27 per DALY. The 2015 Global Burden of Disease study estimated a 20% decline in the DALY burden of onchocerciasis between 2005 and 2015 (*24*). Between 1995 and 2010, annual MDA with ivermectin was estimated to have cumulatively averted about 500 000 DALYs that would have resulted from coendemic infections with soil-transmitted helminthiases, lymphatic filariasis or scabies, which represents an additional 5.5% relative to the total burden averted from onchocerciasis (8.9 million DALYs) (*25*).

The African Programme for Onchocerciasis Control formally ended in December 2015 (*26*), but its considerable achievements are now being built on by the Expanded Special Project for Elimination of Neglected Tropical Diseases. In addition to working to eliminate onchocerciasis, this expanded programme is also focused on accelerating the reduction and elimination of other NTDs from the African Region by 2020, namely lymphatic filariasis, schistosomiasis, soil-transmitted helminthiases and trachoma.

NTD control programmes based on community-directed distribution not only boost NTD-related capacity and activities but they also have other positive effects on health systems (*27,28*). This is especially notable with regard to primary health care services, particularly in areas where resources and infrastructure are lacking. Evidence for the ancillary benefits of community-directed distribution on broader health systems includes a three-country study that considered the effects of the African Programme for Onchocerciasis Control's community-directed treatment with ivermectin and found that most community distributors were involved in at least one other health and development activity, including: immunization, water and sanitation, family planning, vitamin A supplementation and eye care, but also community development (*29*). The community distribution approach also affected the behaviour of health workers (that is, workers employed within the health system) who became more engaged in outreach activities as a result of community distribution and who also came to view the community-based distributors as partners, involving them in additional outreach activities.

Another study found that using community-directed treatment with ivermectin efficiently provided integrated delivery of at least three additional health interventions, achieving significantly higher coverage for vitamin A supplementation, insecticide-treated nets and home management of malaria (*30*). The coverage of malaria interventions was reported to have more than doubled. The approach also affected expenditures, with the cost being lower at the district level and comparable to non-community-directed approaches at the first-line health-facility level. The community-directed strategy, building upon core primary health care principles, is an effective and efficient model for integrating the delivery of health interventions at the community level in Africa. Thus, it has the potential to be a foundational element in any national plan that is coping with scarce resources and seeking to move towards UHC.

The success of community-directed treatment with ivermectin, especially in remote areas in countries affected by conflict, has opened the doors to a number of other health care interventions that lend themselves to community-directed distribution (*31*). (In many areas in Africa where there is or was conflict, community involvement in NTD control represents one of the few actively functioning elements of a health system.) In 2015, Nigeria launched its first nationwide plan to address both lymphatic filariasis and malaria; it is based on community-directed distribution of both preventive chemotherapy and long-lasting insecticide-treated nets. Synergies are also being explored as part of a World Bank project for providing seasonal malaria chemoprevention in the Sahel subregion of Africa (*32*).

In recognition of preventive chemotherapy's and, by extension, community-directed distribution's importance as catalysts for accelerating the delivery of cost–effective primary care, the preventive chemotherapy strategy for NTDs launched by WHO in 2006 includes an operational model for strengthening primary health care services that addresses fundamental health-system elements, such as medicine supply chains, systems for monitoring, surveillance and evaluation, and mechanisms for engaging communities (*33*).

4.2.6 Other NTD initiatives that support national health systems

Preventive chemotherapy delivered through community-driven initiatives is one of the great NTD success stories of the past decade, and it is fundamentally important to developing the health systems required to make progress towards achieving UHC. But it is not the only NTD-related initiative that can benefit health systems. Other notable contributions relate to disease management, laboratory, research and surveillance capacities, and health education.

Disease management. This refers to the medical interventions used to address the symptoms of NTDs for which there are no effective preventive tools or for situations in which the widespread use of existing tools is limited. When NTD infection becomes chronic it requires medical treatment to prevent further pain, disability or even death. NTDs such as visceral leishmaniasis are nearly 100% fatal when left untreated. Surgical interventions are required for a number of manifestations of NTDs, including hydrocele in men with lymphatic filariasis, trachoma-related trichiasis, and the severe lesions due to Buruli ulcer.

WHO's strategy of innovative and intensified disease management (Box 4.2) focuses on ensuring that diseases that are not amenable to treatment with preventive chemotherapy are managed within primary health care systems in the affected countries. Although it could be argued that this focus, and the technical guidance and advocacy efforts behind it, are materially beneficial to national health systems, it is clear that the main drivers of progress in these efforts are the national health systems.

That said, specific initiatives developed by WHO have made significant contributions, such as the morbidity management and disability prevention toolkit and other resources developed with partner institutions to provide tools and templates for use when implementing the activities necessary for strengthening health-system delivery of the recommended minimum package of care for people living with lymphatic filariasis (*34*). The morbidity management and disability prevention toolkit focuses on three key areas: planning, including estimating the number of patients; building capacity to deliver the appropriate services; and documenting the services.

The Morbidity Management and Disability Prevention Project is a 5-year, US$ 35 million global project that helps countries provide high-quality treatment and care for people suffering from the debilitating effects of trachoma and lymphatic filariasis. The project, which runs from July 2014 to July 2019, is funded by the United States Agency for International Development and led by Helen Keller International in partnership with the African Filariasis Morbidity Project, the Kilimanjaro Centre for Community Ophthalmology and RTI International. Key activities of the project include developing cadres of master trainers to train local surgeons and care providers, and planning and implementing surgery for trichiasis and hydrocele, as well as engaging in lymphoedema management campaigns.

In its focus on lymphatic filariasis, the project offers surgery to men with hydrocele. The project also helps individuals with badly swollen limbs and their carers learn effective ways to manage lymphoedema and prevent recurring bouts of inflammation. In cases in which individuals refuse surgery for trichiasis, the project supports countries in offering information about proper techniques for eyelash epilation. Finally, the project also

procures the equipment and consumables needed to ensure that the surgeries offered are of high quality. The project is active in Burkina Faso, Cameroon and Ethiopia, and in many cases it is essential for providing surgical services to populations that otherwise would have little access to such treatment.

Building laboratory capacity. The effective prevention and treatment of NTDs requires reliable and efficient laboratories to carry out diagnostic tests and to support disease- and entomological mapping surveys, yet laboratory systems are often weak in the low- and middle-income countries where the majority of this testing is undertaken (*35*). The lack of capacity in laboratory systems is a major barrier to achieving the NTD goals for 2020 and the 2030 SDGs, and these needs are spurring capacity strengthening initiatives in NTD laboratories worldwide, encompassing technical training for staff, supervision for student research projects and the provision of equipment. Notable initiatives are being undertaken in Ghana, Kenya, Malawi and Sri Lanka, and these are supported by the United Kingdom's Department for International Development and funded by the Centre for Neglected Tropical Diseases at the Liverpool School of Tropical Medicine. The Centre aims to strengthen one laboratory in each of these countries to support intervention activities aimed at achieving the Roadmap's targets for 2020.

A 2014 survey of capacity-strengthening efforts in the four countries found that NTDs had been recognized as a national priority, resulting in greater national funding and support for human resources for NTD laboratories (*36*). Capacity-building plans included Kenya's national, multiyear strategic plan for controlling NTDs, which was published in 2011. In all four of the countries, NTD laboratories also reported having strong links to policy-makers and national and regional collaborations. However, the same survey revealed a number of challenges. For example, the allocation of funding for NTD research within the laboratories was reported to be a lower priority than funding for laboratory operations and management. Other challenges faced by all of the laboratories were a lack of quality assurance documentation and safety systems, a lack of formalized agreements with national NTD programmes and the need to rely on external funds. A major concern was the disease-specific focus of each laboratory, which prevented laboratories from addressing diseases of the poor as a whole (*36*).

Research and development. Making progress towards the NTD targets for 2020 and the 2030 SDGs will depend in part on ensuring there is better use of the tools available and on developing new tools to improve outcomes. WHO hosts the Special Programme for Research and Training in Tropical Diseases, or TDR, which is also sponsored by UNICEF, the United Nations Development Programme and the World Bank; the Programme has a pivotal role as a facilitator and adviser in the global health research arena (*37*). The Programme has led research in support of five major NTD elimination campaigns, generated evidence demonstrating the effectiveness of long-lasting insecticide-treated nets and artemisinin-based combination therapy, and supported implementation research for onchocerciasis control.(Box 3.2 presents innovation in research and development).

The Programme's work to strengthen research capacity includes training thousands of individual researchers in countries where NTDs are endemic and supporting local researchers to run clinical trials and develop community-based approaches to delivering treatment, including artemisinin to treat malaria and ivermectin to treat onchocerciasis and lymphatic filariasis.

The Programme has also actively supported product development partnerships; for example, the Programme acts a permanent observer at the Drugs for Neglected Diseases *initiative* which was set up in 2003 by public-sector research and health institutions in countries where NTDs are endemic. Members include the Oswaldo Cruz Foundation in Brazil, the Indian Council of Medical Research, the Kenya Medical Research Institute, the Ministry of Health of Malaysia and France's Institut Pasteur. Seed funding was provided by Médecins Sans Frontières. Among the medicines developed by the initiative are an improved treatment for human African trypanosomiasis (the result of a 6-year partnership among NGOs, governments, pharmaceutical companies and WHO); combination treatments for visceral leishmaniasis, and a paediatric formulation of benznidazole for Chagas disease.

In 2003, the Special Programme for Research and Training in Tropical Diseases, together with the Bill & Melinda Gates Foundation, also set up FIND (the Foundation for Innovative New Diagnostics), a public–private partnership that is dedicated to developing accurate and affordable diagnostic tests for use in developing countries. Also in 2003, in recognition of the Programmes' impact on health and its vital contribution to attaining the MDGs, UNICEF became a cosponsor (*38*).

Strengthening surveillance systems. NTD programmes have had a significant role in strengthening surveillance systems (*39*,*40*); for example, the Global Trachoma Mapping Project brought together health ministries, NGOs and research institutions, and was funded by the United Kingdom's Department for International Development and the United States Agency for International Development (*41*,*42*). In January 2016, the Global Trachoma Mapping Project completed population-based prevalence surveys in 1546 districts in which trachoma was suspected to be present but for which prevalence data had not been available. The data permit interventions against trachoma to be implemented where they are needed and not in areas where the prevalence of trachoma does not constitute a public health problem. The mapping project was able to fulfil its mandate while (i) simultaneously collecting data on the prevalence of dracunculiasis, rabies and yaws, as well as information on the distribution of preventive chemotherapy for those NTDs amenable to treatment with it, and on access to water and sanitation; (ii) maintaining the highest standards of quality and comparability; and (iii) ensuring that health ministries engaged in leadership and took ownership of the mapping (*43*).

The mapping project also led directly to the establishment of Tropical Data, a WHO-led service launched in July 2016 initially to support national programmes in conducting prevalence surveys for trachoma wherever they are needed (*44*). Tropical Data offers support for the full survey process, from planning and protocol development through to applying a survey's findings. The aims of the initiative include ensuring that surveys are conducted using WHO-approved methods, that outputs are of the highest quality, and that ministries of health have full ownership of their data.[1] The team behind the service is a consortium of the scientific, technological and implementation partners that made the Global Trachoma Mapping Project a success. Additional functionalities for other diseases will be added as demand warrants.

1. www.tropicaldata.org

The global programme to eliminate human African trypanosomiasis has a long history of strengthening surveillance systems. Partly because of the focal nature of the disease, control efforts have always relied heavily on disease mapping. However, the widespread diffusion of geographic information systems and satellite-aided positioning systems, such as the United States Global Positioning System, have greatly enhanced mapping capacity and are the basis of the systematic approach taken to mapping that is embodied in the Atlas of Human African Trypanosomiasis, the first attempt to geographically reference at the village level all cases of sleeping sickness reported from affected countries (*45*). The Atlas has improved the completeness and accuracy of data about this disease, thus allowing effective monitoring of control and elimination efforts; it is supported by WHO, the FAO, the global programme, national sleeping sickness control programmes, NGOs and research institutes (*46*).

The global dracunculiasis eradication programme has focused on developing community-based surveillance systems, but more sophisticated mapping tools now use remotely sensed data from Landsat (*47*). These data have permitted remote settlements in dracunculiasis-endemic areas to be identified. This information has become a potent tracking tool when used in conjunction with geographic information systems that contain digitized maps and with field data collected by handheld receivers for global positioning systems. Village-based surveillance, which was non-existent in countries such as Ghana and Nigeria at the start of the eradication programme, is now being used to report on other diseases, such as tetanus, lymphatic filariasis and leprosy (*48*,*49*). The geographic information systems database established and developed by UNICEF for the Burkina Faso eradication programme also serves other UNICEF-supported health, nutrition, education, water and sanitation interventions (*50*).

Other initiatives to strengthen surveillance systems include a project supported by WHO to create a global data warehouse for epidemiological surveillance data about leishmaniasis. The project is designed to promote prompt, accurate reporting of leishmaniasis cases from countries where all forms of the disease are endemic (*51*). WHO has also collaborated in developing an integrated NTD database (**Box 4.4**), following a recommendation made by the monitoring and evaluation working group of the Strategic and Technical Advisory Group for Neglected Tropical Diseases.

Box 4.4. Improving surveillance with an integrated database

The Integrated NTD Database, developed by WHO in collaboration with partners, consolidates all data on NTDs into a single repository that standardizes data pathways, promotes countries' ownership of their programme's data and improves data security. Countries are encouraged to use the integrated database, particularly in instances where no consolidated database exists at the national level to host NTD data (*52*).

The indicators used in the database were drawn from WHO's established Joint Reporting Forms, from NTD partners' databases, and from collaborating organizations, medicine donation programmes and reporting forms for severe adverse events. Extensive information about field-level development processes was received from WHO's Regional Offices for South-East Asia and for the Western Pacific, as well as the ministries of health in Burkina Faso, the Congo, Indonesia, Malawi, the Philippines and Sierra Leone.

The Integrated NTD Database strengthens data storage, sharing and management at the country level, as well as reporting because it automatically generates the standardized reports that are required to be submitted to WHO and partners in NTD programmes. This automatic generation of reports improves the timeliness and completeness of reporting from the national level to the regional and global levels.

As part of the roll-out for the database, resource personnel and technical officers were trained from the Regional Offices for Africa and for the Eastern Mediterranean, from partner agencies (the Schistosomiasis Control Initiative, Sightsavers, the Malaria Consortium and the Centre for Neglected Tropical Diseases) and research institutions (the Kenya Medical Research Institute and the Noguchi Memorial Institute of Medical Research). These personnel can provide technical support to national NTD programmes that may require assistance in implementing the database. Additionally, training workshops organized by the Regional Office for Africa are expanding the roll-out of the tool to increase its use and uptake by national programmes.

4.2.7 NTDs and protection from financial risk

Protection from financial risk is a core component of UHC programmes: the aim is to reduce health systems' reliance on people paying for care out of pocket at the time they are seen (*50*). Relying on out-of-pocket payments to fund health care systems discourages people from seeking care, especially poorer people, who must often choose between paying for health care and paying for other necessities, such as food or rent. For poor people who do seek treatment, there is the risk of impoverishment or even destitution (*53*,*54*,*55*).

Compulsory prepayment and risk-pooling mechanisms are essential attributes of systems that have made good progress in reducing the financial risks of health care, neither of which is within the scope of NTD programme activities. However, NTD programmes make an important contribution to reducing the financial burden on families seeking care in both the way interventions are delivered – free of charge and often through community-directed distribution – and their emphasis on preventive care. By preventing disease, NTD programmes can reduce exposure to the physical and mental effects that give rise to costs that can devastate families (*33*).

Protection from financial risk is particularly important for the populations bearing the main burden of NTDs because they tend to be least able to afford to support care. If NTD interventions are not provided to them, these populations can find themselves trapped in a cycle of ruinous health costs, poverty and disease (*56*). The medical poverty trap affects people worldwide, including in Cambodia and Viet Nam, where 50–67% of households have incurred debt as a result of dengue (*57,58*), or in Bangladesh (*59*), India, Nepal and Sudan, where 25–75% of households in which someone is affected by visceral leishmaniasis have had some type of financial difficulty in obtaining diagnosis and treatment, even when tests and medicines are provided free of charge (*33*).

4.2.8 NTDs and multisectoral approaches

NTD programmes have long recognized the importance of taking cross-sectoral action to combat NTDs, with the most notable example being efforts to support WASH interventions. These are essential in preventing many NTDs, including soil-transmitted helminthiases, the transmission of which relies on faecal pathogens, such as worm eggs, that contaminate the environment and infect people through their food, water, dirty hands and direct skin contact with the soil (*60*). WHO launched a global strategy and action plan to integrate WASH with other public health interventions in 2015. The plan aims to intensify control or elimination efforts for certain NTDs in specific regions by 2020, and it is based on the assumption that closer collaboration between WASH and NTD programmes can lead to synergistic activities in terms of planning, delivering and evaluating programmes; strengthening and sharing evidence; and using monitoring tools to improve equity in health services. (The impact of NTD–WASH efforts is discussed in **section 2.6**)

Integrated, cross-sectoral responses are also at the heart of NTD-related efforts of vector management and control, reflecting the impact and interactions of responses and vectors. For example, responses to combat the diseases transmitted by *Ae. aegypti* that are limited to health-system interventions – such as encouraging the use of repellents, insecticide-treated bednets, or indoor residual spraying – will struggle unless efforts are also made to eliminate places for mosquitoes to breed – such as discarded cans and tyres –and to provide a reliable, piped water supply and regular solid waste management (*61*). Similarly, vector responses that do not properly manage and monitor the use of pesticides will negatively impact sectors outside of health. It is for this reason that vector ecology and management interventions underlie intersectoral vector-control efforts. WHO's draft Global Vector Control Response emphasizes the importance of taking a comprehensive, intersectoral approach to vector control and calls for strengthening inter- and intrasectoral action and collaboration (*6*).

Collaboration is also important for NTD responses that address neglected zoonotic diseases, which require cross-disciplinary and cross-sectoral efforts owing to the complex interactions among the ecosystems shared by humans and animals (**Fig. 2.4**). Guided by the One Health concept, WHO, FAO and OIE have been working together to minimize the health, social and economic impacts of diseases arising at the human–animal interface by preventing, detecting, controlling, eliminating or managing disease risks to humans that originate directly or indirectly from domestic or wild animals (*62*).

4.2.9 Mainstreaming NTD interventions within health systems

Although a great deal of what has been described above has been achieved by NTD programmes during the past decade (2007–2016) working mostly independently of national health systems, progress towards achieving NTD and UHC targets will depend on bringing NTD programmes, functions and activities into the mainstream of broader health systems. Although it is apparent that NTD programmes have much to contribute to health systems, it is equally clear that the support of adequately resourced and properly managed health systems is essential to continuing to make progress on NTDs, as it is for making progress towards UHC (*27*,*63*,*64*).

The SDGs put the strengthening of health systems at the heart of the UHC project, encouraging a system-wide integration of approaches, partly as a result of lessons learnt during the MDGs about vertical programmes, which may actually undermine already fragile health systems in countries with limited resources. For example, by drawing resources away from the complementary strategies needed to sustainably reduce the burden of disease, such as health-system strengthening and socioenvironmental measures (*63*,*65*).

But how are NTDs to be mainstreamed? The answer varies depending on the activity. Responses to NTDs are composed of different activities, ranging from preventive chemotherapy and IDM to taking action to improve water, sanitation and hygiene to veterinary public health services and vector ecology and management. Each of these areas has a bearing on health, and each presents different challenges for mainstreaming.

Mainstreaming preventive chemotherapy. The challenge of mainstreaming preventive chemotherapy seems relatively minor, at least as far as integrating the delivery of the medicines used for NTDs. The relatively limited extent to which preventive chemotherapy depends on national health systems has already been described, and the functional and physical distance from other health services has also been noted. In a sense, preventive chemotherapy is an extension of the formal health care system: it increases the capacity of primary health care services by focusing on delivering a specific service to large numbers of people, including those who are far from fixed health facilities.

Therefore, it is not surprising that integration efforts have tended to focus on preventive chemotherapy programmes, such as in Mali where in 2007 health authorities started to integrate into their health system the activities of five NTD-specific national control programmes. To achieve long-term sustainability and to build local capacity, the NTD control activities were integrated into the primary health care system at the local level where community health centres have a key role in providing services (*66*). Workers at the community health centres play an important part in the programme, providing training and supervision for community-based distributors, being responsible for allocating the medicines, collating treatment data in their catchment area, and reporting the data to district health officers. Ghana is another example where the country's NTD programme has a dedicated management structure at the national level but it uses general health-system structures at the regional and district levels to implement its activities. A 2016 study assessed the extent of the integration of the NTD programme into the health system at the national, regional and district levels, and found that NTD activities were better integrated at the district level than at the regional and national levels of the health system, particularly with regard to service delivery (*67*).

Mainstreaming innovative and intensified disease management. The mainstreaming challenge is greater for IDM, mainly because of the demands that it places on primary health care systems. Rather than bringing extra capacity into the system, as preventive chemotherapy does, IDM requires that systems develop capacity and add services that have been lacking. For this reason WHO's IDM strategy focuses on ensuring that NTDs are managed within the primary health care systems of the affected countries.

Because several NTDs have significant cutaneous manifestations that are associated with long-term disfigurement and disability, integrating screening and care activities for skin diseases into the primary health care service can be a cost–effective way to expand coverage (*68*). For example, skin examination offers an opportunity to screen people in their communities or in schools to identify multiple conditions during a single visit (**Box 2.1**). WHO's Department of Control of Neglected Tropical Diseases plans to promote an integrated strategy for controlling skin NTDs.

In some cases, nurses trained to undertake surgery have struggled because they are called on to perform surgeries infrequently, for example, for trichiasis or hydrocele. Teaching patients with lymphoedema and their families about skin care, elevation of limbs and personal hygiene present less of an obstacle, which suggests that such teaching could be integrated into programmes for chronic diseases such as Buruli ulcer, diabetes, leprosy and podoconiosis.

The process of integration and coimplementation is challenging and it requires preparation, including undertaking a realistic situation analysis, building commitment to the programmes, formulating clear plans for integration, training health workers and providing adequate and timely information to the public (*27*).

Mainstreaming vector control. Integrating global efforts for vector control into health systems is a core aim of WHO's draft Global Vector Control Response, which can serve as a blueprint for mainstreaming NTD-related vector-control interventions. Two of the four pillars of the Response are particularly important for the aim of mainstreaming: strengthening inter- and intrasectoral action and collaboration, and expanding the use of and integrating vector-control tools and approaches.

The case for integrating these responses, and thus for mainstreaming, is easily made and focuses on optimizing the impact of interventions that can be applied to multiple vectors and diseases. As a simple example, insecticide-treated bednets are not just effective against malaria but they also reduce the incidence of lymphatic filariasis. Similarly, in India indoor residual spraying against malaria also has a positive impact on leishmaniasis, and using larval control measures against malaria also affects dengue vectors in cities with particular vector habitats. Indeed, any approach that is effective against the *aedes* mosquito will have an impact on dengue, chikungunya, Zika virus disease and yellow fever where these diseases overlap, and it may also have an impact on malaria in urban settings where the anopheles mosquito lives in similar habitats or exhibits similar behaviours (*6*). Getting the various parts of the response puzzle to fit together will be challenging, requiring high-level political commitment to ensure collaboration at the national and subnational levels, including within local governments and municipalities. Establishing clear roles and responsibilities from the outset is key to sustaining these responses. Because effective vector control also requires intersectoral collaboration, high-level commitment from multiple ministries is also needed to plan, fund and implement these activities.

Mainstreaming veterinary public health services. The principal challenge going forward for mainstreaming veterinary public health services will be to combine different activities into a One Health approach that brings together animal and human health, as well as the food safety and environmental sectors, in recognition of the links among human and animal health and the health of the ecosystems they inhabit (*69*). Essential to implementing such an approach is to ensure collaboration among stakeholders and the institutions where they work.

A lack of collaboration is the principal obstacle to making progress against rabies, there being no biological or technical challenges to eliminating it (*70*). Making progress on rabies will depend on achieving greater political commitment at the country level as well as on increasing collaboration among FAO, OIE and WHO and the affected countries to ensure that rabies responses are prioritized. A One Health approach is also essential if progress is to be made on echinococcosis; ideally, efforts to address echinococcosis would include integrating control packages for rabies. As with the other dog-transmitted NTDs, managing waste is important to discourage roaming packs of dogs (*71*). It will also be critical to involve other sectors, including the veterinary sector, as well as the water, sanitation and hygiene sectors. Collaboration among the public health, veterinary health and the environmental sectors is also essential to tackling taeniasis and cysticercosis, and foodborne trematodiases.

4.2.10 Conclusions

This section has sought to demonstrate the degree to which NTD strategies and interventions align with the goals for achieving UHC or have components that are relevant to UHC. Similarities between NTD strategies and the goals for UHC include emphasizing the need to expand the coverage of services to ensure they reach all who need them and to provide financial protection from the costs of treatment or care.

Although it is apparent that mainstreaming NTD interventions into health services offers benefits for both health systems and NTD programmes, it would be counterproductive to allow the current drive towards greater integration to blur what has been achieved and can still be achieved by NTD-specific elimination campaigns, which derive much of their efficacy from targets, plans and timelines.

Elimination campaigns are generally time limited (that is, a target date is set for elimination), often intensive and typically organized in programmes that operate separately from national health systems. Elimination programmes tend to have a well-defined scope with a clear objective and endpoint, substantial donor support and a short duration. There is an argument for supporting such campaigns from outside the health care system, allowing them to pursue strategies that have proved successful and, crucially, to adapt quickly when required. That adaptation may include integration. Human African trypanosomiasis provides an example. Historically, the response involved a centralized and vertical programme deploying mobile teams with expert staff to screen the population at the village level in outreach clinics, with testing and referral to the general health services when needed (*64*). Today, in many settings, active surveillance is shifting to passive surveillance by health systems because the number of cases has decreased along with the risk. Even in an elimination programme, there may be a time and a place for integration.

There is certainly scope to harmonize the activities of elimination campaigns for NTDs and those for other infectious diseases. Such harmonization could establish common policies and norms and share resources, notably to sustain surveillance for infectious diseases, including against outbreaks.

NTD control programmes offer services that are more comprehensive and longer term than elimination campaigns. Such programmes should be integrated within health systems across all of its elements, including financing. The success of integration depends on health systems being strong. However, the reality is that despite some progress, most health systems in countries where NTDs are endemic continue to face challenges, often functioning at national and district levels but breaking down at the level of first contact, the primary health care system. This limits the scope for the kind of community interventions that have been shown to be effective in NTD programmes.

In many countries, meaningful UHC-related reform will require a shift towards a greater decentralization of health services, including extending outreach beyond fixed health facilities to provide people-centred integrated health services for all, regardless of their location, gender or socioeconomic status (*38*). Strengthening primary health care services is essential if progress is to be made on UHC and if NTD control is to be integrated into the health services.

References

1. WHO Framework Convention on Tobacco Control. Geneva: World Health Organization; 2005 (http://apps.who.int/iris/bitstream/10665/42811/1/9241591013.pdf).
2. Transforming our world: the 2030 Agenda for Sustainable Development [Resolution adopted by the General Assembly on 25 September 2015]. New York (NY): United Nations; 2015 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).
3. Health in 2015: from MDGs, Millennium Development Goals, to SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf).
4. What is universal coverage? Geneva: World Health Organization; 2015 [web page]. (http://www.who.int/healthsystems/universal_health_coverage/en/, accessed 15 March 2017).
5. Working to overcome the global impact of neglected tropical disease: first WHO report on neglected tropical diseases. Geneva: World Health Organization; 2010 (WHO/HTM/NTD/2010.1 (http://apps.who.int/iris/bitstream/10665/44440/1/9789241564090_eng.pdf).
6. Draft global vector control response 2017–2030. Geneva: World Health Organization; 2016 (http://www.who.int/malaria/areas/vector_control/Draft-WHO-GVCR-2017-2030.pdf).
7. Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation [Roadmap approved by the Strategic and Technical Advisory Group for Neglected Tropical Diseases in 2011]. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/2012.2; http://www.who.int/neglected_diseases/NTD_RoadMap_2012_Fullversion.pdf).

8. Water, sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://www.who.int/water_sanitation_health/publications/wash-and-ntd-strategy/en/).
9. The London Declaration on neglected tropical diseases. Uniting to Combat NTDs; 2012 (http://unitingtocombatntds.org/resource/london-declaration, accessed 13 March 2017).
10. Update on the global status of the donation managed by WHO of the medicines for preventive chemotherapy chemotherapy [dated 08 February 2017]. Geneva: World Health Organization; 2017 (http://www.who.int/neglected_diseases/preventive_chemotherapy/PC_medicines.pdf).
11. Making fair choices on the path to universal health coverage: final report of the WHO Consultative Group on Equity and Universal Health Coverage. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/112671/1/9789241507158_eng.pdf).
12. Fitzpatrick C, Asiedu K, Jannin J. Where the road ends, yaws begins? The cost–effectiveness of eradication versus more roads PLoS Negl Trop Dis. 2014;8:e3165. doi:10.1371/journal.pntd.0003165.
13. Alonso LM, Alvar J. Stigmatizing neglected tropical diseases: a systematic review. Soc Med (Soc Med Publ Group). 2010;5:218–227.
14. Engelman D, Fuller LC, Solomon AW, McCarthy JS, Hay RJ, Lammie PJ et al. Opportunities for integrated control of neglected tropical diseases that affect the skin. Trends Parasitol. 2016;32:843–54. doi.org/10.1016/j.pt.2016.08.005.
15. Pinto Dias JC. Human Chagas disease and migration in the context of globalization: some particular aspects. J Trop Med. 2013:789758. doi.org/10.1155/2013/789758.
16. Gascon J, Bern C, Pinazo MJ. Chagas disease in Spain, the United States and other non-endemic countries. Acta Trop. 2010;115:22–7. doi:10.1016/j.actatropica.2009.07.019.
17. Fitzpatrick C, Engels D. Leaving no one behind: a neglected tropical disease indicator and tracers for the Sustainable Development Goals. Int Health. 2016;8(Suppl 1):i15–i18. doi:10.1093/inthealth/ihw002.
18. Preventive chemotherapy in human helminthiasis. Coordinated use of anthelminthic drugs in control interventions: a manual for health professionals and programme managers. Geneva: World Health Organization; 2006 (http://apps.who.int/iris/bitstream/10665/43545/1/9241547103_eng.pdf).
19. Assuring the safety of preventive chemotherapy interventions for the control of neglected tropical diseases: practical advice for national programme managers on the prevention, detection and management of serious adverse events. Geneva: World Health Organization; 2011 (http://apps.who.int/iris/bitstream/10665/44683/1/9789241502191_eng.pdf).
20. Community-directed treatment with ivermectin: report of a multi-country study. Geneva: World Health Organization; 1996 (WHO/AFT/RP/96.1; http://www.who.int/tdr/publications/tdr-research-publications/ivermectin-cd/en/).
21. Helminth control in school-age children: a guide for managers of control programmes, 2nd edition. Geneva: World Health Organization; 2011 (http://apps.who.int/iris/bitstream/10665/44671/1/9789241548267_eng.pdf).
22. Fobi G, Yameogo L, Noma M, Aholou Y, Koroma JB, Zouré HM et al. Managing the fight against onchocerciasis in Africa: APOC experience. PLoS Negl Trop Dis. 2015;9:e0003542. doi.org/10.1371/journal.pntd.0003542.
23. Amazigo U, Okeibunor J, Matovu V, Zouré H, Bump J, Seketeli A. Performance of predictors: evaluating sustainability in community-directed treatment projects of the African programme for onchocerciasis control. Soc Sci Med. 2007;64:2070–82. doi:10.1016/j.socscimed.2007.01.018.

24. Progress report on the elimination of human onchocerciasis, 2015–2016. Wkly Epidemiol Rec. 2016;43:505–514. (http://apps.who.int/iris/bitstream/10665/250643/1/WER9143.pdf).
25. Krotneva SP, Coffeng LE, Noma M, Zouré HGM, Bakoné L, Amazigo UV et al. African Program for Onchocerciasis Control 1995–2010: impact of annual ivermectin mass treatment on off-target infectious diseases. PLoS Negl Trop Dis. 2015;9:e0004051. doi:10.1371/journal.pntd.0004051.
26. The African Programme for Onchocerciasis Control (APOC) closes and a new body is set up to eliminate neglected tropical diseases [press release]. Brazzaville: WHO Regional Office for Africa [Media centre]; December 2015 (http://www.afro.who.int/en/media-centre/pressreleases/item/8239-the-apoc-closes-and-a-new-body-set-up-to-eliminate-neglected-tropical-diseases.html, accessed 15 March 2017).
27. Gyapong JO, Gyapong M, Yellu N, Anakwah K, Amofah, Bockarie M et al. Integration of control of neglected tropical diseases into health-care systems: challenges and opportunities. Lancet. 2010;375:160–5. doi.org/10.1016/S0140-6736(09)61249-6.
28. Hotez PJ, Pecoul B. "Manifesto" for advancing the control and elimination of neglected tropical diseases. PLoS Negl Trop Dis. 2010;4:e718. doi.org/10.1371/journal.pntd.0000718.
29. The involvement of community-directed distributors of ivermectin in other health and development activities. 2003. UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases.
30. The CDI Study Group. Community-directed interventions for priority health problems in Africa: results of a multi-country study. Bull World Health Org. 2010;88:509–18. doi:10.2471/BLT.09.069203.
31. Report of the external mid-term evaluation of the African Programme for Onchocerciasis Control. World Health Organization African Programme for Onchocerciasis Control; 2010. (JAF 16.8; http://www.who.int/apoc/MidtermEvaluation_29Oct2010_final_printed.pdf).
32. WB support to prevent malaria and tropical diseases in Africa's Sahel [press release]. Washington (DC): The World Bank Group; 11 June 2015 (http://www.worldbank.org/en/news/press-release/2015/06/11/wb-support-to-prevent-malaria-and-tropical-diseases-in-africas-sahel, accessed February 2017).
33. Investing to overcome the global impact of neglected tropical diseases: third WHO report on neglected diseases. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/152781/1/9789241564861_eng.pdf).
34. Managing morbidity and preventing disability (MMDP) toolkit. Geneva: World Health Organization; 2015 (http://www.who.int/lymphatic_filariasis/global_progress/managing_morbidity_preventing_disability_toolkit/en/).
35. Nkengasong JN, Nsubuga P, Nwanyanwu O, Gershy-Damet G-M, Roscigno G, Bulterys M et al. Laboratory systems and services are critical in global health: time to end the neglect? Am J Clin Pathol. 2010;134:368–73. doi:10.1309/AJCPMPSINQ9BRMU6.
36. Njelesani J. A systematic approach to capacity strengthening of laboratory systems for control of neglected tropical diseases in Ghana, Kenya, Malawi and Sri Lanka. PLoS Negl Trop Dis. 2014;8:e2736. doi:10.1371/journal.pntd.0002736.
37. Making a difference: TDR strategic plan 2012–2017. Geneva: World Health Organization Special Programme for Research and Training in Tropical Diseases; 2012 (http://apps.who.int/iris/bitstream/10665/75138/1/TDR_STRA_12.2_eng.pdf).
38. Accelerating progress on HIV, tuberculosis, malaria, hepatitis and neglected tropical diseases: a new agenda for 2016–2030. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/204419/1/9789241510134_eng.pdf).

39. Hotez PJ, Molyneux DH, Fenwick A, Kumaresan J, Ehrlich Sachs S, Sachs JD et al. Control of neglected tropical diseases. N Engl J Med. 2007;357:1018–27. doi:10.1056/NEJMra064142.

40. Molyneux DH. Combating the "other diseases" of MDG 6: changing the paradigm to achieve equity and poverty reduction. Trans R Soc Trop Med Hyg. 2008;102:509–19. doi:10.1016/j.trstmh.2008.02.024.

41. Solomon AW, Kurylo E. The global trachoma mapping project. Community Eye Health / International Centre for Eye Health 2014;27:18. http://researchonline.lshtm.ac.uk/1805380/1/jceh_27_85_018.pdf

42. Solomon AW, Pavluck A, Courtright P, Aboe A, Adamu L, Alemayehu W et al. The global trachoma mapping project: methodology of a 34-country population-based study. Ophthalmic Epidemiol. 2015;22:214–5. doi:10.3109/09286586.2015.1037401.

43. Engels D. The Global Trachoma Mapping Project: a catalyst for progress against neglected tropical diseases. Ophthalmic Epidemiol. 2016;23(Supp1):1–2. doi:10.1080/09286586.2016.1257139.

44. Hooper PJ, Millar T, Rotondo LA, Solomon AW. Tropical Data: a new service for generating high quality epidemiological data. Community Eye Health Journal. 2016;29:38.

45. Simarro PP, Cecchi G, Paone M, Franco JR, Diarra A, Ruiz JA et al. The Atlas of human African trypanosomiasis: a contribution to global mapping of neglected tropical diseases. Int J Health Geogr. 2010;9:57. doi:10.1186/1476-072X-9-57.

46. Simarro PP, Cecchi G, Franco JR, Paone M, Diarra A, Priotto G et al. Monitoring the progress towards the elimination of gambiense human African trypanosomiasis. PLoS Negl Trop Dis. 2015;9:e0003785. doi:10.1371/journal. pntd.0003785.

47. Callahan K, Bolton B, Hopkins DR, Ruiz-Tiben E, Withers PC, Meagley K. Contributions of the guinea worm disease eradication campaign toward achievement of the Millennium Development Goals. PLoS Negl Trop Dis. 2014;7:e2160. doi:10.1371/journal.pntd.0002160.

48. Levine R, What Works Working Group Case 11: reducing Guinea worm in Asia and sub-Saharan Africa. In: Case studies in global health: millions saved. Sudbury, MA: Jones & Bartlett Learning; 2007:6–7.

49. Muller R. Guinea worm disease – the final chapter? Trends Parasitol. 2005;21:521–4. doi:10.1016/j.pt.2005.08.024.

50. Health systems financing: the path to universal coverage: World Health Report 2010. Geneva: World Health Organization; 2010 (http://www.who.int/whr/2010/en/).

51. WHO to implement online epidemiological surveillance for leishmaniasis [web release dated 21 June 2016]. Geneva: World Health Organization (http://www.who.int/neglected_diseases/news/WHO_implement_epidemiological_surveillance_leishmaniasis/en/, accessed February 2017).

52. Integrated NTD Database. WHO, APOC, CNTD, RTI International. September 2014 (http://www.who.int/neglected_diseases/data/ntddatabase/en/).

53. Gottret P, Schieber G. Health financing revisited: a practitioner's guide. Washington (DC): The International Bank for Reconstruction and Development/The World Bank; 2006 (https://siteresources.worldbank.org/INTHSD/Resources/topics/Health-Financing/HFRFull.pdf).

54. Carrin G, Buse K, Heggenhougen K, Quah SR. Health systems policy, finance, and organization, 1st edition. Elsevier: Academic Press; 2009.

55. Mills A, Ataguba JE, Akazili J, Borghi J, Garshong B, Makawia S et al. Equity in financing and use of health care in Ghana, South Africa, and Tanzania: implications for paths to universal coverage. Lancet. 2012;380:126–33. doi:10.1016/S0140-6736(12)60357-2.

56. Conteh L, Engels T, Molyneux DH. Socioeconomic aspects of neglected tropical diseases. Lancet. 2010;16:239–47. doi:10.1016/S0140-6736(09)61422-7.

57. Huy R, Wichmann O, Beatty M, Ngan C, Duong S, Margolis HS et al. Cost of dengue and other febrile illnesses to households in rural Cambodia: a prospective community-based case-control study. BMC Public Health. 2009;9:155. doi:10.1186/1471-2458-9-155.

58. Harving, ML, Rönsholt FF. The economic impact of dengue hemorrhagic fever on family level in southern Vietnam. Dan Med Bull. 2007;54:170–2. https://www.ncbi.nlm.nih.gov/pubmed/17521539.

59. Anoopa Sharma D, Bern C, Varghese B, Chowdhury R, Hague R, Ali M et al. The economic impact of visceral leishmaniasis on households in Bangladesh. Trop Med Int Health. 2006;11:757–64. https://www.ncbi.nlm.nih.gov/pubmed/16640630.

60. Soil-transmitted helminth infections [fact sheet]. Geneva: World Health Organization; 2016.

61. A toolkit for integrated vector management in sub-Saharan Africa. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/VEM/2016.02; http://apps.who.int/iris/bitstream/10665/250267/1/9789241549653-eng.pdf).

62. The FAO-OIE-WHO Collaboration. Sharing responsibilities and coordinating global activities to address health risks at the animal–human–ecosystems interfaces: a tripartite concept note. Geneva: World Health Organization; 2010 (http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf).

63. Utzinger J, Raso G, Brooker S, De Savigny D. Schistosomiasis and neglected tropical diseases: towards integrated and sustainable control and a word of caution. Parasitology. 2009;136:1859–74. doi.org/10.1017/S0031182009991600.

64. Marchal B, Van Dormael M, Pirard M, Cavalli A, Kegels G, Polman K. Neglected tropical disease (NTD) control in health systems: the interface between programmes and general health services. Acta Trop. 120(Supp1):S177–85. doi.org/10.1016/j.actatropica.2011.02.017.

65. Spiegel JM, Dharamsi S, Wasan KM, Yassi A, Singer B, Hotez PJ et al. Which new approaches to tackling neglected tropical diseases show promise? PLoS Med. 2010;7:e1000255. doi:org/10.1371/journal.pmed.1000255.

66. Dembélé M, Bamani S, Dembélé R, Traoré MO, Goita S, Traoré MN et al. Implementing preventive chemotherapy through an integrated national neglected tropical disease control program in Mali. PLoS Negl Trop Dis. 2012;6:e1574. doi:10.1371/journal.pntd.0001574.

67. Mensah EO, Aikins MK, Gyapong M, Anto F, Bockarie MJ, Gyapong JO. Extent of integration of priority interventions into general health systems: a case study of neglected tropical diseases programme in the Western Region of Ghana. PLoS Negl Trop Dis. 2016;10:e0004725. doi:10.1371/journal.pntd.0004725.

68. Mitjà O, Marks M, Bertran L, Kollie K, Argaw D, Fahal AH et al Integrated control and management of neglected tropical skin diseases. PLoS Negl Trop Dis. 2017;11:e0005136. doi:10.1371/journal.pntd.0005136.

69. People, pathogens and our planet [Volume 1]. Towards a One Health approach for controlling zoonotic diseases. Washington (DC): The International Bank for Reconstruction and Development/The World Bank; 2010 (http://siteresources.worldbank.org/INTARD/Resources/PPP_Web.pdf).

70. Rabies: rationale for investing in the global elimination of dog-mediated human rabies. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/NZD/2015.2; http://apps.who.int/iris/bitstream/10665/185195/1/9789241509558_eng.pdf).

71. Echinococcosis [web page]. Geneva: World Health Organization; (http://www.who.int/echinococcosis/en/).

4.3 Monitoring NTDs within the Sustainable Development Goals

4.3.1 Introduction

This section considers how NTDs are monitored within the SDG framework, highlighting the contribution that NTD interventions will make to achieving the health goal (SDG 3) and its relevance for other SDGs. Tracking the progress made towards achieving the MDGs was key to that agenda's success (*1,2*). Tracking the progress made towards the SDGs will be no less important, but because of the wider diversity of the goals it is likely to be far more demanding. Monitoring the MDGs depended on following the 60 key indicators that were used to track the 8 MDGs and their 21 targets, but monitoring the SDGs requires following 230 global indicators to track the progress made on the 169 targets that underpin the 17 goals.

The health goal ("ensure healthy lives and promote well-being for all at all ages") comprises no fewer than 13 targets including "by 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, waterborne diseases and other communicable diseases", which is target 3.3 and in this section is referred to as the infectious disease target.

Including NTDs among the targets for infectious diseases was overdue. NTDs were neglected in the MDGs relative to AIDS, malaria and tuberculosis, in part because the burden of NTDs tends to be focalized within poor, rural and otherwise marginalized populations. Today, even after the achievements made during the past decade, the NTDs still account for a disease burden of at least 26 million DALYs, which is around half the burden of TB or malaria (*3,4*). Clearly then, progress towards the infectious disease target cannot be measured without taking NTDs into account. However, as this section shows, monitoring the progress of NTD interventions can also offer insights into the progress made towards achieving UHC, as well as other development goals and targets, including those in other sectors.

4.3.2 Monitoring NTDs

The infectious disease target is tracked using five indicators: the number of new HIV infections per 1000 uninfected population, by sex, age and key populations (indicator 3.3.1); tuberculosis incidence per 1000 population (indicator 3.3.2); malaria incidence per 1000 population (indicator 3.3.3); hepatitis B incidence per 100 000 population (indicator 3.3.4); and the number of people requiring interventions against NTDs (indicator 3.3.5) (**Box 4.5**).

The NTD indicator (3.3.5) tracks the progress made towards a broad set of targets that have been endorsed by the World Health Assembly (*5*). Originally set out in WHO's Roadmap for NTDs (*6*), the targets focus on eradicating or eliminating 11 diseases globally or regionally by 2020. The NTD indicator also captures the progress made on implementing the five main interventions required to achieve those targets (for details, see **section 4.2.3**).

The NTD indicator counts, and thus renders visible for the first time the more than 1 billion people estimated to require treatment and care for NTDs. For the most part, these are among the world's poorest people, regardless of whether they live in low- or middle-income countries. Because NTDs proliferate in areas where people do not have access to adequate health care, clean water, sanitation or adequate housing, monitoring these diseases is a clear expression of the overall idea behind the SDGs of leaving no one behind and of the imperative to bring health interventions to the poorest and most marginalized populations (*7*). Monitoring will also build stronger and more equitable health systems, enabling countries to judge which initiatives are working and where investments need to be made. Thus, this indicator will drive efforts to strengthen and, in some cases build from the beginning, systems that will greatly improve the health of neglected populations.

Box 4.5. Tracking the number of people requiring interventions against NTDs

The challenge in monitoring progress towards ending NTDs was to agree on a single indicator that would work for NTDs as a group. Progress made towards achieving the targets established by the Roadmap was already being measured and reported to WHO, but this monitoring was disease specific, so the decision was taken to monitor target 3.3.5 (the NTD indicator) by using the data already being collected to inform a single umbrella NTD indicator (*8*). Thus, the NTD indicator will track the annual average number of people requiring treatment and care for NTDs, with treatment and care being defined broadly to include preventive, curative, surgical or rehabilitative treatment and care.

Monitoring efforts will focus on two important numbers: (i) the annual average number of people requiring the mass treatment known as preventive chemotherapy for at least one NTD that is amenable to this treatment and (ii) the number of new cases requiring individual treatment and care for other NTDs. The number of people requiring these medical interventions is expected to decrease as the 2030 deadline for the SDGs approaches as NTDs are eradicated, eliminated or controlled. The number of people requiring other interventions against NTDs is expected to decrease less rapidly. Tracking the other NTD interventions – such as vector ecology and management, veterinary public health services, and access to clean water, sanitation and hygiene – will be undertaken in the context of other targets and indicators, namely UHC and universal access to water and sanitation.

The number of people requiring treatment and care for NTDs is not equivalent to the number of people at risk for NTDs, but it is a subset of the people who are at risk. Mass treatment is administered to people living in districts where prevalence is above a threshold but it does not cover people living in districts where there is any risk of infection. Similarly, individual treatment and care is offered to those who are infected or have already been infected; it does not include their contacts and others at risk of infection. The principal sources for these numbers are countries reporting through Joint Reporting Forms and Joint Requests for Selected Preventive Chemotherapy Medicines (for donated medicines), the Integrated NTD Database and other reports to WHO. National NTD programmes within ministries of health are responsible for reporting. In 2016, data were reported by 185 countries from all WHO regions.

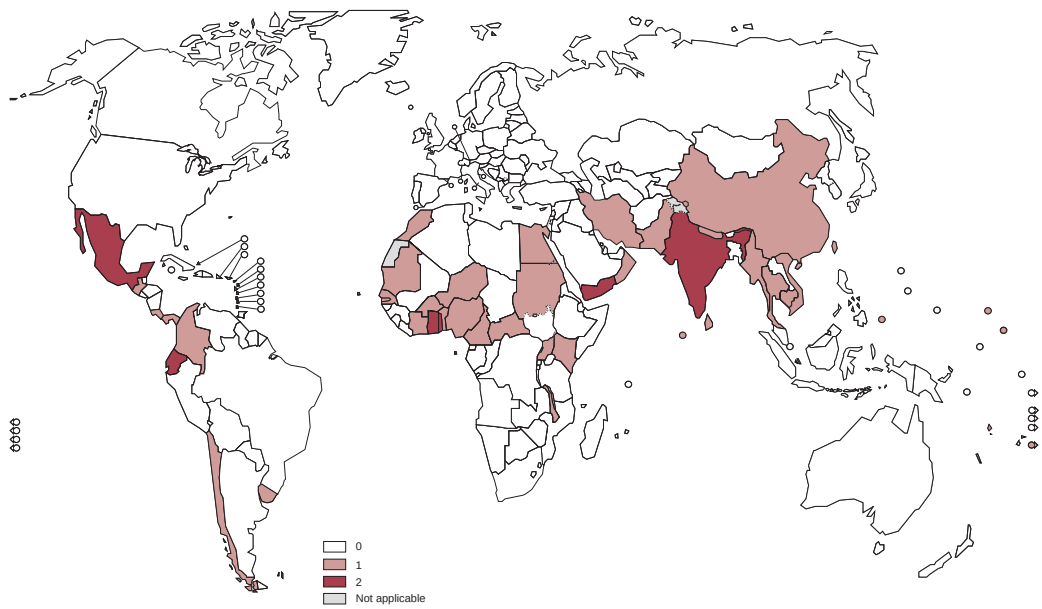
However, there are a number of gaps in NTD reporting systems, including a lack of information about the number of people requiring treatment and care for dengue, and a lack of information about Chagas disease and zoonotic NTDs, as well as the number of new cases requiring and requesting surgery or rehabilitation. Also, in the reporting systems for donated medicines, disaggregation by sex and by urban or rural area is optional or depends on which diseases are coendemic. Some disaggregation by age is possible. To address these gaps, as well as to disaggregate data by socioeconomic status, requires the development of a comprehensive information management system.

Additionally, reports from countries may not be comparable over time due to changes in surveillance and case-finding, and some adjustments may be required. For example, it is possible that improved surveillance and case-finding may lead to an apparent increase in the number of people known to require treatment and care. If reports are missing for some years, data may need to be extrapolated for some diseases in those years (*8*).

4.3.3 Countries that have "ended" selected NTDs

WHO already tracks disease-specific indicators of NTDs and can translate existing Roadmap 2020 targets into equivalent SDG subtargets, such as the number of people requiring treatment and care for a specific NTD. The SDGs aim to end NTDs but, although this is a compelling term for the purposes of advocacy, it needs some refinement; in this report, it is interpreted as meaning either the control or elimination (which can refer to the elimination of transmission or to elimination as a public health problem) of NTDs targeted by World Health Assembly resolutions. A number of NTDs have already been successfully eliminated (Fig. 4.2).

Fig. 4.2. Number of selected NTDs eliminated or undergoing verification of elimination, by country, 2000–2015, The NTDs included in the figure are dracunculiasis, lymphatic filariasis, onchocerciasis, rabies, trachoma, visceral leishmaniasis and yaws

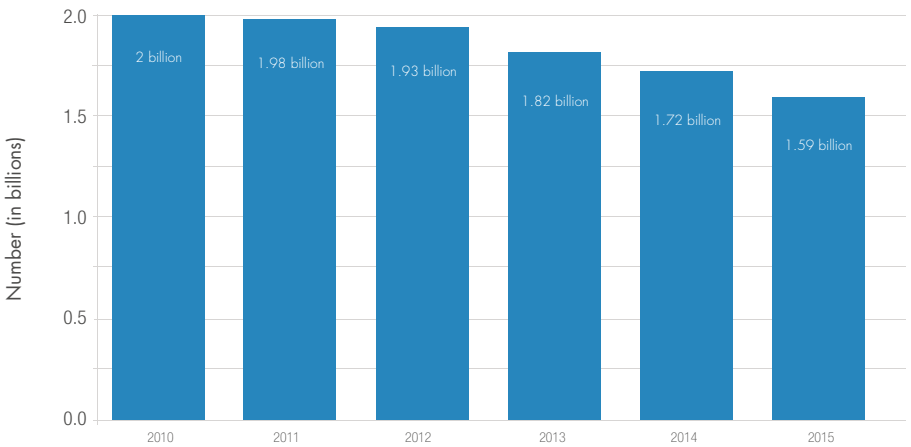


4.3.4 Number of people requiring interventions against NTDs

As noted in Box 4.5, the main sources of data on the number of people requiring interventions against NTDs are the information systems within countries, with reporting being the responsibility of national NTD programmes within ministries of health. In 2015, 1.59 billion people required mass or individual treatment and care for NTDs,[1] down from 2.0 billion in 2010 (Fig. 4.3). Almost all of these people were living in developing countries, but 960 million were living in lower-middle-income rather than low-income countries (Fig. 4.4). This confirms the fact that NTDs are diseases of poverty and not diseases that burden only the poorest countries.

1. Unless otherwise noted, all statistics in the text and figures are based on data from: Global Health Observatory. Geneva: World Health Organization, and the Preventive Chemotherapy and Transmission Control (PCT) databank. Geneva: World Health Organization.

Fig. 4.3. Number of people requiring interventions against NTDs, 2010–2015



Sources: WHO Global Health Observatory (http://apps.who.int/gho/data/node.main.A1629?lang=en) and the Preventive Chemotherapy and Transmission Control (PCT) databank (http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/)

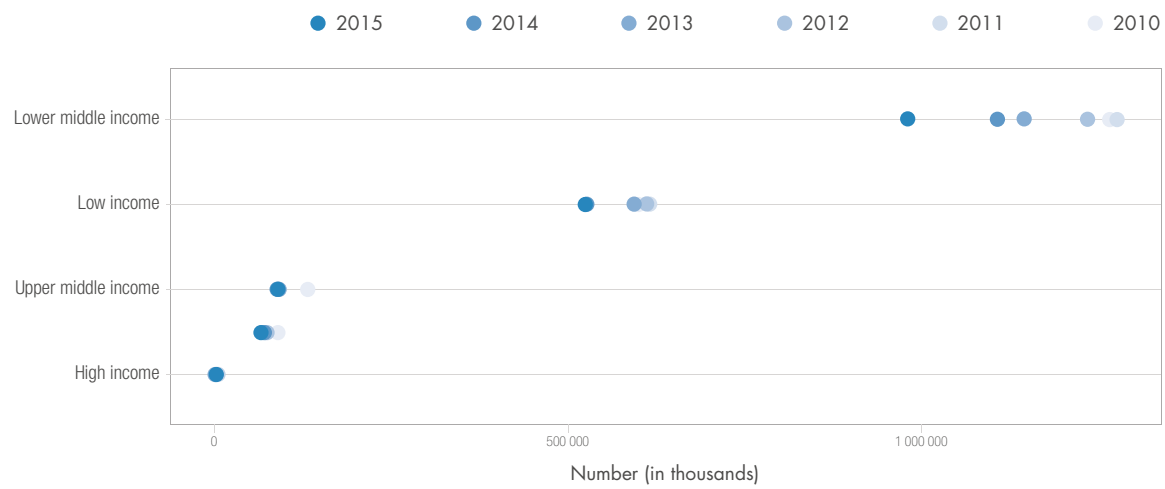
However, this does not suggest that poor countries do not carry a heavy burden. Indeed, the 523 million people requiring treatment in low-income countries represents 58% of those countries' populations compared with 36% of people requiring treatment in lower-middle-income countries. During 2010–2015, progress was made in all income groups in reducing the number of people requiring interventions.

When data are disaggregated by WHO region, it is apparent that there is considerable need for treatment and care in both the African and the South-East Asia Regions (**Fig. 4.5**). However, the South-East Asia Region has managed to reduce the number affected by about 200 million during 2010–2015, whereas the African Region has had a slight increase since 2010, with population growth in 2010–2015, exceeding the progress that was made during 2014–2015.

Most people who needed an intervention for NTDs required MDA for lymphatic filariasis, soil-transmitted helminthiases, schistosomiasis, trachoma or onchocerciasis, or some combination of these (**Fig. 4.6**). Since 2010 there has been a reduction in the number of people requiring interventions, and most of this reduction can be attributed to the elimination of lymphatic filariasis in 18 countries and trachoma in 8 countries.

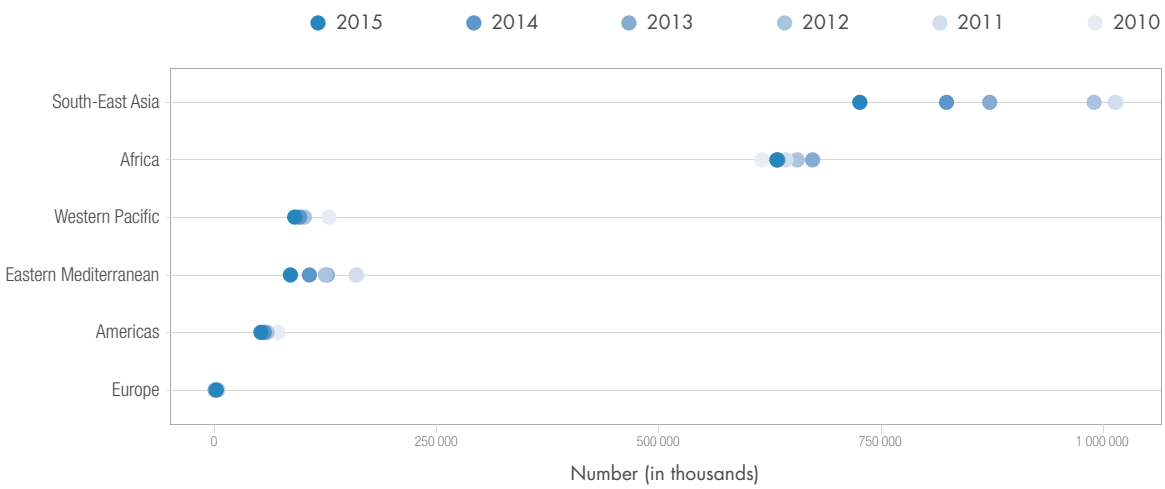
Also notable is the large number of people with dengue who required individual care. Slightly fewer people required individual treatment for leprosy and the leishmaniases, and, as a result of concerted and continued efforts, the number of people affected by human African trypanosomiasis and dracunculiasis has been greatly reduced. In 2015, the 2733 people required treatment for human African trypanosomiasis (*T.b. gambiense*) (a 60% reduction from 6779 people in 2010). The considerable uncertainty in the estimates of yaws in 2015 is due to late reporting by some countries.

Fig. 4.4. Number of people requiring interventions against NTDs, by World Bank income group, 2010–2015



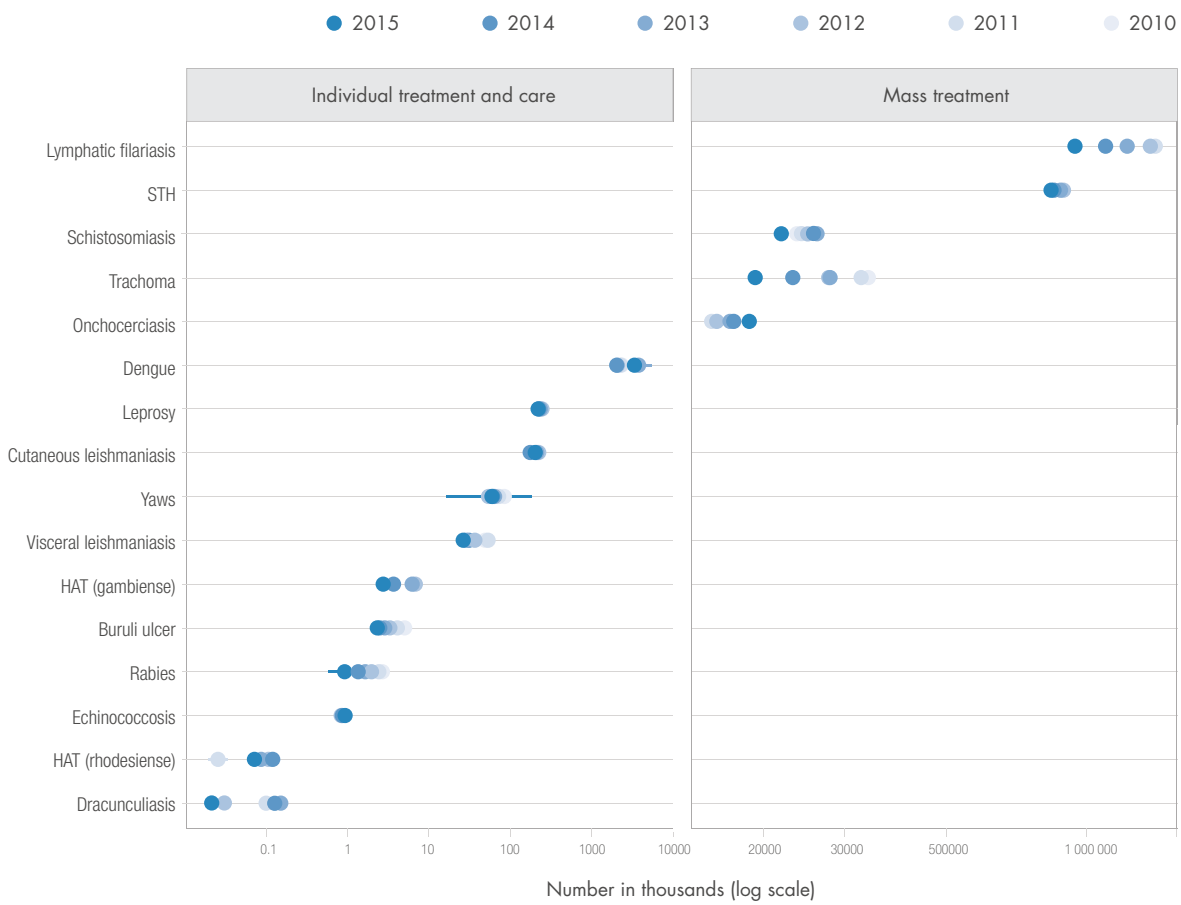
Sources: WHO Global Health Observatory (http://apps.who.int/gho/data/node.main.A1629?lang=en) and the Preventive Chemotherapy and Transmission Control (PCT) databank (http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/)

Fig. 4.5. Number of people requiring interventions against NTDs, by WHO region, 2010–2015



Sources: WHO Global Health Observatory (http://apps.who.int/gho/data/node.main.A1629?lang=en) and the Preventive Chemotherapy and Transmission Control (PCT) databank (http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/)

Fig. 4.6. Number of people requiring interventions against NTDs, by disease and type of treatment, with best estimates and 95% uncertainty intervals,[a] 2010–2015



HAT, human African trypanosomiasis; STH, soil-transmitted helminthiases

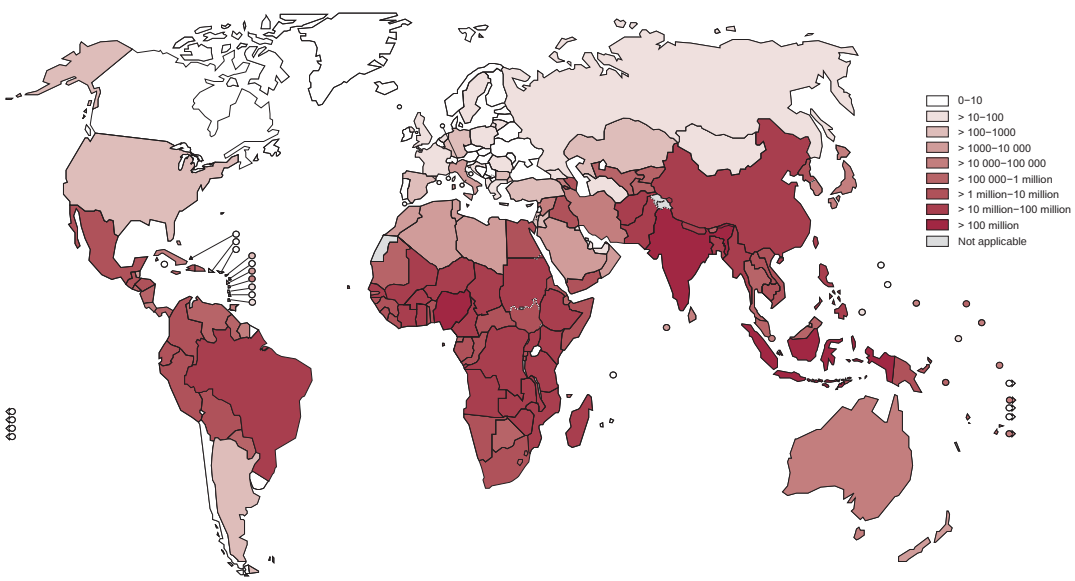
[a] These are reported numbers; the best estimates and 95% uncertainty intervals refer to missing values. The total number for echinococcosis represents data only for the European Region and Mongolia; data are not routinely reported from other countries. The number for rabies represents only deaths; data for the larger number of people requiring post-exposure prophylaxis are not routinely reported. The number of people requiring treatment and care for Chagas disease, cysticercosis, foodborne trematodiases and mycetoma are not routinely reported.

Sources: WHO Global Health Observatory (http://apps.who.int/gho/data/node.main.A1629?lang=en) and the Preventive Chemotherapy and Transmission Control (PCT) databank (http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/)

Fig. 4.7 shows the geographical distribution of people requiring interventions for NTDs, reflecting the preponderance of disease burden in the tropical regions. The largest numbers of people needing treatment and care – in excess of 100 million – are found in India, Indonesia and Nigeria, which together account for 47% of the total.

As countries progress towards or achieve the elimination of NTDs, the number of people requiring treatment and care will drop. Fig. 4.8 indicates where the most progress is being made: since 2010, Bangladesh, Brazil, China, Egypt, India, Indonesia, Pakistan and the United Republic of Tanzania have reduced the number of people needing treatment by more than 10 million. In other countries the number of people requiring treatment has increased; this may be due to population growth or increased year-on-year variation in the number of cases reported in areas that generally report only a few cases.

Fig. 4.7. Number of people requiring interventions against NTDs, 2015

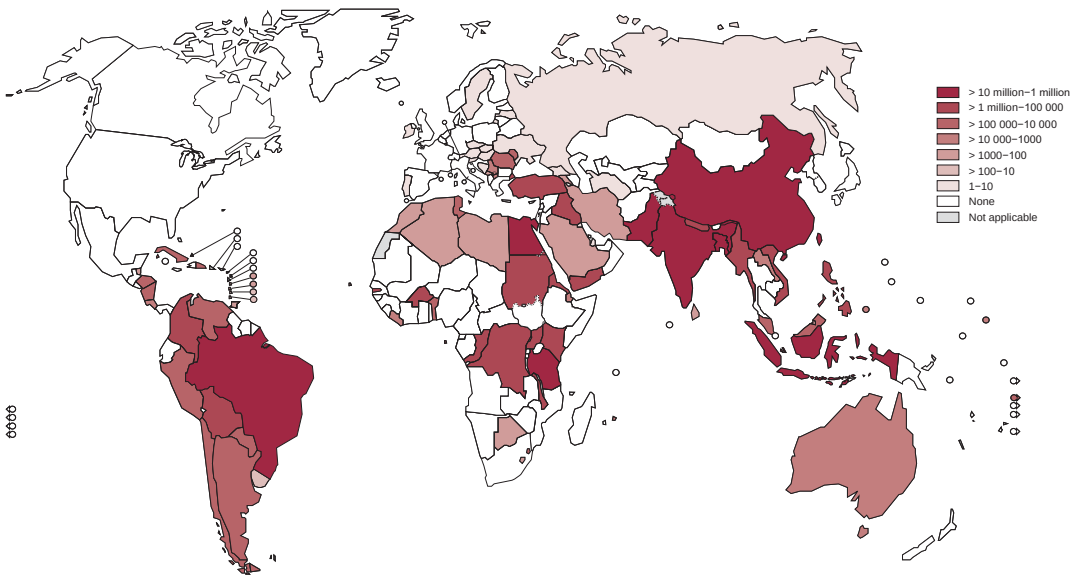


Sources: WHO Global Health Observatory (http://apps.who.int/gho/data/node.main.A1629?lang=en) and the Preventive Chemotherapy and Transmission Control (PCT) databank (http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/)

4.3.5 Using NTD indicators to monitor equity in universal health coverage

Although established NTD indicators are clearly vital to monitoring the infectious disease target (3.3), they also offer opportunities to track progress in other areas, including UHC and access to adequate water, sanitation and hygiene. The UHC target (3.8) has considerable relevance for NTDs, calling for "access to quality essential health care services and access to safe, effective, quality and affordable essential medicines and vaccines for all." Providing preventive chemotherapy, IDM, vector ecology and management and veterinary public health services are all consistent with this target. Moreover, the SDGs and targets focusing on universal access to water and sanitation are recognized as critical to accelerating and sustaining progress on NTDs.

Fig. 4.8. Decreases in the number of people requiring interventions against NTDs, 2010–2015



Sources: WHO Global Health Observatory (http://apps.who.int/gho/data/node.main.A1629?lang=en) and the Preventive Chemotherapy and Transmission Control (PCT) databank (http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/en/)

The 2030 Agenda for Sustainable Development (*9*) makes achieving the UHC target a prerequisite for achieving the broader health goal (SDG 3). Tracking progress made towards UHC will be challenging, given that UHC addresses population coverage, service coverage and protection from financial risk, all of which have systemwide implications. WHO and the World Bank have developed a viable monitoring framework to track UHC, which is based on case studies of countries, technical reviews and on consultations and discussions with country representatives, technical experts and global health and development partners (*10*). The framework focuses on the two core components of UHC: coverage of the population with quality, essential health services and coverage of the population with financial protection, the key to which is reducing health-systems' dependence on direct out-of-pocket payments for services at the time of use.

The proposed indicators are a composite coverage index of essential services (**Box 4.6**) that is disaggregated into key markers of equity and a measure of the lack of financial protection against the costs of health services. The two indicators are to be interpreted side by side to assess the state of UHC, both nationally and globally.

Box 4.6. Monitoring essential services to assess universal health coverage

Although countries may have different health priorities and will develop their own indicators, it is possible and helpful to identify a set of tracer indicators that can be combined into an index suitable for monitoring regional and global UHC.

WHO's proposed SDG indicator for UHC is an index of coverage based on 16 tracer indicators that are grouped into four main categories:

- reproductive, maternal, newborn and child health;
- infectious diseases;
- noncommunicable diseases;
- service capacity and access, and health security.

Each of the four main categories has four indicators.

All tracer indicators are scored between 0% and 100%, with 100% implying full coverage. Data for these indicators come from household surveys and administrative data. The tracer indicators are combined into a UHC service coverage index in two steps: first, the average coverage in each of the four categories is computed and, second, the average of these four category-level scores is computed. Geometric means are used to increase the index's sensitivity to very low coverage levels for any indicator (*12*, *13*).

The four tracer indicators for infectious diseases are: effective tuberculosis treatment, antiretroviral treatment for HIV infection, coverage of insecticide-treated nets used to prevent malaria, and improved water sources and adequate sanitation. NTD interventions are not currently included in the UHC coverage index.

NTD interventions are not currently included in the UHC coverage index. However, it is clear that monitoring NTD coverage could make a significant contribution to tracking the coverage of essential health services.

WHO has developed an NTD coverage index that is methodologically comparable to the proposed UHC index described in **Box 4.6**. In 2015, a relatively large number of countries had very low values on the NTD coverage index despite having high coverage for some individual diseases. The NTD coverage index emphasizes equity and integrated delivery across diseases. Thus, having very high coverage for one disease does not mitigate very low coverage for another disease.

The good news is that progress can be achieved quickly, especially in those countries that have very low coverage for only one disease. Between 2010 and 2015, many countries, including low-income countries, made significant improvements in their scores on the NTD coverage index.

The NTD coverage index can offer valuable insights into the progress made towards UHC – for example, by helping to monitor equity and ensuring that the care and treatment of those who are the least well off are prioritized. In cases in which health systems rank well on the UHC coverage index but are low on the NTD coverage index, there might be reason to question whether progress towards UHC is truly prioritizing the people who are least well off.

The NTD coverage index captures data about the coverage of preventive chemotherapy for five NTDs (lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma). It could easily be expanded to include other NTD interventions (for example, the percentage of health centres with the capacity to diagnose and treat NTDs, or the percentage of the at-risk population that lives within a certain number of hours from a facility offering diagnosis and treatment).

More data would be required to track the coverage of the use of IDM, vector ecology and management strategies, veterinary public health services, and morbidity management and disability prevention interventions. In principle, data about all of these could be accommodated within a single index.

When different categories of indicators exist (for example, mass treatment, individual treatment, active surveillance), a geometric mean of geometric means could be used to give equal weight to each category rather than to each disease. This is how the UHC index combines the four categories of four tracer indicators.

4.3.6 Using NTDs as tracer indicators for general monitoring of the Sustainable Development Goals

Having articulated how the coverage of NTD interventions can act as a tracer indicator for equity in the progress made towards UHC, this subsection discusses how NTD monitoring can be used more broadly to track progress towards achieving the SDGs, in particular, the health goal (SDG 3), the goal for clean water and sanitation (SDG 6), the antipoverty goal (SDG 1), the goal to end hunger (SDG 2), the education goal (SDG 4) and the goal for sustainable cities and communities (SDG 11). The multiple connections among NTDs and these SDGs are described in **section 2**. **Table 4.3** sets out the NTD tracer indicators that support the monitoring of SDG targets. The development of tracer indicators for equity is most advanced for clean water and sanitation (SDG 6).

Both NTD targets and targets for water, sanitation and hygiene feature in the SDGs. In August 2015, WHO launched a global strategy and action plan to integrate WASH interventions with other public health interventions (*13*). The joint NTD–WASH strategy for 2015–2020 aims to support efforts to combat NTDs by targeting investments to improve water, sanitation and hygiene services in those communities that need them most – that is, the communities in which NTDs are endemic. The plan consists of four strategic objectives, one of which is to monitor WASH interventions and NTD actions to "highlight inequalities, target investment and track progress" (*14*).

Operationalizing this objective relies on disaggregating and mapping data about WASH coverage using NTD endemicity as a proxy for disadvantage and marginalization. The mapping of some NTDs, such as trachoma, already includes monitoring for WASH coverage. However, it seems that monitoring WASH coverage in relation to multiple NTDs could help highlight inequalities, reveal where investment should be targeted and track progress.

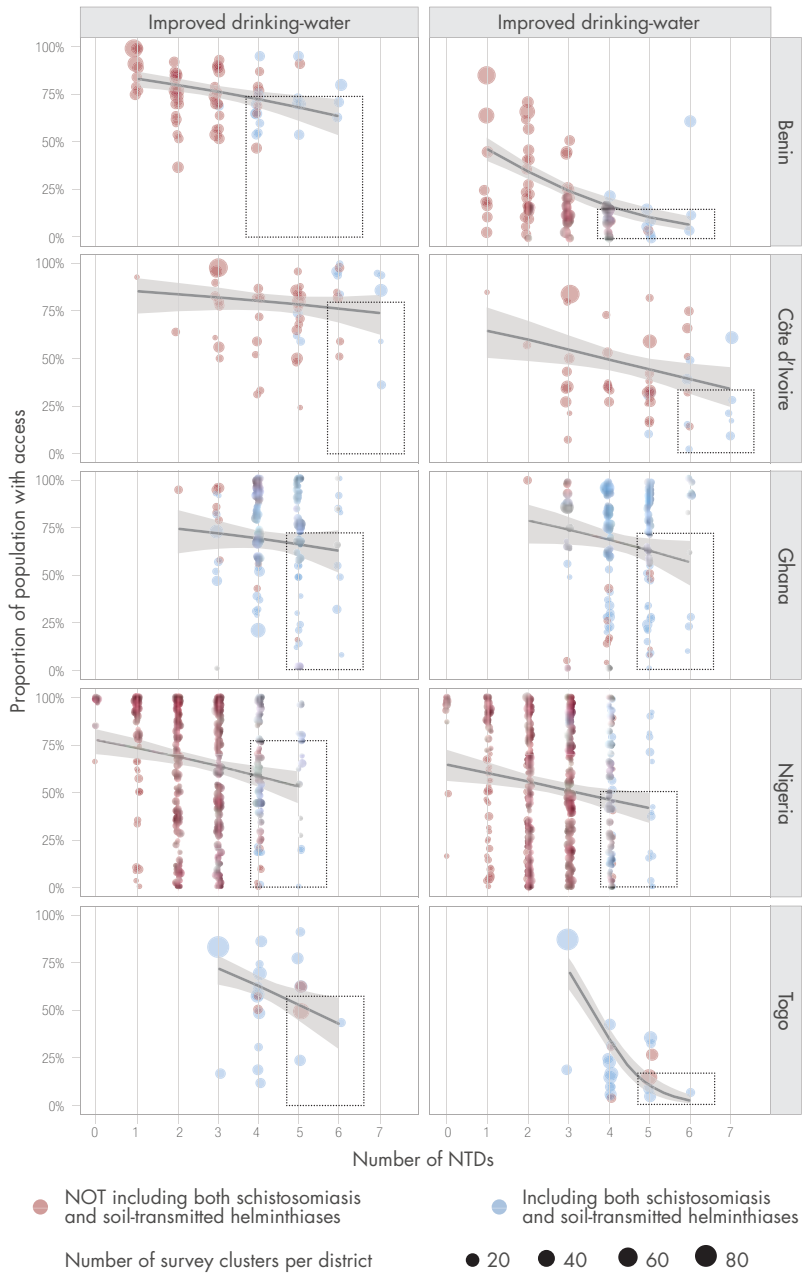
Fig. 4.9 shows the coverage of improved drinking-water and sanitation services for the five NTDs that are amenable to treatment with preventive chemotherapy, as well as Buruli ulcer, leprosy and yaws, in five countries in West Africa (Benin, Côte d'Ivoire, Ghana, Nigeria and Togo). Among these NTDs, WASH interventions are particularly important for schistosomiasis and soil-transmitted helminthiases, the ending of which entirely depends on universal access to adequate sanitation by 2030. District-level endemicity (defined as the presence of NTDs requiring a public health intervention) was determined using prevalence surveys and treatment history for the NTDs amenable to treatment with preventive chemotherapy, and case reports for Buruli ulcer, leprosy and yaws. Data on the coverage of WASH interventions were extracted by WHO's global programme on water, sanitation and hygiene from household surveys (for example, Demographic and Health Surveys), and the indicators used were the proportion of the population with access to improved drinking-water and to improved sanitation.

There is evidence of district-level inequalities in the coverage of water and sanitation, although the relationship with NTD endemicity is complex (**Fig. 4.9**). Coverage is low among many districts that have a high number of endemic NTDs. This is not surprising given that the transmission of some NTDs (especially schistosomiasis and soil-transmitted helminthiases) is directly related to inadequate coverage of water and sanitation. However,

Table 4.3. Proposed NTD tracers of equity for selected Sustainable Development Goals (emphasis added)

Sustainable Development Goal	Relevant target	Relevant indicator	Proposed NTD tracer indicator
	3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and **neglected tropical diseases** and combat hepatitis, waterborne diseases and other communicable diseases	3.3.5 Number of people requiring interventions against neglected tropical diseases	– – –
	3.8 Achieve **universal health coverage**, including financial risk protection, access to quality essential health care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	3.8.1 Coverage of essential health services	3.8.1. **NTD** Coverage index for NTDs
	6.1 By 2030, achieve universal and equitable access to safe and affordable **drinking-water** for all	6.1.1 Proportion of population using safely managed drinking-water services	6.1.1. **NTD** Proportion using safely managed water services in districts where NTDs are endemic
	6.2 By 2030, achieve access to adequate and equitable **sanitation and hygiene** for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	6.2.1. **NTD** Proportion of population using safely managed sanitation services in districts where NTDs are endemic
	1.1 By 2030, eradicate extreme **poverty** for all people everywhere, currently measured as people living on less than US$ 1.25 a day	1.2.1 Proportion of population living below the national poverty line, by sex and age	1.2.1. **NTD** Proportion of population living below the national poverty line in districts where NTDs are endemic
	2.2 By 2030, end all forms of **malnutrition**, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age	2.2.1 Prevalence of stunting among children under 5 years of age	2.2.1. **NTD** Prevalence of stunting among children in districts where NTDs are endemic
		2.2.2 Prevalence of malnutrition among children under 5 years of age, by type (wasting and overweight)	2.2.2. **NTD** Prevalence of wasting among children in districts where NTDs are endemic
	4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary **education**, leading to relevant and effective learning outcomes	4.1.1 Proportion of children at the end of primary school or lower secondary school achieving at least a minimum proficiency level in mathematics and reading, by sex	4.1.1. **NTD** Proportion of children at the end of primary school or lower secondary school achieving at least a minimum proficiency in mathematics and reading in districts where NTDs are endemic
	11.1 By 2030, ensure access for all to adequate, **safe and affordable housing** and basic services, and upgrade slums	11.1.1 Proportion of urban population living in slums, informal settlements or inadequate housing	11.1.1. **NTD** Proportion of population living in slums in districts where NTDs are endemic

Fig. 4.9. Coverage of improved drinking-water and sanitation services at the district level by the number of NTDs requiring intervention, Benin, Côte d'Ivoire, Ghana, Nigeria and Togo, 2011–2014[a,b]



a For Benin, the coverage of water and sanitation is based on data from 2011 and 2012; for all other countries it is based on data from 2013 and 2014. The number of NTDs is based on data for the five NTDs that are amenable to preventive chemotherapy and Buruli ulcer, leprosy and yaws.

b The black lines and grey ribbons represent the best fit with 95% confidence intervals; observations are weighted by the number of clusters surveyed in a district. The black rectangles indicate districts in which coverage was below the national median and the number of endemic NTDs above the national median. These figures are illustrative only; ultimately it will be up to countries to decide which percentiles they want to focus on.

there are also districts that have a high number of NTDs (including schistosomiasis and soil-transmitted helminthiases) despite relatively high levels of coverage. Lags between changes in coverage and changes in endemicity are to be expected and distortions due to poor or incomplete data cannot be excluded, but this finding may point to inequalities at the subdistrict level in the coverage of water, sanitation and hygiene, and highly focalized hotspots of NTD transmission.

The black rectangles of Fig. 4.9 indicate districts where the coverage of water and sanitation was below the national median and the number of endemic NTDs was above the national median. Focusing on these underserved and overburdened districts has the potential to guide the WASH sector in targeting investments at the most disadvantaged and marginalized communities. This targeting would also help the NTD sector accelerate and sustain its progress towards control and elimination targets.

This exploratory work has contributed to efforts by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation to explore approaches and indicators to monitor subnational inequalities in access to water, sanitation and hygiene in the SDG era. The pros and cons of using NTD endemicity to disaggregate WASH data were discussed by the Joint Monitoring Programme's inequality task force. Further refinements and analyses are expected in 2017. Similar work is needed to develop NTD tracer indicators of equity for the antipoverty goal (SDG 1), the goal to end hunger (SDG 2), the education goal (SDG 4) and the goal for sustainable cities and communities (SDG 11).

4.3.7 Monitoring equity in access to financing for SDGs

Monitoring NTD financing can also help to monitor equity in financing for SDGs, including official development assistance and domestic government financing for infectious diseases. The goal to "strengthen the means of implementation and revitalize the global partnership for sustainable development" (SDG 17) covers a wide range of development topics, including finance, technology, capacity–building, trade, policies and institutional coherence, partnerships with multiple stakeholders, data, monitoring and accountability. This goal recognizes the importance of both foreign and domestic financing for the SDGs (see section 5).

One official indicator (17.9.1) is the "dollar value of financial and technical assistance committed to developing countries." The source for this indicator is the Organisation for Economic Co-operation and Development's (OECD) database known as the Creditor Reporting System, which tracks official development assistance from bilateral agencies, as well as multilateral aid and some philanthropic aid (notably from the Bill & Melinda Gates Foundation). In this context, the aggregate of these sources is referred to as development assistance. However, it is important to note that the database does not capture the value of medicines donated by the pharmaceutical industry.

As can be seen in Fig. 4.10, in 2013, half of all low- and middle-income countries received less than US$ 0.35 per person (in 2015 dollars) in development assistance for NTDs and other neglected or emerging infectious diseases. The numerator excludes assistance that was earmarked for HIV, tuberculosis or malaria, but it includes assistance for other infectious diseases that are not formally NTDs (that is, they are not included on WHO's list); the Creditor Reporting System does not disaggregate data about these other infectious diseases. Therefore, the numerator overstates the amount of development assistance specifically targeted at NTDs, but it recognizes that investing in a health-

system's response to infectious diseases in general also strengthens the response to NTDs. The denominator is the number of people requiring interventions against NTDs; these are people who are also at high risk of other neglected or emerging infectious diseases.

Alarmingly, the majority of low-income countries receive much less than this global average. In fact, in 2013, 26 low-income countries received less than US$ 0.35 per person in development assistance to combat NTDs and other neglected or emerging infectious diseases.

Clearly, when the indicator of the number of people requiring interventions against NTDs is combined with other indicators, it has considerable potential to support efforts to meet the SDGs. In this case, international donors striving to target their investments to control infectious diseases at countries where they are most needed can use the NTD indicator to help guide them.

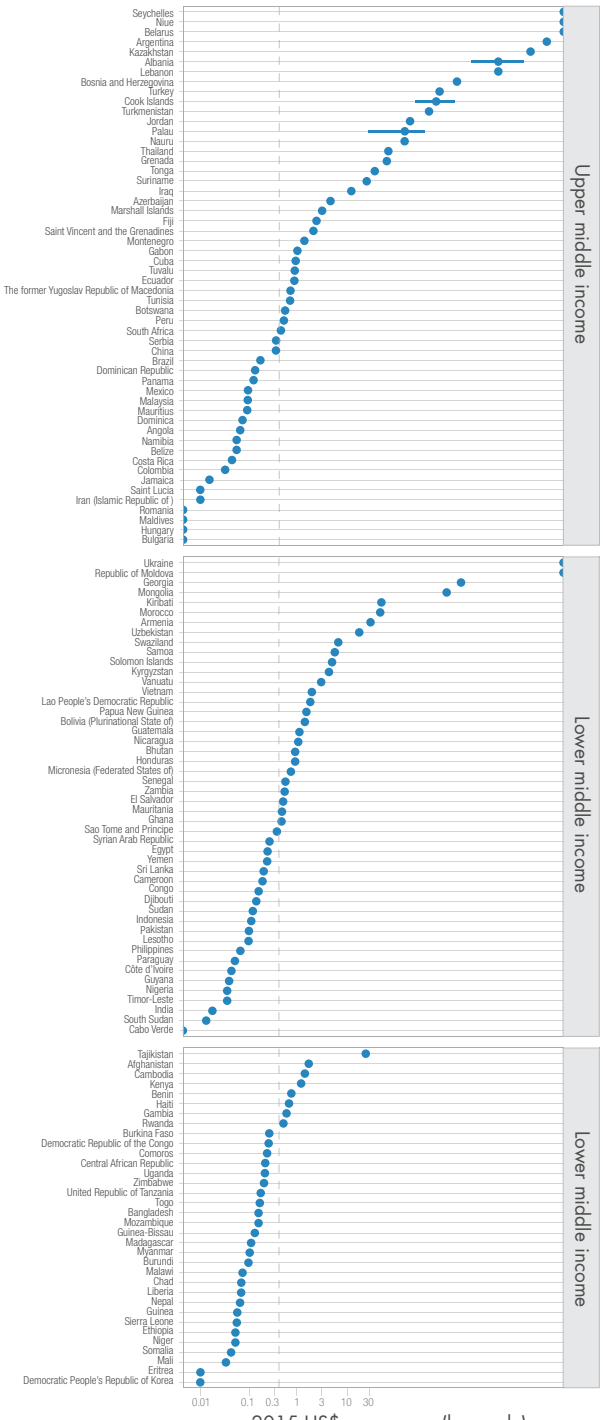
This type of targeting has always been an aspiration for international donors. Going forward, it is likely to be more of an imperative as the SDG-driven demand for international resources increases in the context of slower global economic growth relative to the MDG era (*15*). Better targeting of international resources is crucial to enhancing aid effectiveness, as was acknowledged at the ministerial NTD health forum in December 2014 (*16*). Indeed, as governments in endemic countries are expected to take on more responsibility for funding responses to NTDs, it will be more important than ever to ensure that scarce international resources are targeted at the countries with the least fiscal resources.

Targeting across subpopulations, diseases or interventions, rather than across countries, will also become increasingly important to ensure that the best use is made of scarce domestic resources. Initiatives such as the *Africa scorecard on domestic financing for health* (*17*) would benefit from ensuring that domestic financing for health is fairly distributed across diseases or interventions, including the infectious diseases mentioned in the relevant target (3.3), in alignment with the principles of orienting health-systems financing towards UHC. It would also be helpful to ensure that the distribution of domestic financing among government and private sources reflects the concentration of some of these diseases among the poorest and most marginalized people.

Evidence from the health accounts of five low-income countries in Africa suggests that the amount of tax revenues being invested by domestic governments in interventions against NTDs is small relative to the number of people requiring those interventions (**Fig. 4.11**); the countries included in the analysis were Benin, Burkina Faso, the Democratic Republic of the Congo, Niger and the United Republic of Tanzania. During 2010–2013, the amount invested in NTD interventions was less than or equal to US$ 0.15 per person. However, in three of the five countries, it appears to have increased during the same period. Domestic household spending (data for which were reported by only two of the five countries) was as little as US$ 0.10 per person per year.

In Burkina Faso, spending by other domestic private sources, namely non-profit institutions serving households, was potentially significant although inconsistently reported, and it amounted to less than or equal to US$ 0.30 per person per year. In the United Republic of Tanzania, spending by corporations amounted to a few cents per person. In low-income countries, private insurance does not yet figure significantly or consistently as part of the NTD financing landscape.

Fig. 4.10. Development assistance for NTDs and other infectious diseases (in 2015 US$), excluding assistance for HIV, tuberculosis and malaria, per person requiring treatment and care for NTDs, 2013[a]



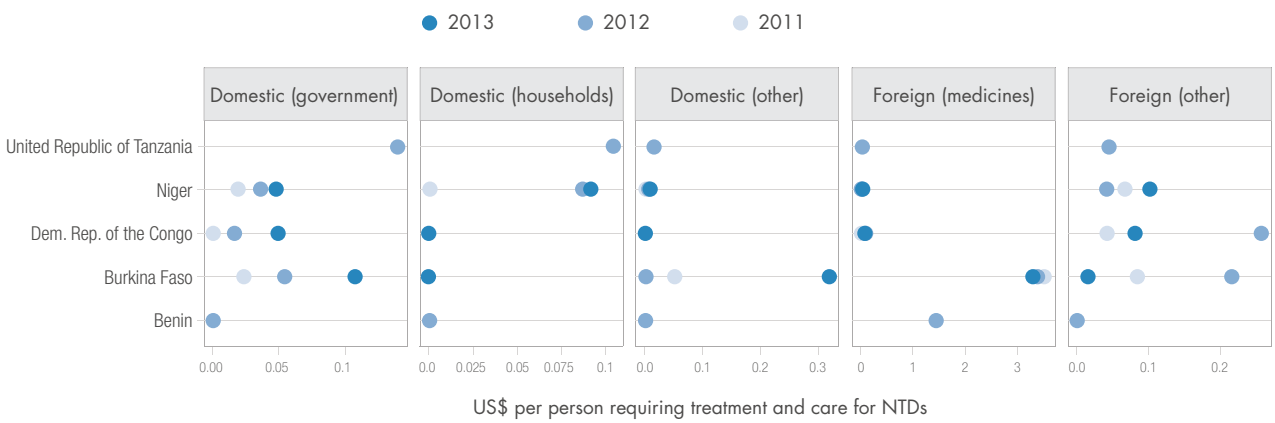
a Only low- and middle-income countries reporting more than 10 000 people requiring treatment and care for NTDs are shown. The vertical line depicts the median value using 2015 US dollars (US$ 0.35) across all countries in 2013.

Source: Institute for Health Metrics and Evaluation. Development Assistance for Health Database 1990–2015. Seattle, United States: Institute for Health Metrics and Evaluation; 2016 (http://ghdx.healthdata.org/record/development-assistance-health-database-1990-2015).

It is important to note that much of the external financing – whether bilateral, multilateral or private – takes the form of donated medicines. Burkina Faso has consistently reported high valuations for donated medicines. In Benin, the only reported source of NTD financing in 2012 was that from foreign private sources, 100% of which was attributed to pharmaceuticals. Clearly, additional resources were obtained from some source to deliver those medicines, and it is to be hoped that future health accounting exercises will reflect that.

The health accounts from Benin and Burkina Faso reveal the importance of correctly capturing donations of medicines in the system of health accounts and in broader efforts to measure progress made under the global partnership goal (SDG 17). It is important to recognize the value of donated medicines, not least for leveraging the other financing, domestic and foreign, that is necessary to distribute them to the people who need them.

Fig. 4.11. Domestic government financing for NTDs in five countries compared with other financing, per person requiring interventions against NTDs, 2011–2013[a]



a Other sources of financing include households, domestic private sources (corporations and non-profit institutions serving households) and foreign sources (bilateral, multilateral and private). The countries and years selected reflect those for which information was publicly available about NTD expenditures from WHO's Global Health Expenditure Database (http://apps.who.int/nha/database/DocumentationCentre/Index/en). The United Republic of Tanzania refers to the mainland and excludes Zanzibar.

4.3.8 Conclusions

The 2030 Agenda states that national governments should "set their own national targets guided by the global level of ambition but taking into account national circumstances" (9). NTDs are part of those circumstances in the 185 countries reporting at least 1 person requiring treatment and care. Although monitoring the SDGs clearly poses a methodological challenge, it also offers a strategic opportunity to focus on strengthening countries' health-information systems, which might otherwise struggle with the SDG focus on monitoring equity, because it implies disaggregation of national indicators by age, sex, urban or rural location, and income or wealth quintile. This section has shown the different ways in which monitoring NTDs can help meet that challenge. But it is important to note that the benefit is reciprocal: the SDGs have important implications for the way NTDs will be monitored in the future, notably in regard to their emphasis on equity. They also have implications for the financing of NTD control efforts. The next section addresses the issue of financing for NTDs in the context of the SDGs and UHC.

References

1. Tracking universal health coverage: first global monitoring report. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/174536/1/9789241564977_eng.pdf).
2. Health in 2015: from MDGs, Millennium Development Goals, to SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf).
3. WHO global burden of disease estimates for 2000–2015 [web page]. Geneva: World Health Organization (http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html; accessed 15 March 2017).
4. Hotez PJ, Alvarado M, Basáñez M-G, Bolliger I, Bourne R, Boussinesq M et al. Th e global burden of disease study 2010: interpretation and implications for the neglected tropical diseases. PLoS Negl Trop Dis. 2014;8:e2865. doi:10.1371/journal.pntd.0002865.
5. Second meeting of the IAEG-SDGs [Inter-agency and Expert Group on Sustainable Development Goal Indicators]. Bangkok, 26–28 October, 2015 (https://unstats.un.org/sdgs/meetings/iaeg-sdgs-meeting-02).
6. Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation. [Roadmap approved by the Strategic and Technical Advisory Group for Neglected Tropical Diseases in 2001.] Geneva: World Health Organization; 2012 (WHO/HTM/NTD/2012.1; http://www.who.int/neglected_diseases/NTD_RoadMap_2012_Fullversion.pdf).
7. Engels D. Neglected tropical diseases in the Sustainable Development Goals. Lancet. 2016;387:223–4. doi.org/10.1016/S0140-6736(16)00043-X.
8. Fitzpatrick C, Engels D. Leaving no one behind: a neglected tropical disease indicator and tracers for the Sustainable Development Goals. Int Health. 2016;8(Suppl 1):i15–i18. doi:10.1093/inthealth/ihw002. http://unstats.un.org/sdgs/metadata/files/Metadata-03-03-05.pdf
9. Transforming our world: the 2030 Agenda for Sustainable Development [Resolution A/RES/70/1 adopted by the General Assembly on 25 September 2015]. New York (NY): United Nations; 2015 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).

10. Monitoring progress towards universal health coverage at country and global levels: framework measures and targets. World Health Organization and International Bank for Reconstruction and Development/The World Bank; 2014 (WHO/HIS/HIA/14.1; http://apps.who.int/iris/bitstream/10665/112824/1/WHO_HIS_HIA_14.1_eng.pdf).

11. World Health Statistics 2016: monitoring health for the SDGs. Geneva: World Health Organization; 2016 (http://www.who.int/gho/publications/world_health_statistics/2016/en/).

12. Hogan D, Hosseinpoor AR, Boerma T. Developing an index for the coverage of essential health services [Technical note]. Geneva: WHO Department of Evidence, Information and Research; 2016 (http://www.who.int/healthinfo/universal_health_coverage/UHC_WHS2016_TechnicalNote_May2016.pdf).

13. WHO strengthens focus on water, sanitation and hygiene to accelerate elimination of neglected tropical diseases. In: WHO/Water, sanitation, hygiene [website]. Geneva: World Health Organization; 2015 (http://www.who.int/water_sanitation_health/events/wash-and-ntd-strategy/en/, accessed 15 March 2017).

14. Water, sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://www.who.int/water_sanitation_health/publications/wash-and-ntd-strategy/en/).

15. World Economic Outlook: too slow for too long. Washington (DC): International Monetary Fund; 2016 (http://www.imf.org/external/pubs/ft/weo/2016/01/).

16. The Addis Ababa NTD commitment 2014. Uniting to Combat Neglected Tropical Diseases; 2016 (http://unitingtocombatntds.org/sites/default/files/document/The_Addis_Ababa_NTD_Commitment.pdf).

17. Africa scorecard on domestic financing for health. African Union; 2016 (http://www.au.int/en/documents/31331/africa-scorecard-domestic-financing-health).

4.4 Financing NTDs in the context of the Sustainable Development Goals

4.4.1 Introduction

The SDGs represent both a challenge to and an opportunity for financing responses to NTDs. They are a challenge because the 2030 Agenda, with its wide range of goals and targets, is likely to stimulate competition for scarce resources and make it even harder for NTD interventions to get the earnmarked funds. They also present an opportunity because meeting the targets that have been set, particularly the target for UHC, may bring NTD interventions into the mainstream, within health and development financing generally and national health budgeting in particular.

There is consensus around the importance of increasing domestic financing to support the SDGs. The implementation and global partnerships goal (SDG 17) includes a target (17.1) calling for domestic resource mobilization to be strengthened, including by providing "international support to developing countries to improve domestic capacity for tax and other revenue collection". Domestic resource mobilization is central to the Addis Ababa Action Agenda, a framework for financing the ambitious 2030 Agenda, which came out of the Third International Conference on Financing for Development in July 2015 (*1*). WHO has also recognized the need to increase and sustain predictable, long-term financing to expand the coverage of infectious disease interventions and asserted that achieving this will depend on integrating essential interventions and services into national health programmes and national health benefit packages (*2*).

This section looks at these issues and presents a framework for NTD financing covering the period 2016–2030. The framework is the result of a meeting held at WHO headquarters in April 2016, which brought together representatives from ministries of health, finance and planning from countries where NTDs are endemic, as well as multilateral and philanthropic donors, and staff from WHO's Health Systems Financing and other infectious disease departments.

4.4.2 The NTD financing challenge

Estimates vary regarding how much money will be needed to meet the SDGs in developing countries, but it is widely assumed that the 2030 Agenda will require billions, if not trillions, of dollars (*3,4*). Focusing solely on low-income countries, it is estimated that between US$ 152 billion and US$ 163 billion in external funding, including official development assistance, will be needed to achieve the SDGs (*4*). It is unclear where all that money will come from but, if current trends continue, it seems likely that official development assistance will be a less important component in the future and countries will need to explore new development financing, including innovative financing, and significantly increase domestic government funding.

Increased competition for scarce resources to fund SDG-related initiatives could put pressure on a worldwide NTD response that is already underfunded. The financing situation for NTDs has improved in recent years, with several international partners committing new funding since the 2012 London Declaration. From 2012 to 2014, foreign aid amounted to about US$ 200–300 million per year, excluding the dollar value of donated medicines.

In 2015, nearly one billion people were being reached by preventive chemotherapy. However, another 600 million people remain in need, of whom 340 million are in sub-Saharan Africa; 260 million people remain in need in the group of least developed countries. The people in sub-Saharan Africa could be covered with new investments of US$ 150 million per year to the year 2020, and the people in the least developed countries could be reached with new investments of US$ 100 million per year provided to 2020 (**Box 4.7**). The amount of new investments needed for vector control, veterinary public health services and WASH interventions are much larger.

The lack of diversification in NTD financing remains a concern. NTD programmes continue to disproportionately depend on two major bilateral donors and one philanthropic donor. The NTD response has had to rely largely on ad hoc and fragmented financing, with domestic financing at the local level being supplemented by charities and community volunteers. A notable exception to this was the African Programme for Onchocerciasis Control, established by a multilateral World Bank trust fund and directly implemented by WHO, which helped the governments of 20 countries deliver donated ivermectin to control onchocerciasis (*5*). The African Programme for Onchocerciasis Control formally ended in December 2015 (*6*) and has been replaced by the Expanded Special Project for Elimination of Neglected Tropical Diseases, which needs to mobilize an annual budget of US$ 10 million to support its operations (*7*).

Box 4.7. Investing in the "end" of selected NTDs: targets and returns

At least 991 million people are already being reached by essential medicines used to combat NTDs, including lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiases and trachoma, in 2015. However, another 600 million people also need treatment, of whom 340 million are in sub-Saharan Africa; an additional 260 million people need treatment in the group of least developed countries;[1] and at least 40 million more people still require coverage with active case-finding for human African trypanosomiasis and, on the Indian subcontinent, visceral leishmaniasis.[2]

The targeted investment

Although essential NTD medicines are for the most part donated,[3] they still have to be delivered to the people who need them, and this delivery has to be paid for. Most people requiring the package of essential NTD medicines can be reached and treated for less than US$ 0.50 per person. Active case-finding costs less than US$ 2.00 per capita in some of the sparsely populated areas of Africa and less than US$ 0.20 per capita on the more densely populated Indian subcontinent.

The 340 million people in sub-Saharan Africa could be covered by new investments of US$ 150 million per year to the year 2020; the 260 million people in the least developed countries could be covered by new investments of US$ 100 million per year to 2020. Put another way: a new investment of US$ 50 million per year would fill 50% of the coverage gap in the least developed countries, reaching 130 million people per year. These new investments would buy highly integrated delivery of essential NTD medicines, the delivery of which is led in most settings by volunteers from local communities. Investments would also fund active case-finding undertaken by mobile teams of trained professionals.

Globally, new investments are expected to decrease year on year after 2020; commitments for beyond 2020 could be made contingent on achieving coverage targets during the period 2017–2020.

The expected return

By 2030, high levels of coverage with the integrated package of essential NTD medicines are expected to result not only in a decrease of about 90% in the number of people requiring treatment but also in the elimination of some NTDs.

The number of people requiring treatment for NTDs has already decreased from 2 billion people in 2010 to 1.6 billion in 2015. In 18 countries lymphatic filariasis has already been eliminated (or is under surveillance for elimination) and the same is true for trachoma in 8 countries.

The elimination of lymphatic filariasis in another 50 countries would reduce the number of people currently requiring treatment for this disease by 950 million. In the least developed countries, another 310 million people would no longer be at risk of new infection that could lead to disfigurement and disability. Eliminating trachoma in another 39 countries would reduce by 200 million the number of people requiring treatment for this disease; in the least developed countries, another 190 million people would no longer be at risk of new infection leading to blindness. Visceral leishmaniasis can be eliminated from 3 countries on the Indian subcontinent and human African trypanosomiasis from the 36 countries where it is still a risk.

These health, social and economic returns could be achieved well in advance of the target to "end NTDs" by 2030, thus setting a high standard of performance for the SDGs.

---

1. Including in *Sub-Saharan Africa*: Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho , Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Sudan, Sudan, Togo, United Republic of Tanzania, Uganda, Zambia; and *in other regions*: Bangladesh, Bhutan, Cambodia, Haiti, Kiribati, Lao People's Democratic Republic, Myanmar, Nepal, Solomon Islands, Timor-Leste, Tuvalu, Vanuatu, Yemen.

2. Other NTD interventions such as individual diagnosis, treatment and care, including surgery and management of morbidity, as well as passive surveillance need to be considered in the context of investments in the health system more broadly, including in an integrated approach to skin-related NTDs; indoor residual spraying against visceral leishmaniasis needs to be considered in the context of investments in an integrated vector control strategy.

3. With the exception of praziquantel for schistosomiasis in adults, for which a donation will need to be negotiated.

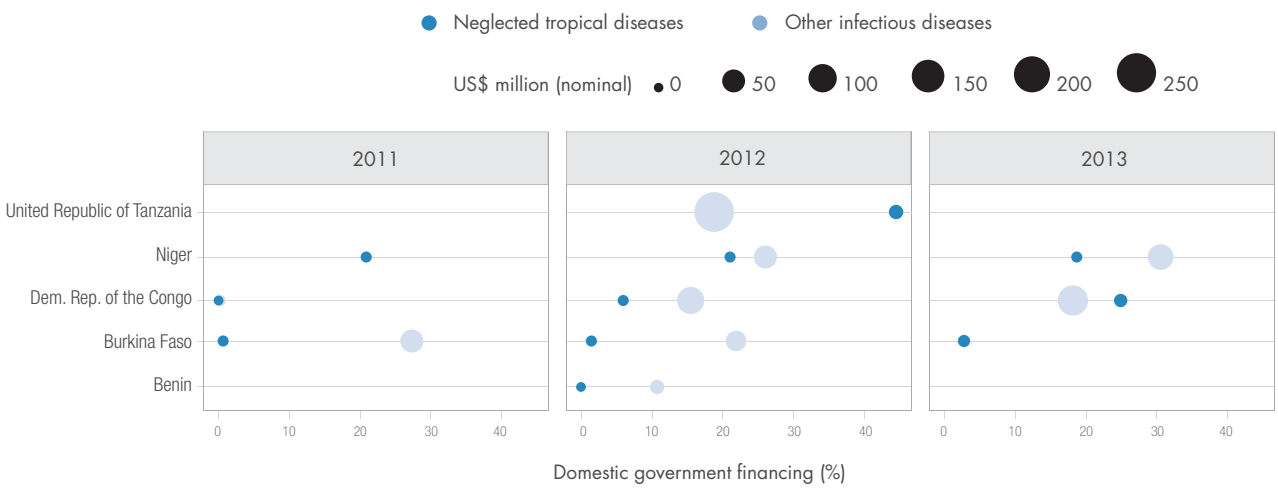
4.4.3 The NTD financing opportunity

Evidence from the health accounts of low-income countries in Africa suggests that the share of financing that comes from domestic governments has often been lower for NTDs than for other infectious diseases (Fig. 4.12), thus leaving NTD programmes disproportionately dependent on foreign funding. Because the amounts invested in NTDs by domestic government are so small, modest increases can have a big impact, allowing even low-income countries to take ownership of an important global health programme. Some countries appear to be making progress on this front.

In the Democratic Republic of the Congo, evidence from health accounts suggests that in the space of 3 years the government's share of NTD financing went from nothing to 25%, slightly higher than the government's share for other infectious diseases. In absolute terms, spending rose from nothing in 2011 to US$ 2 million in 2013, a significant increase but still small relative to the government's financing for infectious diseases as a whole. The United Republic of Tanzania (mainland) is another example, with the government spending about US$ 7 million on NTDs in 2012, accounting for more than 40% of total NTD spending but only 2.5% of government spending on other infectious diseases.

As the health accounts of other countries are published, the domestic financing picture for NTDs will become clearer. In the meantime, other sources of data suggest that global progress is indeed being made on domestic financing. The rapid increase in the number of people reached by preventive chemotherapy (rising from 857 million in 2014 to 979 million in 2015, an increase of 14% despite flat foreign funding) appears to have been driven by increases in domestic financing and efficiency gains.

Fig. 4.12. Domestic government financing as a percentage of total financing for NTDs and other infectious diseases, five countries, 2011–2013[a]



a The percentage includes domestic government financing for HIV, tuberculosis and malaria and all other infectious and parasitic diseases, as reported by countries. For Burkina Faso, private sources have been excluded because these represent a large private donation of medicines for regional use (that is, outside of Burkina Faso). The countries and years selected reflect those for which information was publicly available about NTD expenditures from WHO's Global Health Expenditure Database (http://apps.who.int/nha/database/DocumentationCentre/Index/en). The United Republic of Tanzania refers to the mainland and excludes Zanzibar.

Sudan is an example of increased domestic spending, where about US$ 1.2 million in extra-budgetary governmental allocations went to NTD projects in 2016. Another US$ 320 000 was made available through an existing mechanism that the Ministry of Finance designed to match cash contributions from outside partners: the NTD programme was able to convince the Ministry that donations of medicines should be eligible for matching. Egypt is another example: in 2016, the Egyptian Ministry of Health and Population announced a plan to accelerate the elimination of schistosomiasis that included an investment of US$ 2 million a year. An initial gap in funding was closed with the help of WHO when a donation of praziquantel was secured from a pharmaceutical company. The implementation of the 5-year project will be entirely funded by the Government of Egypt.

Although such examples are obviously encouraging, it is clear that higher levels of domestic funding in the context of a shift from disease-specific to health-systems financing will be required to increase access to NTD interventions during 2015–2030. This is especially true for middle-income countries, which not only carry the heaviest burden in terms of the absolute numbers of people requiring interventions against NTDs but also have the fiscal ability to do something about it.

4.4.4 A framework for NTD financing

Countries attending the Third International Conference on Financing for Development agreed to an array of measures aimed at widening the revenue base for development, including improving tax collection, combating tax evasion and illicit financial flows, and phasing out inefficient fossil fuel subsidies and excessive tax incentives for extractive industries. Countries also agreed to consider what are known as sin taxes – that is, taxing harmful substances to deter consumption and to increase domestic resources. They recognized that as part of a comprehensive strategy of prevention and control, the price of tobacco, in particular, and tax increases have the potential to generate revenue for financing development in many countries.

It was against this backdrop that WHO's Department of Control of Neglected Tropical Diseases convened a 2-day meeting in Geneva to discuss the implications of the SDGs and UHC for NTD financing domestically and internationally, and to develop a draft framework for NTD financing for 2016–2030. The framework that resulted from that meeting builds on the WHO Roadmap for implementation, which laid out milestones and targets for eradicating, eliminating and controlling NTDs (*8*), and on WHO's third NTD report (*9*), which outlined the case for investing in NTD responses and also set investment targets to 2030, including domestic investment targets.[1]

The main intention of the framework is to assist those responsible for planning and implementing NTD programmes to initiate a dialogue about financing with other in-country stakeholders, including ministries of health, finance and social affairs, and also with ministries of education, water and sanitation. The framework also encourages dialogue with international donors, including multilateral and bilateral donors, philanthropic organizations, private investors (including wealthy individuals) and the private sector.

1. Focusing on the implementation of NTD programmes and initiatives, the framework does not address the specific financing needs of NTD-related research and development; that issue is being discussed elsewhere – for example, in WHO's Health Product Research and Development Fund: a Proposal for Financing and Operation (Geneva: World Health Organization on behalf of the Special Programme for Research and Training in Tropical Diseases; 2016 (http://www.who.int/tdr/publications/r_d_report/en/).

Finally, the framework provides an opportunity for national programmes to articulate what type of technical cooperation they hope to receive from WHO on NTD financing, bearing in mind the anticipated shift from international to domestic financing and from disease-specific to health-system financing.

The framework is relevant to all NTDs and NTD interventions – that is, preventive chemotherapy and transmission control, innovative and intensified disease management, vector ecology and management, neglected zoonotic diseases and WASH interventions. Importantly, it recognizes that financing challenges vary from disease to disease. It also recognizes that financing strategies need to reflect differences between the medium-term (2020) and longer-term (2030) objectives of NTD programmes.

The framework takes into account multiple financing channels, aligned with those identified as important by the Addis Ababa Action Agenda, including:

- domestic public resources, such as tax revenue, and compulsory social health insurance;
- resources from domestic and international private businesses and financing, including individual and corporate philanthropy (including in-kind contributions, such as medicines), and private health insurance;
- international development cooperation, including budget support and project grants from bilateral agencies and the grant portion of development loans from multilateral agencies;
- multi-stakeholder partnerships, including public, public–private and civil society partnerships;
- North–South, South–South and triangular regional and international cooperation on science, technology, innovation and capacity building, including cooperation affording access to those public goods.

The framework is built on eight core principles:

- delivering on existing commitments – ensuring follow-through on the various declarations and commitments made in recent years;
- enhancing value for money – ensuring the optimal efficiency and effectiveness of NTD interventions;
- leaving no one behind – ensuring equitable access to high-quality, people-centred services;
- promoting country ownership – ensuring that governments own and take responsibility for national responses to NTDs;
- strengthening international solidarity – ensuring optimal support through official development assistance and philanthropic giving;
- engaging affected communities – ensuring that NTD interventions reach the communities that need them;
- aligning with UHC – ensuring the optimal integration of NTD strategies and interventions into health systems transitioning to UHC;
- mainstreaming within the SDGs – ensuring that the mobilization of NTD-related resources reflects the many cross-cutting issues that link NTDS to all of the SDGs, which has implications for resource mobilization from sectors other than health.

4.4.4.1 Delivering on existing commitments

There have been several significant statements of intent in recent years, in which different international groups have lined up behind the idea of doing something to address the challenge of NTDs. Notable among them is Resolution WHA66.12, which calls for "predictable, long-term, international financing for the control of neglected tropical diseases". The resolution also highlights the importance of national health systems supporting NTD-related activities, advocating "integrating neglected tropical diseases control programmes into primary health care services and vaccination campaigns, or into existing programmes where feasible, in order to achieve greater coverage and reduce operational costs". Additionally, the resolution calls for Member States to ensure that "resources match national requirements and flow in a sustainable manner as a result of thorough planning and costing of prevention and control activities and detailed analysis of associated expenditures". Recognizing the cross-sectoral nature of many infectious disease challenges, the resolution also advocates for enhancing and sustaining "national financial commitments, including resource mobilization from sectors other than health" (*10*).

Another recent statement that has a bearing on NTD funding is the 2014 Addis Ababa NTD Commitment, which was made at the ministerial NTD health forum on 9 December 2014 (*1*). Ministers and heads of delegations of 24 African countries[1] made 5 core commitments, the first of which was a commitment to increase "domestic contribution to the implementation of NTD programs through the expansion of government, community and private sector commitments".

Most recently, leaders at the Group of 7 (G7) summit held in Germany in June 2015 (*11*) made seven commitments in a declaration, including a commitment to fight NTDs on two fronts: first, by supporting NTD-related research and, second, by supporting health-system strengthening. Specifically, the declaration committed the G7 to "continue to advocate [for] accessible, affordable, quality and essential health services for all [and] support community based response mechanisms to distribute therapies and otherwise prevent, control and ultimately eliminate these diseases". To achieve these aims the G7 committed to investing in efforts to prevent and control NTDs to achieve the 2020 elimination goals.

One commitment that has resulted in significant follow-through is the aforementioned 2012 London Declaration. Uniting to Combat NTDs, a group of high-profile stakeholders – including USAID, the World Bank, the Bill & Melinda Gates Foundation, and several pharmaceutical companies – came together under the London Declaration, pledging to provide the resources necessary for implementing a medicine donation programme to support preventive chemotherapy. One of the central commitments of the London Declaration is to ensure that medicines are donated by pharmaceutical companies. In 2015, 991 million people received preventive chemotherapy for at least 1 disease. The trajectory of preventive chemotherapy coverage continues to accelerate, with coverage increasing from 35% of those needing the intervention in 2008 to 62% in 2015.

USAID remains a global leader in the widespread implementation of integrated treatment programmes for NTDs, focusing on expanding MDA to target the control or elimination, or both, of lymphatic filariasis, trachoma, onchocerciasis, schistosomiasis

1. Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Mali, Malawi, Nigeria, South Sudan, Sudan, Togo, Uganda and the United Republic of Tanzania.

and soil-transmitted helminthiases; in 2016, USAID supported 25 countries and regional programmes in Africa and the Americas, helping them to reach treatment targets and to monitor and evaluate control and elimination goals. During 2014–2016 (Fig. 4.13), USAID allocated US$ 100 million each year to NTD activities, accounting for almost half of all foreign aid committed to NTD-related activities (*12*).

The Government of the United Kingdom is another important supporter of NTD programmes, having pledged in 2012 to provide £245 million (US$ 392 million) to programmes to fight lymphatic filariasis, onchocerciasis, schistosomiasis and dracunculiasis (*13*). Also notable is the newly launched £1 billion (US$ 1.3 billion) Ross Fund (*14*), which will be managed by the United Kingdom's Department for International Development and the Department of Health, and has committed £200 million (US$ 260 million) to developing medicines and diagnostic tests for NTDs (**section 4.4.4.5**).

Other commitments are less visible, but no less important. These include the daily commitments made by community volunteers. Although they are harder to quantify, these millions of volunteers represent a considerable force, notably in regard to preventive chemotherapy, which they deliver through community- and school-based platforms (*15*). Volunteers also play an important part in the early detection and treatment of people with NTDs (*16*). The significance of community- based NTD efforts for health systems is discussed in **section 4.2**; they will play a major part in ensuring optimal integration of NTD strategies and interventions into health systems transitioning to UHC.

4.4.4.2 Enhancing value for money

In 2006, interventions for NTD control were judged to be among the most cost–effective infectious disease interventions in the second edition of the Disease Control Priorities Project, which, for example, highlighted the value of annual MDA for treating populations at risk of lymphatic filariasis (US$ 4.00 to US$ 8.00 per DALY averted) and community-directed ivermectin treatment programmes to control onchocerciasis (US$ 6.00 per DALY averted) (*17*). The forthcoming third edition will again include NTD interventions among its essential package of interventions for developing countries, based on cost–effectiveness ratios that fall well within the threshold of US$ 250 per DALY averted.

The cost–effectiveness of interventions notwithstanding, there is much that can be done to achieve greater value for money in the way NTD interventions are financed. Developing optimal financing requires balancing the "four Es" of economy, efficiency, effectiveness and equity. It is important to consider factors that are specific to NTD programmes and, in particular, elimination campaigns. Notable among these is the risk and cost of disease resurgence.

History contains far too many examples of disease elimination campaigns that came close to their stated objectives, only to ease up during the endgame, which led to resurgence. The yaws eradication campaign is just one example: between 1952 and 1964, WHO and UNICEF led a global eradication campaign using injectable benzathine benzylpenicillin, which reduced the prevalence of treponematoses from 50 million to 2.5 million (*18*), but the campaign was not pursued to eradication, permitting the resurgence of disease in the 1970s. Quite apart from the suffering such mistakes engender, they are also costly in terms of economy, efficiency, effectiveness and equity, and they should not be repeated.

Another value for money consideration that is specific to NTDs is the opportunity cost of "free" NTD medicines. The widespread donation of medicines by the pharmaceutical industry has boosted preventive chemotherapy campaigns. However, such resources are not infinitely renewable and, therefore, it is vital that advanced NTD programmes have viable plans for winding down donation requests. Key to achieving this will be the mainstreaming of NTD programme activities into health systems as a part of the transition to UHC.

Mainstreaming also has the potential to improve efficiency and effectiveness in other ways. Indeed, without implementing system-wide, integrated approaches to delivering NTD interventions, responses will continue to carry the cost burden associated with, for example, duplication of effort. Even when NTD health programmes are well run, if they duplicate functional responsibilities – such as contracting with providers, and engaging in procurement and monitoring – they impose costs on the system as a whole.

Value for money may also be enhanced by the optimal use of what is known as innovative financing. The term innovative financing has been applied to solidarity levies on a range of products and services, including airline tickets, mobile phone calls, financial market transactions, and tobacco and alcohol sales. But truly innovative financing does more than just tap into new sources of revenue for governments: it also alters service-delivery mechanisms to better align incentives, and to take advantage of potential contributions from the private sector.

One such mechanism that may have particular relevance for NTD responses is development impact bonds, a form of payment by results that leverages private investment against commitments from governments and donors to pay for a predefined outcome (**Box 4.8**). The United Kingdom's Department for International Development announced its interest in and support for these bonds in 2014 (*19*), applying the instrument to a project to control human African trypanosomiasis by using veterinary public health interventions in Uganda. The Department for International Development plans to support other such partnerships by bringing together investors, governments and aid agencies to design new investments.

Groups behind the initial development of the bond for human African trypanosomiasis are looking at the feasibility of using such bonds for dengue and rabies control. Initiatives such as these will help to identify the necessary conditions under which these bonds might be expected to improve the performance of health systems in controlling these and other NTDs (*9*). As innovative as they may turn out to be, these bonds are not a replacement for the public provision of public goods, but rather one possible option for allowing engagement with the private sector in areas in which it may offer better value for money.

Finally, enhancing value for money depends on robust, transparent and accountable financial management. Greater transparency of the flow of funding and accountability for results will help to tackle inefficiencies and the misuse of available resources.

Box 4.8. Development impact bonds

Development impact bonds are a variation on social impact bonds, which have been used in a number of developed countries to facilitate investments intended to yield some sort of social benefit. However, development impact bonds are not bonds at all but rather results-based contracts in which private investors (outcome funders) provide financing for socially beneficial programmes and public sector agencies pay back their principal plus a return if these programmes succeed in delivering previously agreed outcomes. Unlike social impact bonds, development impact bonds involve donor agencies, either as full or joint funders of outcomes (*20*).

Development impact bonds may represent a significant opportunity for NTD-related programmes, bringing together those who implement projects or programmes that need capital to get started with investors who want to use their resources to generate a social benefit. Those resources are not limited to money and may include products, skills and expertise. Because investors make a financial return only if the project or programme achieves the agreed-upon outcome, they have financial motivation to pursue innovation and excellence to achieve better results.

The likely private investors range from those who may expect a social return but no financial return (for example, charities making grants) to those who expect solid financial returns without necessarily any social return (for example, private equity investors). Because development impact bonds are in their infancy, the initial investors are likely to comprise socially motivated individuals and organizations willing to accept some financial risk in exchange for potential social returns. Thus, investors might include trusts and foundations, development finance institutions and wealthy individuals with an interest in a particular population or social or health issue. As experience with these bonds grows, and the opportunities for investment expand and diversify, they may attract a wider range of more mainstream investment capital.

4.4.4.3 Leaving no one behind

As noted in **section 4.2**, the 2030 Agenda puts UHC at the heart of the health goal, emphasizing one of its key aims with the resonant phrase, "No one must be left behind" (*21*). This is also the cornerstone of the NTD strategy. More than ever, NTDs are diseases of poor people than diseases of poor countries, with the greatest number of people requiring NTD interventions being found in middle-income countries. It is encouraging to note that the principle of leaving no one behind is also at the heart of the Addis Ababa Action Agenda (*1*), which calls for, "fiscally sustainable and nationally appropriate social protection systems and measures for all … with a focus on those furthest below the poverty line and the vulnerable, persons with disabilities, indigenous persons, children, youth and older persons".

Ensuring that leaving no one behind becomes more than just a principle depends on a range of actions, from providing high-quality health services across the continuum of care to reducing dependence on out-of-pocket payments. It also depends on effectively monitoring those actions, as emphasized in the Action Agenda, which calls for countries "to increase and use high-quality, timely and reliable data disaggregated by sex, age, geography, income, race, ethnicity, migratory status, disability, and other characteristics relevant in national contexts (*1*)." That addressing the needs of those living with NTDs is central to the UHC goal is recognized in the first WHO/World Bank global monitoring report on UHC, which states that monitoring the coverage of NTD interventions is "key to ensuring that the diseases of the least well-off are being prioritized from the very beginning of the path towards UHC" (*22*).

4.4.4.4 Promoting country ownership

Without a significant increase in domestic resources for NTD interventions, achieving the 2020 and 2030 goals for NTDs will remain only an aspiration. In many developing countries, domestic resources are increasingly available. This is partly a result of the increases in gross domestic product (GDP) in many developing countries during the past decade. For example, countries in WHO's African Region have seen average annual GDP growth of 5% during the past 15 years. This has not always resulted in comparable increases in state revenues, partly because of challenges in tax collection, but two thirds of African countries with available data have seen an average 4% increase in tax revenue as a share of GDP during the same period (*23*). Today, governments in low- and middle-income countries collect more than US$ 40 in domestic revenue through taxation for every dollar of foreign aid received (*9*).

Some of that money is being spent on health care. Governments' per capita health expenditures rose by about 40% between 2000 and 2013, with increases reported in all regions (*24*). This has resulted in a rebalancing of health funding, with a clear shift towards domestic funding for health. In 2014, the domestic share of total expenditure

Table 4.4. Key health financing indicators (in purchasing power parity equivalents): regional benchmarks and unweighted averages, 2014

	African Region	Region of the Americas	South-East Asia Region	European Region	Eastern Mediter-ranean Region	Western Pacific Region	TOTAL
Total health expenditure as a share of GDP	6	7	5	8	6	7	7
Public expenditure on health as a share of GDP	3	4	3	5	3	5	4
Public expenditure on health as a share of total health expenditure	51	57	57	67	56	72	60
Private expenditure on health as a share of total health expenditure	49	43	43	33	44	28	40
Public expenditure on health as a share of total public expenditure	10	14	10	13	9	12	12
External expenditure as a share of total health expenditure	24	3	9	1	3	18	10
Out of pocket expenditure as a share of total health expenditure	32	32	38	28	38	22	31
Private health insurance expenditure as a share of total health expenditure	4	8	2	5	5	5	6
Per capita total health expenditure	274	1327	459	2548	1082	1128	795
Per capita public health expenditure	164	774	321	1904	741	795	912

GDP, gross domestic product
Source: reference *23*

on health was 76% in WHO's African Region) and 99% in the European Region (Table 4.4). It is important to note that this includes public and private expenditure, as well as out-of-pocket payments that discourage and, in some cases prevent, poor people from seeking care. However, that important caveat aside, health is now predominantly financed by domestic resources in low- and middle-income countries.

Broadly speaking, governments already own the funding of health care. Unfortunately, that ownership still falls short of the requisite funding levels and commitments. This is notably the case in WHO's African Region, where only a handful of countries are now meeting the 2001 Abuja Declaration target of spending 15% of annual expenditures on health. In 2014, the average annual public expenditure on health in the region was 10% of total public spending, ranging from 4% in Cameroon to 17% in Swaziland (*23*). Even where countries are meeting expenditure targets, much of the money is still going into tertiary level hospitals rather than to the primary health care clinics upon which formal health-system delivery of NTD interventions depends. Moreover, annual health budgets are not systematically or fully disbursed. Altogether, for every US$ 100 that goes into state coffers in the African Region, on average US$ 16 is allocated to health, but only US$ 10 is spent, and less than US$ 4 is allocated correctly (*23*).

A key issue is how ensure that an appropriate share of domestic resources goes to NTD interventions. In the past, the reflex has been to earmark or ring-fence funds, but the evidence suggests that ring-fencing specific amounts for specific diseases may actually limit rather than empower countries, for example by reducing discretionary budget allocations, thus resulting in little if any increase in the total public funding available to extend coverage (*25*). The mainstreaming of NTDs into health systems will help to ensure that the domestic share of funding for NTDs is no less than that for the interventions of the health sector as a whole.

Foreign funders can play an important part through co-financing or matched funding arrangements. For example, the funding model of the Global Fund to Fight AIDS, Tuberculosis and Malaria includes a requirement for countries to commit to co-financing the response to these diseases. It consists of two elements: a co-financing requirement, which obliges countries to increase government spending on health and increase the co-financing of programmes supported by the Global Fund, and a co-financing incentive, the amount and focus of which is determined by a country's income classification (*26*). To access the incentive, countries need to make additional co-financing investments in areas that directly benefit programmes supported by the Global Fund; importantly, this can include investments that support resilient and sustainable health systems.

One of the key challenges to prioritizing NTD control at the national level is the fact that these efforts remain largely absent from national health plans and budgets, and from the plans and budgets for other sectors. Another challenge is that many countries where NTDs are endemic do not yet have a clear understanding of how much or how little domestic investment is directed towards NTD programmes relative to foreign aid or relative to other priority disease programmes. WHO is working with countries to track their actual expenditures on NTDs through the WHO Health Accounts Country Platform

Approach.[1] Health accounts have been completed for 53 countries, and at least 5 low-income, high-burden countries in Africa are now tracking their expenditures on NTDs as part of their national statistics. The results for these five countries are presented in Fig. 4.12. Making improvements in the timeliness, completeness and quality of data will be the focus of future efforts, including efforts directed at ensuring better monitoring of donated medicines.

4.4.4.5 Strengthening international solidarity

Despite the need to shift towards more domestic funding for NTD programmes, it is clear that not all countries are ready to graduate from official development assistance, and many will require more of it. Given the budget constraints confronting many donors, substantial increases are unlikely in the near future. Therefore, it is crucial that aid is targeted to where it is needed most – that is, towards the least developed countries and poor or marginalized populations. Effectively targeting aid at the least developed countries will not only increase resources in areas of need but will also have a catalytic role in leveraging other sources of finance. To support better targeting, it would be helpful to develop a transitional framework in which the option of additional capacity building or technical support could be leveraged with increasing domestic ownership.

Despite the progress that has been made by NTD programmes and described earlier in this report, and despite affirmations to the contrary, it is clear that NTDs continue to be neglected. To note just one example, unlike the other major communicable diseases targeted by the infectious disease target (SDG target 3.3), the Global Fund does not include financing for NTDs. However, the aid landscape continues to evolve, and a number of entities are emerging that can play a part in advancing NTD financing.

These include the Ross Fund (*14*), which will focus on supporting research into and the development of products for infectious diseases, as well as strengthening the delivery of new products (see **section 4.4.4.1** for details). The fund targets three areas: antimicrobial resistance; diseases with epidemic potential, such as Ebola virus disease; and NTDs. The Fund has committed £200 million (US$ 260 million) to developing products, including medicines and diagnostic tests. The fund is also continuing the United Kingdom's investments in prevention and treatment, for example, in working towards eradicating dracunculiasis. The fund will also continue to tackle trachoma, lymphatic filariasis, onchocerciasis, schistosomiasis and visceral leishmaniasis.

Another emerging entity is the Islamic Development Bank's Lives and Livelihoods Fund, an innovative, blended strategy aimed at fighting poverty in International Development Association member countries (*27*). The fund will provide up to US$ 2.5 billion during 5 years in concessional loans aimed at saving lives and improving people's livelihoods. The fund's projects will focus on four areas: (i) controlling and eradicating infectious diseases; (ii) enhancing primary health care, including improving maternal, neonatal and child health; (iii) enhancing agriculture and food security by enabling the poorest people to grow more staple products, feed their families and earn a basic living; (iv) enhancing basic infrastructure, including developing alternative energy sources and off-grid rural power generation and distribution, small-scale water and sanitation projects for unconnected communities, and digital payment systems using mobile technology.

1. http://www.who.int/health-accounts/platform_approach/en/

In Uganda, the Lives and Livelihood Fund has already committed up to US$ 43 million over 3 years with the aim of meeting three main objectives: (i) training health workers to train communities and village health teams to conduct active surveillance for the most prevalent NTDs, (ii) providing essential medicines and supplies to those already suffering from NTDs, and (iii) improving community sanitation. This cross-sectoral initiative is expected to benefit more than 5 million people in 73 districts living near bodies of water, and the expected results include enhanced sanitation awareness in 75% of the districts where schistosomiasis is endemic; 25 000 health workers trained to diagnose and manage cases of visceral leishmaniasis and Buruli ulcer; 43 000 village health teams trained and engaged in case identification of tungiasis, podoconiosis and Buruli ulcer; communities trained in how to manage morbidity and disability; improved community sanitation; reduced morbidity from NTDs related to poor sanitation; and, finally, improved supervision and monitoring of NTD programmes by health workers (*28*).

Other multilateral development banks will continue to have an important role. These include regional development banks, such as the African Development Bank, the Inter-American Development Bank and the Asian Development Bank. These institutions have already demonstrated their capacity to generate unique and innovative models for financing national NTD programmes, such as the Regional Malaria and Other Communicable Disease Threats Trust Fund set up by the Asian Development Bank, which seeks to attract financing from regional economies, development partners, the private sector and foundations (*29*). The Asian Development Bank also supports dengue control programmes and recently announced that it will increase operations in the health sector to between 3% and 5% of its annual spending, up from 2% during 2008–2012 (*30*). This commitment is an opportunity to contribute more resources to support national NTD control and elimination programmes.

The World Bank's International Development Association Fund has already helped leverage domestic financing for NTDs with a mix of grants and loans. It has financed dedicated NTD projects, notably for schistosomiasis control in China, Egypt and Yemen, as well as multisectoral projects, including water resource development in the Senegal River basin. Countries have matched every dollar of International Development Association Funds with about two dollars of domestic revenue. Also encouraging is the World Bank's commitment to expanding its investment in NTDs by working with endemic countries in Africa to give them access to US$ 120 million in International Development Association funds to support efforts to control and eliminate NTDs. Another US$ 75 million project to combine preventive chemotherapy for NTDs with seasonal malaria chemoprevention in the Sahel will leverage domestic funding in Burkina Faso, Mauritania and Niger (*31*). Possible sources of new funding for NTDs include the thus-far untapped source of World Bank funds in the US$ 400 million financing facility available for results-based financing.

Of course, these initiatives express the volition and ingenuity of the institutions involved, but they also signal the prioritization of NTDs by governments in endemic countries. Additionally, they acknowledge that NTDs are a cross-cutting issue that is tied not only to health but also to efforts to improve education, gender equity, agriculture, and water and sanitation (*32*).

4.4.4.6 Engaging affected communities

Community health workers have played a crucial part in implementing NTD interventions, especially by delivering preventive chemotherapy (*33*,*34*) and they will continue to do so (*35*). However, it is important to note that relying on community volunteers can be problematic if it results in fragmented NTD projects that fail to deliver the high levels of sustained coverage that are required to interrupt transmission. Moreover, NTD control programmes that have been expanded to cover more than 1 billion people may struggle to recruit and retain sufficient numbers of volunteers when programmes targeting other major diseases are offering incentives.

On the demand side, communities have important roles to play in demanding that high-quality services and interventions are made available and that health systems are adequately financed to meet that end. Community engagement will be particularly important in ensuring that funders stay the course as responses to NTDs enter the endgame and case numbers start to decline.

4.4.4.7 Aligning with universal health coverage

The mainstreaming of NTDs into health systems transitioning towards UHC implies a significant change in the way NTD interventions will be financed. Most of the financing that will be made available for health from domestic sources will be made available through health systems rather than individual, disease-specific programmes. In principle, much of the financing available for NTD interventions may be integrated into overall programmes for UHC. The health systems that have made the most progress towards UHC have been underpinned by the introduction of compulsory prepayment[1] and risk-pooling mechanisms (including general revenue financing for national health systems) (*36*), and these systems present an opportunity to develop robust, integrated responses to NTDs.

One of the most obvious challenges of aligning NTD financing with UHC reforms will be to determine which interventions will be included in benefit packages. UHC is defined as "ensuring that all people have access to needed promotive, preventive, curative and rehabilitative health services, of sufficient quality to be effective, while also ensuring that people do not suffer financial hardship when paying for these services" (*37*). The majority of people requiring NTD interventions live in severe poverty – and are, therefore, unable to pay for any NTD intervention without being pushed further into poverty. Given that NTDs mostly affect people who are already poor and disadvantaged, moving towards UHC seems to imply that health services addressing NTDs should be offered free of charge. This challenge, although daunting, is at least clear and the key issue, apart from mobilizing the funds required, will be to garner support for public health policies and interventions that prioritize poor people.

1.The essential attribute of systems that have made progress towards UHC is compulsion and subsidization. Compulsion is essential to make sure that those who can afford to pay do not opt out; subsidization is essential so that those who cannot afford to pay are not excluded.

Generally, this should be easier in countries where NTD endemicity (and, therefore, public awareness) is high. This is the case in Madagascar, for example, one of the countries already working to integrate core NTD interventions into planned health-system reforms designed to advance their UHC agenda. Policy documents in Madagascar not only explicitly reference UHC as a guiding principle but also reference NTDs, which are given consideration alongside HIV and AIDS, tuberculosis and malaria (*38*). The importance of key NTD-related interventions is also emphasized, including vector control, veterinary public health services, WASH interventions and multi- and intersectoral collaboration.

Certain specific considerations should be borne in mind. For example, the relatively small scale or limited duration of some NTD interventions may make it impractical to explicitly include these NTDs in benefit packages. Thus, although the design of a benefit package may not need to target individual NTDs or NTD interventions, it should include interventions, such as outreach, that are of greatest benefit to the people who are the least well off. Core interventions against NTDs, including preventive chemotherapy, are often delivered outside of fixed health facilities. UHC financing will need to take this into account.

The transition towards UHC and the mainstreaming of NTDs within broader health systems will depend in part on key stakeholders coming together. The Addis Ababa Action Agenda calls for better alignment among partnerships of multiple stakeholder, such as the GAVI Alliance and the Global Fund to Fight AIDS, Tuberculosis and Malaria, and encourages them to increase the contributions aimed at strengthening health systems. Signs of increasing collaboration on health financing are already apparent, for example, among groups working to address the chronic infectious diseases of poverty. This is reflected in WHO's report Accelerating progress on HIV, tuberculosis, malaria, hepatitis and neglected tropical diseases: a new agenda for 2016-2030, which concludes that, "The drive to end epidemics will also require greater integration across disease programmes, and between disease programmes and the health systems within which they work"(*2*).

4.4.4.8 Mainstreaming within the Sustainable Development Goals

Although it is uncertain how the SDGs will influence overall financing for health, the breadth and scope of the SDGs implies a shift in official development assistance away from health but towards areas such as infrastructure development. It is to be hoped that financing for the health-related SDG targets (outside of the health goal, SDG 3) will, nonetheless, create new opportunities for financing progress towards the "end of NTDs" under the infectious disease target (3.3).

The multiple ways in which NTD and SDG targets interrelate is discussed in **section 4.1**, and the interface between NTDs and UHC is explored in **section 4.2**, which emphasizes the number of non-health-related SDG targets that have important implications for health and, thus, relevance for UHC (*39*). These include targets for reducing poverty and hunger, and coverage targets for WASH interventions, all of which have a significant bearing on health in general and UHC in particular. Because UHC is a cross-cutting issue that has

links to the achievement of all health-related SDG targets, it has the potential to serve as a platform for developing more integrated financing. When combined with a Health in All Policies approach, it can facilitate better priority setting and the more efficient use of resources and also encourage the development of synergies, such as those envisioned in the joint NTD–WASH strategy.

It is significant that NTDs will be used as a tracer indicator for equity in progress towards ensuring universal water, sanitation and hygiene services (SDG 6), not least because this will help to target investments in these services where they are needed most. The joint NTD–WASH Strategy for 2015–2020 (*40*) will ensure closer collaboration between WASH and NTD programmes and can lead to benefits from joint planning, including financial planning; the delivery and evaluation of programmes; the strengthening and sharing of evidence; and using monitoring tools to improve the equity of health services (*41*). The expectation is that taking a more integrated approach to NTDs and water, sanitation and hygiene will increase efficiencies and, thus, sustainability.

Also notable are the goals for financing safe cities (SDG 11) and adapting to climate change (SDG 13), both of which may provide more opportunities and, thus, funding for controlling vector-borne diseases. Several NTDs are profoundly rooted in urban environments, partly because of the conditions in which the urban poor often live and partly because of the affinity of certain NTD vectors for urban areas. Mosquitoes such as *Ae. aegypti* thrive in urban areas. Efforts to improve conditions in cities will inevitably impact NTDs and efforts to control NTDs will inevitably affect cities.

Climate change is likely to expand the geographical distribution of several mosquito-borne diseases (*42*), notably dengue (*43*), but also chikungunya and Zika virus disease, both of which are highly sensitive to climatic conditions, especially temperature, rainfall and relative humidity (*44*). The Addis Ababa Action Agenda calls on developed countries to implement their commitment to a goal of jointly mobilizing US$ 100 billion per year by 2020 to address the climate change needs of developing countries. Also notable is the decision of the board of directors of the Green Climate Fund to aim for a 50:50 balance between mitigation and adaptation and to aim to have at least 50% of the adaptation allocation targeted to particularly vulnerable countries, including least developed countries (*44*).

For zoonotic NTDs, the principal challenge going forward will be to combine different streams of activity into a One Health approach that brings together the animal and human health, food production and environment sectors in recognition of the inextricable links among human and animal health and the health of the ecosystems they inhabit (*45*). Essential to implementing such an approach and to developing synergies, is ensuring collaboration, including collaboration on budgeting, and among stakeholders and the institutions within which they work because these have the power to make a difference.

The financial advantages of such collaboration were discussed at a meeting in 2010 hosted by the United States Centers for Disease Control and Prevention that included WHO, OIE and FAO (*46*), during which opportunities for cost-sharing were highlighted, including cost-sharing for logistics and service provision. A 2014 review of the scientific and grey literature that considered the One Health approach (*47*) noted that benefits

included a cost–effective reduction in disease transmission and incidence, cost savings achieved by sharing resources (for example, a 15% reduction in logistics costs), increased cost effectiveness for control interventions when human and animal health are investigated as a single social system (for example, rabies, brucellosis), and improved vaccination coverage at the same or less cost. As to One Health initiatives in the field, the efforts of the International Fund for Agricultural Development to mobilize investment to enable rural people living in poverty to improve their food security and nutrition, raise their incomes, and strengthen their resilience is worthy of note because it also provides opportunities for controlling zoonotic NTDs.

4.4.5 Conclusion

It is clear that the financing of NTDs in the context of the SDGs presents several challenges, the most obvious being that investments in interventions against NTDs might fall short of global targets and commitments. But as with the *London Declaration*, there are reasons to hope that funding for NTDs will improve between now and 2030 owing to the prospect of other declarations, avowals and agendas that will result in action and increased focus on domestic funding as a part of the transition towards UHC, despite increased competition from other SDG priorities.

Integrating NTD financing into broader health-systems financing as part of the transition towards UHC will not be simple. The trade-offs between cost–effectiveness and equitable coverage, which underpin the development and maintenance of UHC in all countries, are accentuated for NTD interventions, the coverage of which requires subsidizing interventions for the very poorest people, who are often living in communities that are beyond the reach of formal health systems. Of course, expanding primary health care coverage is at the heart of the UHC endeavour, but careful thought will have to go into deciding how best to commit limited resources and, in some cases, how best to reach beyond the last clinic on the road. Thus, community-based initiatives will continue to have an important role. At the international level, support for the very lowest income states and otherwise vulnerable states will also continue to be vital.

References

1. The Addis Ababa NTD commitment 2014. Uniting to Combat Neglected Tropical Diseases; 2016 (http://unitingtocombatntds.org/sites/default/files/document/The_Addis_Ababa_NTD_Commitment.pdf).
2. Accelerating progress on HIV, tuberculosis, malaria, hepatitis and neglected tropical diseases: a new agenda for 2016–2030. Geneva: World Health Organization; 2015 (http://apps.who.int/medicinedocs/documents/s22340en/s22340en.pdf).
3. From billions to trillions: transforming development finance. post-2015 financing for development [Multilateral Development Finance Development Committee Discussion Note]. African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank, International Monetary Fund, World Bank Group; 2015 (http://siteresources.worldbank.org/DEVCOMMINT/Documentation/23659446/DC2015-0002(E)FinancingforDevelopment.pdf).
4. Schmidt-Traub G. Investment needs to achieve the Sustainable Development Goals: understanding the billions and trillions [SDSN Working Paper]. Paris: Sustainable Development Solutions Network; 2015 (http://unsdsn.org/wp-content/uploads/2015/09/151112-SDG-Financing-Needs.pdf).
5. Bundy DAP, Dhomun B, Daney X, Schultz L, Tembon A. Investing in onchocerciasis control: financial management of the African Programme for Onchocerciasis Control (APOC). PLoS Negl Trop Dis. 2015;9:e0003508. doi:10.1371/journal.pntd.0003508.
6. The African Programme for Onchocerciasis Control (APOC) closes and a new body is set up to eliminate neglected tropical diseases [press release]. Brazzaville: WHO Regional Office for Africa [Media centre]; December 2015 (http://www.afro.who.int/en/media-centre/pressreleases/item/8239-the-apoc-closes-and-a-new-body-set-up-to-eliminate-neglected-tropical-diseases.html).
7. ESPEN – New initiative to tackle neglected tropical diseases in Africa. [feature story]. Brazzaville: WHO Regional Office for Africa (http://www.afro.who.int/en/espen/features/item/8263-espen-new-initiative-to-tackle-neglected-tropical-diseases-in-africa.html).
8. Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/2012.1; http://www.who.int/neglected_diseases/NTD_RoadMap_2012_Fullversion.pdf).
9. Investing to overcome the global impact of neglected tropical diseases: third WHO report on neglected diseases. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/2015.1; http://apps.who.int/iris/bitstream/10665/152781/1/9789241564861_eng.pdf).
10. Resolution WHA66.12. Neglected tropical diseases. In: Sixty-sixth World Health Assembly. Geneva, 20–28 May 2013. Geneva: World Health Organization; 2015 (http://www.who.int/neglected_diseases/mediacentre/WHA_66.12_Eng.pdf).
11. Leaders' Declaration, G7 Summit, 7–8 June 2015 (https://sustainabledevelopment.un.org/content/documents/7320LEADERS%20STATEMENT_FINAL_CLEAN.pdf).
12. Funding. In: Neglected Tropical Diseases Programme [website]. Washington (DC): United States Agency for International Development; 2016 (https://www.neglecteddiseases.gov/about/funding, accessed 15 March 2017).
13. Annual report 2014–15: report for the All-Party Parliamentary Group on Malaria and Neglected Tropical Diseases]. London: UK Coalition against NTDs; 2015 (http://www.mmv.org/sites/default/files/uploads/docs/publications/APPMG-NTD-REPORT-2015_16.pdf).
14. The Ross Fund – Combatting the world's most serious diseases [news story]. In: Health in developing countries [web site]. London (UK): Department for International Development and Department of Health; 2016 (https://www.gov.uk/government/news/the-ross-fund-combatting-the-worlds-most-serious-diseases, accessed 15 March 2017).
15. Downs PW, Bardin LE, McFarland DA. Modeling the dynamics of incentives in community drug distribution programs. Trends Parasitol. 2014;30:317–9. doi:10.1016/j.pt.2014.04.001.

16. Barogui YT, Sopoh GE, Johnson RC, de Zeeuw J, Dossou AD, Houezo JG et al. Contribution of the community health volunteers in the control of Buruli ulcer in Bénin. PLoS Negl Trop Dis. 2014;8:e3200. doi.org/10.1371/journal.pntd.0003200.
17. Disease control priorities in developing countries, 2nd edition. Oxford University Press and The World Bank (http://dcp-3.org/dcp2).
18. Marks M. Yaws: towards the WHO eradication target. Trans R Soc Trop Med Hyg. 2016 ;110:319–320. doi.org/10.1093/trstmh/trw032.
19. UK development bonds will combat global poverty [press release]. In: Health in developing countries [web site]. London (UK): Department for International Development and Department of Health; 2014 (https://www.gov.uk/government/news/uk-development-bonds-will-combat-global-poverty, accessed 15 March 2017).
20. Investing in social outcomes: development impact bonds. The Report of the Development Impact Bond Working Group. London (UK): Center for Global Development; 2014 (https://www.cgdev.org/sites/default/files/investing-in-social-outcomes-development-impact-bonds.pdf).
21. Transforming our world: the 2030 Agenda for Sustainable Development [Resolution A/RES/70/1 adopted by the General Assembly on 25 September 2015]. New York (NY): United Nations; 2015 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).
22. Tracking universal health coverage: first global monitoring report. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/174536/1/9789241564977_eng.pdf).
23. Public financing for health: from Abuja to the SDGs. WHO 2016 (http://apps.who.int/iris/bitstream/10665/249527/1/WHO-HIS-HGF-Tech.Report-16.2-eng.pdf).
24. Global Health Expenditure Database. In: Health Accounts [website]. Geneva; World Health Organization; 2011 (http://www.who.int/health-accounts/ghed/en/, accessed 15 March 2017).
25. Raising revenues for health in support of UHC: strategic issues for policy makers [Health Financing Policy Brief No 1.]. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/192280/1/WHO_HIS_HGF_PolicyBrief_15.1_eng.pdf).
26. Co-financing. In: Funding model [website]. Geneva: The Global Fund (http://www.theglobalfund.org/en/fundingmodel/process/cofinancing/, accessed 15 March 2017).
27. The Lives and Livelihoods Fund. In: Financing for Development [website]. http://www.un.org/esa/ffd/ffd3/commitments/commitment/the-lives-and-livelihood-fund.html, accessed 15 March 2017.
28. An end to neglected tropical diseases in Uganda. Seattle (WA): Bill & Melinda Gates Foundation, Lives and Livelihoods Fund; 2015.
29. Regional Malaria and Other Communicable Disease Threats Trust Fund (RMTF). In: Funds and resources [website]. Metro Manila: Asian Development Bank; 2016 (http://www.adb.org/site/funds/funds/rmtf, accessed 15 March 2017).
30. Strengthened ADB support for regional health security. Asian Development Fund (ADF) 12 replenishment meeting, 24–27 February 2016, Kathmandu, Nepal. Metro Manila: Asian Development Bank; 2016 (https://www.adb.org/sites/default/files/page/176089/adf-12-strengthen-regional-health-security.pdf).
31. WB support to prevent malaria and tropical diseases in Africa's Sahel [Press release]. Washington (DC): The World Bank Group; 11 June 2015 (http://www.worldbank.org/en/news/press-release/2015/06/11/wb-support-to-prevent-malaria-and-tropical-diseases-in-africas-sahel).

32. Delivering on promises and driving progress. London (UK): Uniting to Combat NTDs (http://unitingtocombatntds.org/sites/default/files/document/NTD_report_04102014_v4_singles.pdf).

33. Community-directed treatment with ivermectin: report of a multi-country study. Geneva: World Health Organization; 2006 1996 (WHO/AFT/RP/96.1; http://www.who.int/tdr/publications/tdr-research-publications/ivermectin-cd/en/).

34. Helminth control in school-age children: a guide for managers of control programmes, 2nd edition. Geneva: World Health Organization; 2011 (http://apps.who.int/iris/bitstream/10665/44671/1/9789241548267_eng.pdf).

35. Kolopack PA, Parsons JA, Lavery JV. What makes community engagement effective? Lessons from the *Eliminate Dengue* Program in Queensland Australia. PLoS Negl Trop Dis. 2015;9:e0003713. doi:10.1371/journal.pntd.0003713.

36. Kutzin J. "Anything goes on the path to universal health coverage? No." Bull World Health Org. 2012;90:867–8. doi:10.2471/BLT.12.113654.

37. What is universal coverage? Geneva: World Health Organization; 2015 [web page] (http://www.who.int/healthsystems/universal_health_coverage/en/, accessed 15 March 2017).

38. Plan de developpement du secteur sante 2015–2019 [Health sector development plan 2015–2019]. Antananarivo: Ministry of Health of Madagascar; 2015 (in French). http://www.sante.gov.mg/extranet/home/uploads/____folderforallfiles/pdss_2015.pdf.

39. Health in 2015: from MDGs, Millennium Development Goals, to SDGs, Sustainable Development Goals. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf, accessed February 2017).

40. Water, sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://www.who.int/water_sanitation_health/publications/wash-and-ntd-strategy/en/).

41. WHO strengthens focus on water, sanitation and hygiene to accelerate elimination of neglected tropical diseases. In: WHO/Water, sanitation, hygiene [website]. Geneva: World Health Organization; 2015 (http://www.who.int/water_sanitation_health/events/wash-and-ntd-strategy/en/, accessed 15 March 2017).

42. Working Group II: impacts, adaptation and vulnerability. In: Reports: assessment reports [website]. Geneva: Intergovernmental Panel on Climate Change (http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=361, accessed February 2017).

43. Naish S, Dale P, Mackenzie JS, McBride J, Mengersen K, Tong S. Climate change and dengue: a critical and systematic review of quantitative modelling approaches. BMC Infect Dis. 2014;14:167. doi:10.1186/1471-2334-14-167.

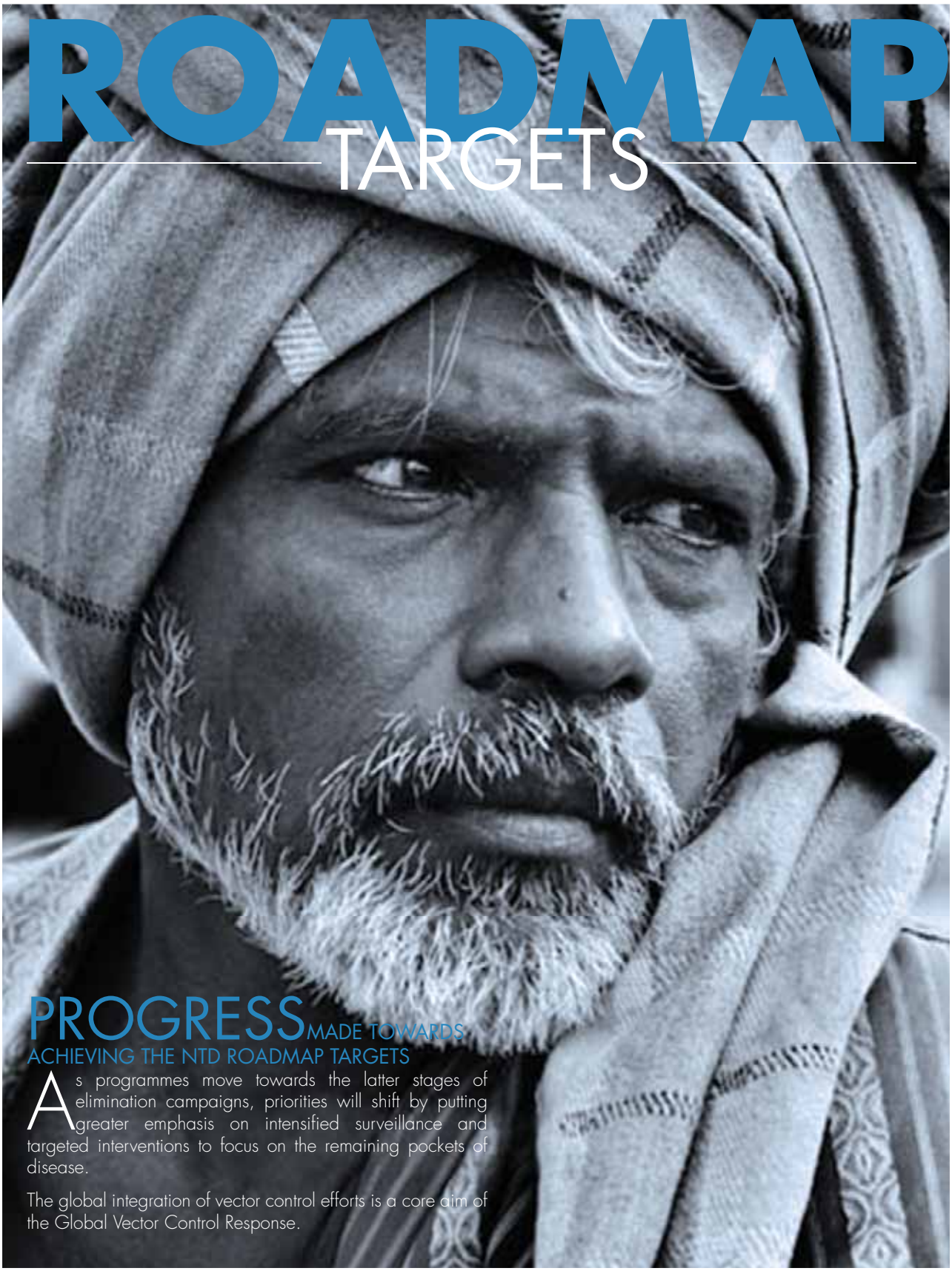
44. Readiness support. In: Funding [website]. Incheon: Green Climate Fund; 2017 (https://www.greenclimate.fund/funding/readiness-support, accessed 15 March 2017).

45. People, pathogens and our planet [Volume 1]. Towards a One Health approach for controlling zoonotic diseases. Washington (DC): The International Bank for Reconstruction and Development/The World Bank; 2010 (http://siteresources.worldbank.org/INTARD/Resources/PPP_Web.pdf).

46. Operationalizing "One Health": a policy perspective—taking stock and shaping an implementation roadmap. Meeting overview, May 4–6, Stone Mountain, Georgia. Atlanta (GA): United States Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of High-Consequence Pathogens and Pathology; 2010 (www.cdc.gov/onehealth/pdf/atlanta/meeting-overview.pdf).

47. Häsler B, Cornelsen L, Bennani H, Rushton J. A review of the metrics for One Health benefits. Rev Sci Tech Off Int. Epiz. 2014;33:453–64 (http://www.oie.int/doc/ged/D14080.PDF).

ROADMAP TARGETS



PROGRESS MADE TOWARDS ACHIEVING THE NTD ROADMAP TARGETS

As programmes move towards the latter stages of elimination campaigns, priorities will shift by putting greater emphasis on intensified surveillance and targeted interventions to focus on the remaining pockets of disease.

The global integration of vector control efforts is a core aim of the Global Vector Control Response.

5. Progress made towards achieving the NTD Roadmap targets

5.1 Buruli ulcer

Buruli ulcer is a chronic, necrotizing skin disease caused by infection with *Mycobacterium ulcerans*, an organism belonging to the same family of mycobacteria that causes tuberculosis and leprosy. However, *M. ulcerans* is considered an environmental mycobacterium and the mode of transmission is not known (*1*). The disease often starts as a painless nodule, but without treatment it can cause extensive ulceration leading to severe deformities and disabilities. Most patients are children aged under 15 years. There is no difference in the incidence of the disease between males and females.

Because the mode of transmission is unknown, no intervention to interrupt transmission of the infection exists, and elimination or eradication of the disease is impossible. The objective of control therefore is to reduce the morbidity and disability associated with the disease.

The principal strategy focuses on early detection and treatment with antibiotic medicines. WHO recommends combined antibiotic treatment using rifampicin and streptomycin for 8 weeks. Since 2004, more than 50 000 people have benefited from combination antibiotic therapy, almost halving the need for surgery, the mainstay of treatment in the past. Skin grafting to speed up healing in extensive ulcers and physiotherapy may be provided depending on the stage, location and extent of the disease (*2*).

The main challenge associated with control is the late detection of cases. More than 30% of patients are still diagnosed with WHO Category III lesions, resulting in costly treatment and disability. To enhance community awareness of the disease and encourage early reporting by patients, WHO has produced a number of information materials, including manuals on diagnosis and treatment, to help health workers in affected areas intensify control activities. Diagnosis by experienced clinicians may suffice to initiate treatment, but increasingly countries are expected to ensure that at least 70% of reported cases are laboratory-confirmed. Since 2014, a WHO manual on the laboratory diagnosis of Buruli ulcer has guided health workers and laboratory scientists in the field (*3*).

Burden and distribution

Globally, 33 countries have reported the occurrence of Buruli ulcer cases. However, during 2002–2015 about 55 000 new cases were reported from 17 countries where the disease is endemic using WHO's standard recording and reporting forms – BU 01 and BU 02 (*4*). These cases are considered to significantly understate the true burden of the disease. Since 2008, the number of cases reported globally has gradually declined by 60%, reaching 2037 cases in 2015 compared with 5156 in 2008 (Fig. 5.1).

Since 2008 the number of cases has been decreasing in Benin and Côte d'Ivoire but increasing in Australia and the Democratic Republic of the Congo (Fig. 5.2).

Outside the African Region most cases occur in Australia (Western Pacific Region), which reported 984 cases during 2002–2015; French Guiana, the main endemic country in the Region of the Americas, reported 80 cases and Japan (Western Pacific Region) 56 cases during the same period (Fig. 5.3).

Without knowing how *M. ulcerans* infection is transmitted, it is difficult to explain this changing trend. One possibility is the varying intensity of case-finding efforts, which depend on the availability of funding.

Fig. 5.1. Distribution of Buruli ulcer cases, worldwide, 2015

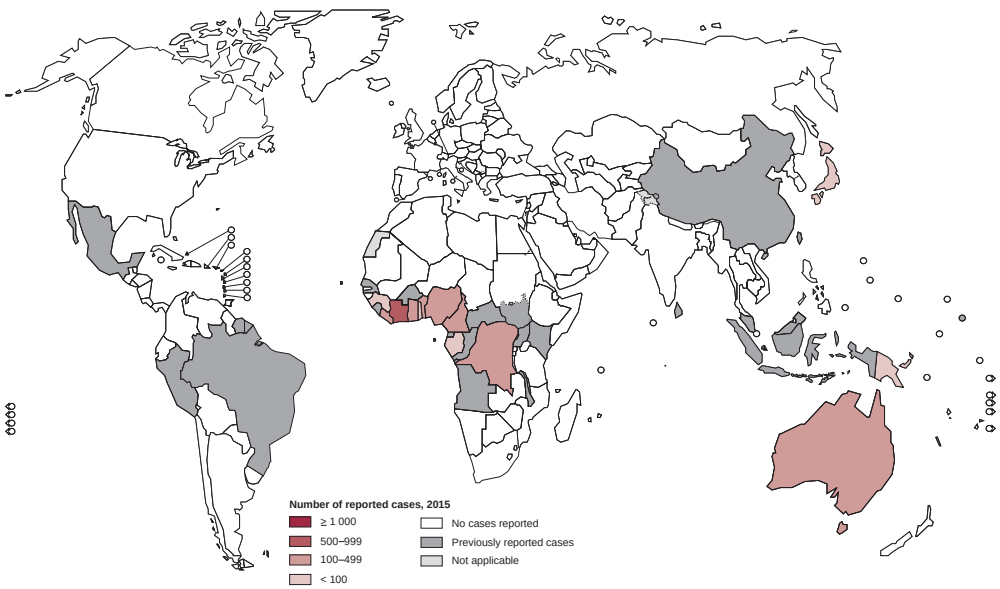
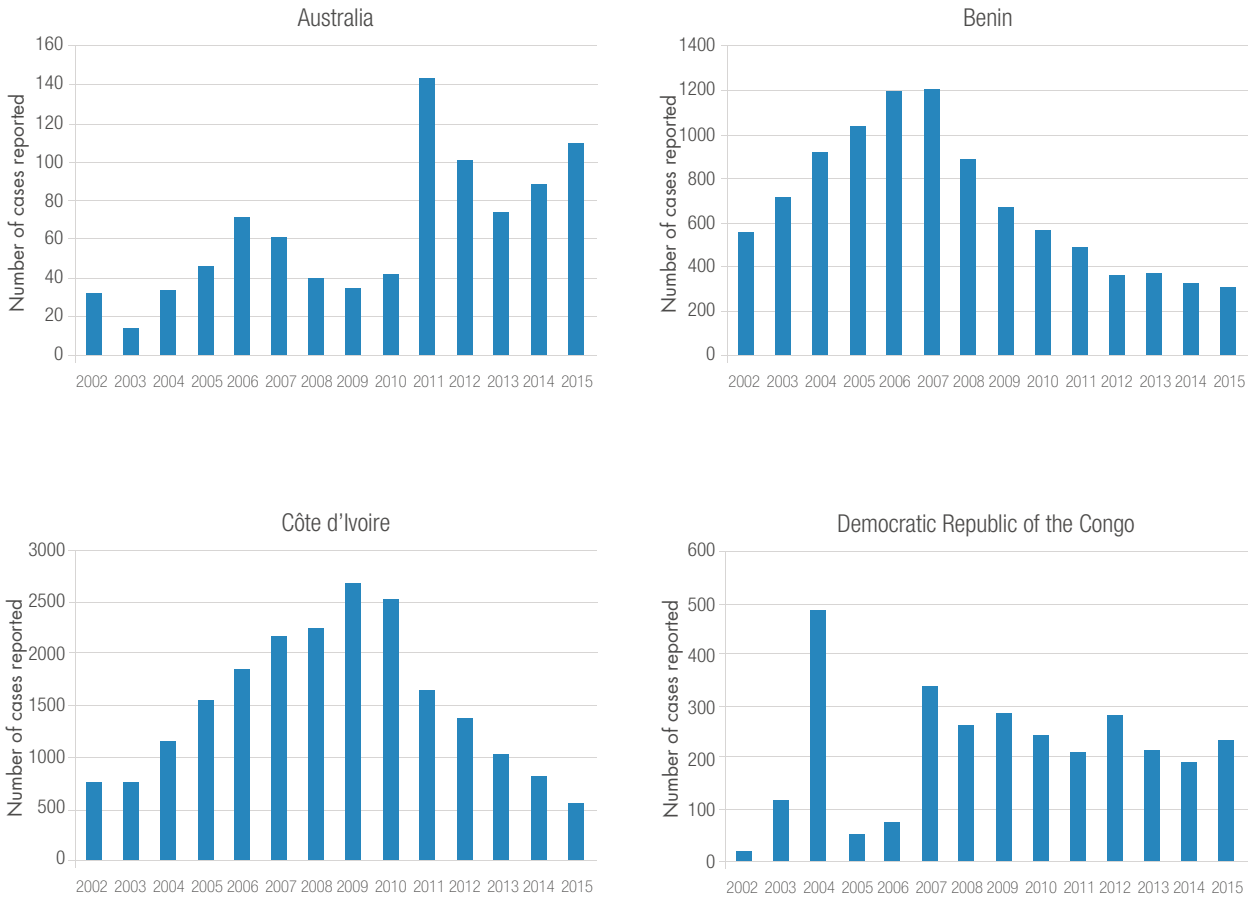


Fig. 5.2. Buruli ulcer cases reported to WHO, four countries, 2002–2015, Australia, Benin, Côte d'Ivoire and the Democratic Republic of the Congo



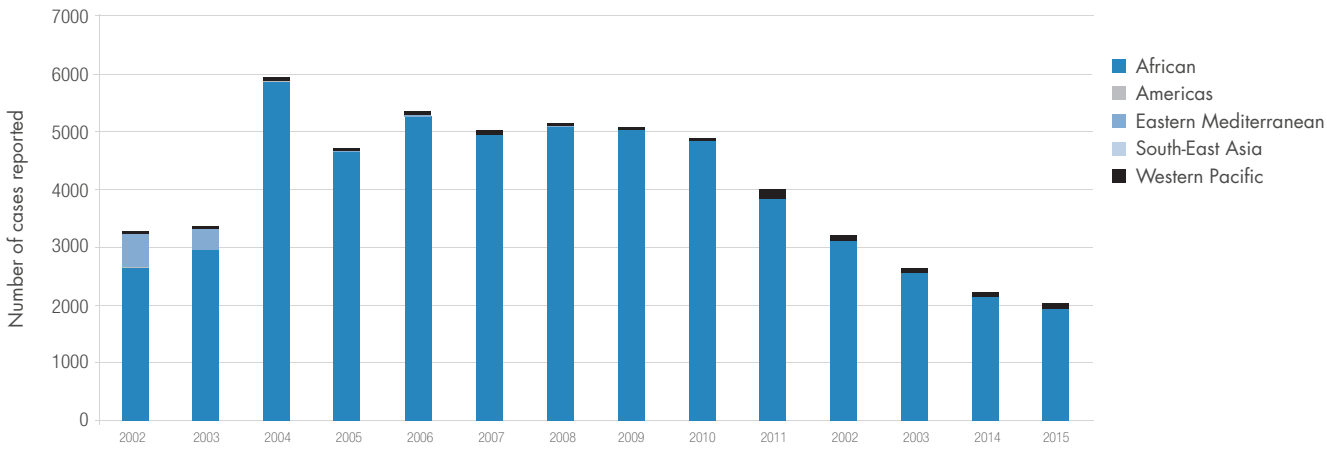
Progress towards Roadmap targets

The targets of the Roadmap are (i) by 2015, to have completed the clinical trial and incorporated the results into control and treatment policy, and (ii) by 2020, to have detected at an early stage and cured 70% of all cases with antibiotics in all endemic countries.

In 1998 when WHO established the Global Buruli Ulcer Initiative, surgery was the only treatment option. Research to develop alternative, antibiotic therapies was thus prioritized, resulting in the recommendation of treatment with a combination of rifampicin and streptomycin. The introduction of antibiotic treatment in 2004 called for a change in the treatment strategy from surgery to antibiotics. However, because the use of an injectable medicine is neither convenient nor practical in the field, a new clinical trial started under the auspices of WHO in 2013, comparing the current, recommended treatment with a completely oral regimen (rifampicin and clarithromycin for 8 weeks) (*5*).

The trial is being conducted in Benin and Ghana, with follow-up of the last patient to be completed at the end of 2017. Interim results are due in March 2017, and it is expected that WHO will issue provisional recommendations to guide countries in using the new oral combination therapy. The use of a fully oral regimen would permit supervision of treatment in the community, obviating the requirement for daily visits to health facilities to receive treatment. The completion of the study and translation of results into policy would also allow the achievement of the Roadmap's second target: to cure 70% of cases in endemic countries by 2020.

Fig. 5.3. Buruli ulcer cases reported to WHO, by region, 2002–2015



Progress has been made also on diagnostic tools. In 2004 the Fifty-seventh World Health Assembly adopted resolution WHA57.1 on surveillance and control of *Mycobacterium ulcerans* disease (Buruli ulcer), urging Member States in which the disease is or threatens to become endemic to support enhanced surveillance of the disease and accelerate development of tools for diagnosis, treatment and prevention. The *Cotonou Declaration on Buruli ulcer*, adopted by the Heads of States of affected countries in Benin in 2009, called on countries to ensure that cases are detected at an early stage in order to reduce the frequency of disabilities (*6*).

Of the four traditional methods used to diagnose Buruli ulcer, polymerase-chain reaction is that most commonly used (*7*). Confirmation of cases is essential to ensure that patients treated with antibiotics for 8 weeks are true cases of Buruli ulcer, and WHO thus requires all endemic countries to ensure that at least 70% of cases reported are laboratory-confirmed. Although this method works well, reference laboratories tend to be far from affected areas. To address this problem, WHO has prioritized the development of a rapid point-of-care test. The focus is on the direct detection of toxin (mycolactone) using thin layer chromatography in human tissue, which may offer a simpler, faster and less expensive way to confirm suspected cases at the district level than using current diagnostic methods (*8*). Studies are in progress in Benin, the Democratic Republic of the Congo and Ghana to assess the feasibility of this technique at the district level. Other diagnostic tests are in development, but progress has been beset by technical difficulties (*9*).

In 2016 the WHO Department of Control of Neglected Tropical Diseases started to promote the integrated control of skin NTDs (Buruli ulcer, cutaneous leishmaniasis, leprosy and yaws) in order to enhance early detection of cases and reduce operational costs.

2020 and beyond

The introduction of a fully oral regimen and diagnosis at the point of care should make Buruli ulcer easier to control and manage than previously. However, community education to encourage early reporting will need to be sustained through routine health education programmes and specific screening activities in highly endemic areas. Case detection and surveillance will be part of WHO's new, integrated strategy on skin NTDs, which will be fully implemented by 2020. Access to diagnosis, treatment and rehabilitation should be improved as countries transition to UHC under the SDGs, thus allowing patients to access health services without financial risk. In the long-term, it is essential that clinicians and laboratory scientists work together on monitoring to detect any development of resistance to rifampicin, streptomycin and clarithromycin. Since these medicines are used also to treat tuberculosis, continuous collaboration with TB control programmes will be key.

As the mode of transmission remains unknown, there is no possibility of eliminating or eradicating the disease. However, should it be discovered or a TB vaccine that is also effective against Buruli ulcer become available, the current control strategy will be reviewed.

References

1. Yotsu RR, Murase C, Sugawara M, Suzuki K, Nakanaga K, Ishii N et al 2015. Revisiting Buruli ulcer. J Dermatol. 2015;42:1033–41. doi:10.1111/1346-8138.13049.
2. Treatment of *Mycobacterium ulcerans* disease (Buruli ulcer): guidance for health workers. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/IDM/2012.1; http://apps.who.int/iris/bitstream/10665/77771/1/9789241503402_eng.pdf).
3. Portaels F, editor. Laboratory diagnosis of Buruli ulcer: a manual for health care providers. Geneva: World Health Organization; 2014 (WHO/HTM/NTD/IDM/2014.1; http://apps.who.int/iris/bitstream/10665/111738/1/9789241505703_eng.pdf).
4. Buruli ulcer: number of new reported cases. Data by country. In: Global Health Observatory Data Repository [online database]. Geneva: World Health Organization; 2016 (http://apps.who.int/gho/data/node.main.A1631?lang=en, accessed 1 March 2017).
5. WHO drug study for Buruli ulcer: comparison of SR8 and CR8. In: Clinical Trials.gov [online database]. Bethesda (MD): National Institutes of Health; 2017 (https://clinicaltrials.gov/ct2/show/NCT01659437?term=Buruli+ulcer?rank=3, accessed 9 March 2017).Chauffour A, Robert J, Veziris N, Aubry A, Jarlier V. Sterilizing activity of fully oral intermittent regimens against *Mycobacterium ulcerans* infection in mice. PLoS Negl Trop Dis. 2016;10:e0005066. doi:10.1371/journal.pntd.0005066.
6. Cotonou Declaration on Buruli ulcer. Geneva: World Health Organization; 2009 (http://www.who.int/neglected_diseases/ Benin_declaration_2009_eng_ok.pdf).
7. Sakyi SA, Aboagye SY, Darko Otchere I, Yeboah-Manu D. Clinical and laboratory diagnosis of Buruli ulcer disease: a systematic review. Can J Infect Dis Med Microbiol. 2016;2016:5310718. doi:10.1155/2016/5310718.
8. Wadagni A, Frimpong M, Phanzu DM, Ablordey A, Kacou E, Gbedevi M et al. Simple, rapid *Mycobacterium ulcerans* disease diagnosis from clinical samples by fluorescence of mycolactone on thin layer chromatography. PLoS Negl Trop Dis. 2015;9:e0004247. doi:10.1371/journal.pntd.0004247.
9. Report of a WHO–FIND consultative meeting on diagnostics for Buruli ulcer. Geneva: World Health Organization; 2014 (WHO/HTM/NTD/IDM/2014.2; http://apps.who.int/iris/bitstream/10665/112669/1/WHO_HTM_NTD_IDM_2014.2_eng.pdf).

5.2 Chagas disease

Chagas disease (also known as American trypanosomiasis) is a potentially life-threatening illness caused by infection with the protozoan parasite *Trypanosoma cruzi*. In Latin America the disease is mainly vector-borne, transmitted to humans through contact with the faeces and/or urine of infected blood-sucking triatomine bugs. The bugs typically live in the walls or roof cracks of poorly constructed homes in rural or suburban areas, becoming active at night, biting exposed areas of skin, then defecating close to the bite. The parasites enter the body when the person inadvertently smears the bug's waste into the bite or another skin break, the eyes or the mouth. *T. cruzi* can also be transmitted by blood transfusion from infected donors; by congenital (mother to child) transmission during pregnancy or childbirth; by consumption of food that has been contaminated with waste from infected triatomine bugs, typically causing outbreaks or oral transmission; by organ transplantation from infected donors; and even by laboratory accidents (*1*).

After the infection is transmitted there is an initial, acute phase that lasts for about 2 months. During this phase a high number of parasites circulate in the blood, but in most cases symptoms are absent or mild. However, the first visible signs of infection, such as a skin lesion or a swollen eyelid (the so-called Romaña sign), can help in the diagnosis of new cases. A chronic phase succeeds the acute phase, when parasites are hidden mainly in the heart and digestive muscles. Up to 30% of patients suffer from cardiac disorders and up to 10% experience digestive, neurological or mixed disorders, which may require specific treatment. In later years, the infection can lead to sudden death principally due to heart arrhythmia or heart failure (*2*).

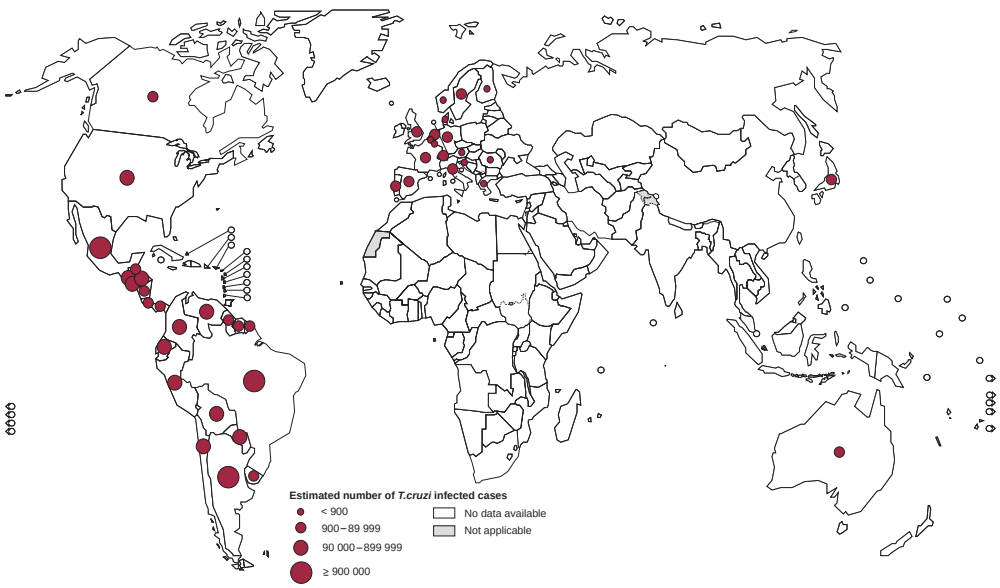
Both of the antiparasitic medicines used to treat the disease (benznidazole and nifurtimox) are almost 100% effective in curing *T. cruzi* infection if given at the onset of the acute phase, but their efficacy diminishes the longer a person has been infected (*3*). Treatment is consequently indicated in children, starting with congenital cases, for those in whom the infection has been reactivated due to immunosuppression and for patients during the early chronic phase. Infected adults, especially those with no symptoms, should be offered treatment because antiparasitic therapy can also prevent, curb or halt progression of the disease and prevent transmission of the infection (*4*,*5*). In these cases, the potential benefits of medication should be weighed against the long duration of treatment (up to 2 months) and possible adverse reactions (occurring in up to 40% of treated patients).

There is no vaccine against Chagas disease and vector control has been the most effective method of prevention in Latin America. Blood screening with laboratory quality control is necessary to prevent *T. cruzi* infection through transfusion and organ transplantation (*6*). Because of the large reservoir of *T. cruzi* parasites in wild animals, the infection cannot be eradicated. Thus, the control targets are to eliminate transmission of the infection to humans and to ensure early case management for the infected population.

In 2010 the World Health Assembly adopted resolution WHA63.20 on control and elimination of Chagas disease, recognizing the need to tackle all transmission routes in disease endemic and non-endemic countries; to provide appropriate medical care for affected populations starting at the primary health care level; to support the mobilization of national and international, public and private financial and human resources; to promote interdisciplinary and intersectoral efforts and collaboration; and to facilitate networking between organizations and partners.

Also in 2010 the 146th session of the Executive Committee of the Pan American Health Organization/World Health Organization (PAHO/WHO) resolved to recommend the adoption of a new resolution on the strategy and plan of action for Chagas disease prevention, control and care for the Region of the Americas (CE146.R14). In 2013 a global strategy, called the tricycle strategy, was launched, evoking the dynamic image of a tricycle. It has four components: two power wheels (interrupting transmission and providing care in affected populations) and a steering wheel (implementing an information and surveillance system and providing information, education and communication (IEC) activities for the tricyclists or key people to be involved). The world information and surveillance system of WHO is an open-source system used to collect the available information on Chagas disease from different sources (official documents, WHO Event Management System, medicine distribution system, and the WHO pharmacovigilance system in collaboration with the Uppsala Monitoring Centre, among others), detect possible epidemiological silences (in time and space) and facilitate: (i) access to disease statistics and dashboard elements; (ii) monitoring and guidance about the control and elimination of the disease; and (iii) verification processes to sustain the achievements. The IEC activities, which include a new WHO course on control of Chagas disease, are essential to increase awareness, reduce biomedical and psychosocial barriers to accessing diagnosis and care; keep the maximum number of actors involved; and reach the affected population, including family, friends and society in general (*7*).

Fig. 5.4. Global distribution of Chagas disease cases, based on official estimates, 2006–2015



Burden and distribution

About 6–7 million people worldwide are estimated to be infected with *T. cruzi*, mainly in endemic areas of 21 Latin American countries: Argentina, Belize, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, and Venezuela (Bolivarian Republic of) (Fig. 5.4). The epidemiological pattern of the disease has changed from a rural to a mostly urban disease, due mainly to population mobility. Furthermore, there has been an increasing trend in the number of cases detected in Canada and the United States of America, and in up to 17 European and two Western Pacific countries (*8*). The high numbers of people who remain undiagnosed or untreated and who have ongoing infection combined with active vectorial and oral transmission put an estimated 75 million people at risk of infection.

Progress towards Roadmap targets

The objectives of the Roadmap are (i) by 2015, to have interrupted transmission by blood transfusion in the Americas, European and Western Pacific regions; and (ii) by 2020, to have interrupted transmission by intradomiciliary vectors in Latin America. Other programmatic objectives relate to interrupting transmission though organ transplantations and by congenital transmission and laboratory accidents, and to detect cases of, and provide care for, populations infected with *T. cruzi*. The terms "elimination" or "enhanced control" are used depending on the country or geographical area; resolution WHA63.20 included both concepts.

According to the most recent results, transmission in Latin America has been significantly reduced or interrupted and the number of human cases has decreased as a consequence (Table 5.1) (*9*). Specifically, rates of domiciliary vectorial infestation have decreased in all endemic areas, and domiciliary transmission of both *Triatoma infestans* and *Rhodnius prolixus* has been interrupted and verified in most territories. Contributing factors to these positive trends include improvement in socioeconomic conditions (including housing) and the availability of more accurate data. However, these achievements are strongly associated with sustained activities in several countries to prevent and control vectorial and transfusional transmission, promote health, and implement home and hygiene improvement programmes and health infrastructure, together with IEC strategies with community participation (*10*).

The recognition of Chagas disease as an important public health problem has also helped to foster country-level commitment, which has been supported by subregional control initiatives and supranational coordination. The Southern Cone, Central American and Mexico, Andean and Amazonian initiatives have been instrumental in expanding vector control, with technical support from PAHO/WHO. These advances have been made possible because of the strong commitment of Member States and the strength of their research and control organizations, together with support from many international partners (*9*).

Table 5.1. Estimated demographic and epidemiological parameters of Chagas disease in Latin America by country, 2010

Latin American countries	Population	Estimated no. of people infected by *T. cruzi*	Estimated annual no. of new cases due to vectorial transmission	Estimated no. of women aged 15–44 years with *T. cruzi* infection	Estimated annual no. of cases of *T. cruzi* infection due to congenital transmission	Estimated prevalence of *T. cruzi* infection per 100 habitants	Estimated incidence due to vectorial transmission per 100 habitants	Estimated incidence of *T. cruzi* infection due to congenital transmission per 100 live births	Estimated population at risk of *T. cruzi* infection	Estimated no. of people with Chagasic cardiopath	Estimated prevalence of *T. cruzi* infection among blood donors
Argentina	41 343 000	1 505 235	1 078	211 102	1 457	3.640	0.0020	0.210	2 242 528	376 309	3.130
Belize	315 000	1 040	10	272	25	0.330	0.0030	0.333	70 252	200	N/A
Bolivia (Plurinational State of)	9 947 000	607 186	8 087	199 351	616	6 104	0.0810	0.235	586 434	121 437	2.320
Brazil	190 755 799	1 156 821	46	119 298	571	0.03	0.084 per 100.000	0.020	25 474 365	231 364	0.180
Chile	17 095 000	119 660	0	11 771	115	0.699	0	0.046	0	35 898	0.160
Colombia	45 805 000	437 960	5 274	116 221	1 046	0.956	0.0110	0.114	4 813 543	131 388	0.410
Costa Rica	4 516 000	7 667	10	1 728	61	0.169	0.0002	0.080	233 333	2 300	0.045
Ecuador	14 483 499	199 872	2 042	62 898	696	1.379	0.0140	0.317	4 199 793	40 384	0.190
El Salvado	6 952 000	90 222	972	18 211	234	1.297	0.0130	0.187	1 019 000	18 044	1.610
Guatemala	13 550 000	166 667	1 275	32 759	164	1.230	0.0090	0.035	1 400 000	20 833	1.340
French Guyana, Guyana and Suriname	1 501 962	12 600	280	3 818	18	0.838	0.0180	0.075	377 258	882	N/A
Honduras	7 989 000	73 333	933	16 149	257	0.917	0.0110	0.126	1 171 133	14 667	1.650
Mexico	112 468 855	876 458	6 135	185 600	1 788	0.779	0.0050	0.089	23 474 780	70 117	0.390
Nicaragua	5 604 000	29 300	383	5 822	138	0.522	0.0060	0.124	642 750	5 990	0.220
Panama	3 557 687	18 337	175	6 332	40	0.515	0.0040	0.056	466 667	3 667	0.500
Paraguay	8 668 000	184 669	297	63 385	525	2.130	0.0030	0.340	1 703 659	32 974	2.550
Peru	28 948 000	127 282	2 055	28 132	232	0.439	0.0070	0.038	1 290 415	25 456	0.620
Uruguay	3 301 000	7 852	0	1 858	20	0.237	0	0.040	0	615	0.230
Venezuela (Bolivarian Republic of)	27 223 000	193 339	873	40 223	665	0.710	0.0030	0.110	1 033 450	38 668	0.320
Total	**543 877 115**	**5 742 167**	**29 925**	**1 124 930**	**8 668**	**1.055**	**0.0050**	**0.089**	**70 199 360**	**1 171 193**	**0.930**

N/A: not available information
Source: reference 9

However, three areas remain a challenge: (i) the frontier between El Salvador and Guatemala, in which the highest number of acute cases have occurred north of the Amazon basin during the past two decades; the Gran Chaco region (which covers parts of Brazil, Argentina, the Plurinational State of Bolivia and Paraguay); and the Amazon basin, where outbreaks of oral (foodborne) transmission of Chagas disease with high mortality rates (up to 10%) have been persistently reported (*11*).

The risk of transmission by blood transfusion has been also drastically reduced. In 2015 all Latin American countries achieved universal blood screening for Chagas disease among blood donors. Based on the risk of infection of their population, Canada and the USA have also been implementing screening protocols using questionnaires or serological tests, or both. Additionally, among the countries reporting cases of Chagas disease, six (France, Portugal, Spain, Sweden, Switzerland and the United Kingdom) have approved national legislation or directives, additional to the European Union recommendation (European Commission's directives, 2004/33/CE and 2006/17/CE) that apply also to the following 11 countries: Austria, Belgium, Croatia, Denmark, Finland, Italy, Germany, Luxembourg, the Netherlands, Portugal and Romania (Norway is not a Member State of the European Union). Japan has approved national control of transfusional transmission through blood testing and Australia has implemented national control through screening of donors using questionnaires.

Progress has been made also on expanding treatment coverage. Since 2008 WHO has supported the distribution of the two antiparasitic medicines in order to prevent or slow the development of the disease (secondary prevention) and to prevent new infections (primary prevention). The system for distributing medicine is combined with that for information and surveillance in order to determine the distribution of cases and active transmission routes; information about the disease is provided to those who receive medication. Distribution not only supports the delivery of health care interventions beyond the antiparasitic treatment but also improves the rational use of these medicines by providing opportunities for pharmacovigilance and operational research.

Access to medication has been significantly improved with the establishment of a warehouse in Panama to stockpile nifurtimox. For benznidazole, the PAHO Strategic Fund has intervened to facilitate its purchase for countries that have requested it. For the rest of the world the distribution of nifurtimox and benznidazole is supported by WHO's headquarters. The total number of people treated with either benznidazole or nifurtimox has increased more than three times during the past 3 years (2013–2016), after the global shortage of benznidazole was solved in 2012.

Several WHO collaborating centres are helping to train community health workers in vectorial control, health care for Chagas disease, and coinfection and co-morbidity conditions. Other notable initiatives include the Catalonian Expert Patient Programme for Chagas disease, which aims to involve and strengthen the responsibility of patients for their own health and to promote self-care (*12*).

Beyond 2020

Sustaining the achievements and completing the agenda of controlling or eliminating the disease, including in areas of low endemicity, will depend on retaining political interest and committing the requisite resources. Specific challenges include:

- strengthening global epidemiological surveillance and effective verification of any advances in control and elimination;
- tackling the persistence of the disease in regions where control had been in progress, such as the Gran Chaco region and a few areas in Central America;
- responding to the emergence of Chagas disease in regions previously considered free of transmission – such as the Amazon basin or outside Latin America – mainly due to increasing population mobility worldwide;
- improving access to diagnosis and care for millions of affected people, including support in distributing antiparasitic medicines, which are to be offered to all infected people (*13*);
- harnessing technical cooperation on medical care with an emphasis on congenital Chagas disease;
- strengthening capacity for clinical management, diagnosis, treatment and follow up by training for technical-level, health-related and university health careers;
- controlling the autochthonous vectors of domiciliary cycles and vectors in endemic areas where control efforts are lagging or where focus is on insecticide resistance (*14*);
- enhancing technical cooperation with a comprehensive approach to controlling vector-borne transmission by native triatomine bugs, such as *Triatoma dimidiata* in Central America; and
- forging institutional progress and effective actions of the Sub-regional Initiatives of Prevention, Control and Attention of Chagas disease; as well as horizontal technical cooperation among countries through the technical support of PAHO/WHO (*15*).

Countries of the Amazon subregion are implementing actions to strengthen their surveillance systems, notably by integrating activities for malaria diagnosis with primary health care, focusing on detecting human cases and implementing control interventions. Efforts are also being focused on the world information and surveillance system to control Chagas disease. Surveillance and control programmes will need to be able to adapt to new epidemiological scenarios (*16*). For example, surveillance will continue to be important to detect the emergence of disease in areas previously considered free of transmission of *T. cruzi* infection, such as the Amazon basin, where transmission would involve wildlife rather than domestic vectors and may include local microepidemics of orally transmitted infection that demand innovative methods of surveillance, prevention and detection, such as the detection of haemoparasites (malaria, filariasis and *T. cruzi*) in blood films collected for malaria control.

Coinfection and co-morbidity with Chagas disease, especially in target populations, present both a challenge and an opportunity to increase detection (*17,18*). Examples include using malaria films to also detect haemoparasites, adding screening for *T. cruzi* infection to other infections checked for at birth, including screening for opportunistic *T. cruzi* infection in the differential diagnosis of meningoencephalitis in the setting of HIV/AIDS, or to the integrated assessment of cardiovascular risk, by adding screening for Chagas disease to screening for hypertension, diabetes, cardiorenal syndrome and rheumatic heart disease (*13*). Surveillance will also be important to sustain achievements and ensure that territories stay free of transmission and to detect any potential re-emergence of disease foci in regions where control had been in progress, particularly in challenging areas such as the Gran Chaco region.

The SDGs offer opportunities to implement screening in target populations at risk of *T. cruzi* infection in the framework of other objectives, such as women of childbearing age (objective 3.7: ensure universal access to sexual and reproductive health care services) and populations at risk for cardiovascular diseases (objective 3.4: reduce mortality from noncommunicable diseases and promote mental health).

References

1. Coura JR, Borges-Pereira J. Chagas disease: 100 years after its discovery. A systemic review. Acta Trop. 2010;115:5–13. doi:10.1016/j.actatropica.2010.03.008.
2. Rassi A Jr, Rassi A, Marcondes de Rezende J. American trypanosomiasis (Chagas disease). Infect Dis Clin North Am. 2012;26:275–91. doi:10.1016/j.idc.2012.03.002.
3. Brum-Soares L, Cubides JC, Burgos I, Monroy C, Castillo L, González S, Viñas PA, Urrutia PP. High seroconversion rates in *Trypanosoma cruzi* chronic infection treated with benznidazole in people under 16 years in Guatemala. Rev Soc Bras Med Trop. 2016;49:721–7. doi:10.1590/0037-8682-0415-2016.
4. Murcia L, Carrilero B, Munoz-Davila MJ, Thomas MC, Lopez MC, Segovia M. Risk factors and primary prevention of congenital Chagas disease in a nonendemic country. Clin Infect Dis. 2013;56:496–502. doi:10.1093/cid/cis910.
5. Fabbro DL, Danesi E, Olivera V, Codebo MO, Denner S, Heredia C et al. Trypanocide treatment of women infected with *Trypanosoma cruzi* and its effect on preventing congenital Chagas. PLoS Negl Trop Dis. 2014;8:e3312. doi:10.1371/journal.pntd.0003312.
6. Sáez-Alquezar A, Albajar-Viñas P, Valpassos Guimarães A, Abol Corrêa J. Quality control in screening for infectious diseases at blood banks: rationale and methodology. EJIFCC. 2015;26:278–85. PMCID: PMC4975364.
7. Sanmartino M, Avaria-Saavedra A, Gómez-i-Prat J, Parada C, Oliveira JW, Albajar-Viñas P. Do not be afraid of us: Chagas disease as explained by people affected by it. Interface. 2015;19:1063–75 doi:10.1590/1807-57622014.1170.
8. Schmunis GA, Yadon ZE. Chagas disease: a Latin American health problem becoming a world health problem. Acta Trop. 2010;115:14–21. doi:10.1016/j.actatropica.2009.11.003.
9. Chagas disease in Latin America: an epidemiological update based on 2010 estimates. Wkly Epidemiol Rec. 2015;90:33–43 (http://www.who.int/wer/2015/wer9006.pdf).

10. Misión de Evaluación de la situación epidemiológica y de control de la enfermedad de Chagas en el Departamento de Alto Paraguay, 2013 [Mission of evaluation of the epidemiological situation of Chagas disease control in the Department of Alto Paraguay, 2013]. In: Chagas disease programme Communicable Diseases and Health Analysis. Washington (DC): Pan American Health Organization/WHO Regional Office for the Americas [website] (http://www.paho.org/hq/index.php?option=com_content&view=article&id=8758%3A2013-mision-evaluacion-epidemiologica-chagas-departamento-alto-paraguay&catid=4534%3Achagas-media-center&Itemid=40353&lang=en, accessed 21 March 2017).
11. Coura JR, Junqueira AC. Ecological diversity of *Trypanosoma cruzi* transmission in the Amazon basin: the main scenarios in the Brazilian Amazon. Acta Trop. 2015;151:51–7. doi:10.1016/j.actatropica.2015.04.029.
12. Claveria GI, Caro Mendivelso J, Ouaarab Essadek H, González Mestre MA, Albajar-Viñas P, Gómez i Prat J. The Catalonian Expert Patient Programme for Chagas Disease: an approach to comprehensive care involving affected individuals. J Immigr Minor Health. 2017;19:80–90. doi:10.1007/s10903-016-0345-y.
13. Dias, JCP, Cláudio LDG, Lima, MM, Albajar-Viñas P, Silva RA, Alves RV et al. Mudanças no paradigma da conduta clínica e terapêutica da doença de Chagas: avanços e perspectivas na busca da integralidade da saúde [Changes in the paradigm of clinical and therapeutic management of Chagas' disease: progress and perspectives in the pursuit of comprehensive health]. Epidemiol Serv Saude 2016;25:87–90. doi:10.5123/S1679-49742016000500003 (in Portuguese).
14. Pessoa GCD, Albajar-Vinas P, Rosa ACLR, Diotaiuti L. History of insecticide resistance of Triatominae vectors. Rev Soc Bras Med Trop. 2015;48:380–9. doi:10.1590/0037-8682-0081-2015.
15. Salvatella R, Irabedra P, Sánchez D, Castellanos LG, Espinal M. South–south cooperation for Chagas disease. Lancet. 2013;382:395–6. doi:10.1016/S0140-6736(13)61671-2.
16. Schofield CJ, Jannin J, Salvatella R. The future of Chagas disease control. Trends Parasitol. 2006;22:583–8. doi:10.1016/j.pt.2006.09.011.
17. Getaz L, Da Silva-Santos L, Wolff H, Vitoria M, Serre-Delcor N, Lozano-Becerra JC et al. Persistent infectious and tropical diseases in immigrant correctional populations. Rev Esp Sanid Penit. 2016;18:57–66. doi:10.4321/S1575-06202016000200004.
18. Shikanai Yasuda MA, Sátolo CG, Carvalho NB, Atala MM, Ferrufino RQ, Leite RM et al. Interdisciplinary approach at the primary healthcare level for Bolivian immigrants with Chagas disease in the city of São Paulo. PLoS Negl Trop Dis. 2017;11: e0005466. doi.org/10.1371/journal.pntd.0005466.

5.3 Dengue and other arbovirus-related diseases

Dengue is an arboviral infection that is widespread in tropical and subtropical regions. The incidence of the disease has increased significantly in the past decades, affecting all regions of WHO since 2010. The flavivirus that causes dengue is transmitted by the bites of female mosquitoes mainly of the species *Aedes aegypti* and, to a lesser extent, *Ae. albopictus*. Both vectors are well adapted to human habitation in urban and semi-urban areas. As the incidence of malaria has decreased, arboviral infections have emerged as the most widespread vector-borne disease; in many countries of Asia and Latin America dengue is now the leading mosquito-borne disease. Between 1990 and 2013, increases in the age-standardized incidence rates of dengue have been among the highest of all vector-borne NTDs, thus countering the global trend for other communicable diseases (*1*).

There are four distinct, but closely related, serotypes of the virus that cause dengue (DEN-1, DEN-2, DEN-3 and DEN-4). Recovery from infection by one provides lifelong immunity against that particular serotype. However, cross-immunity to the other serotypes after recovery is only partial and temporary. Subsequent infections by other serotypes increase the risk of developing severe dengue, also known as dengue haemorrhagic fever, which was first recognized in the 1950s during dengue epidemics in the Philippines and Thailand. Today, severe dengue affects most Asian and Latin American countries and has become a leading cause of hospitalization and death among children and adults in these regions (*2*). There is no specific treatment for dengue or severe dengue, but early detection and access to proper medical care lowers case–fatality rates below 1%. Dengue prevention and control depends on effective vector control measures (*2*). A dengue vaccine has been licensed by several national regulatory authorities for use in people aged 9–45 years living in endemic settings on the basis of recommendations issued by the WHO Strategic Advisory Group of Experts on Immunization (*3*).

The principal vectors of dengue have now spread to more than 150 countries. The reasons include increased movement of people, poor disposal of solid waste and increased transportation of goods such as used tyres and plants with axils containing dried mosquito eggs (*4*). These vectors transmit not only dengue virus but also other closely related arboviruses such as chikungunya, yellow fever and Zika viruses.

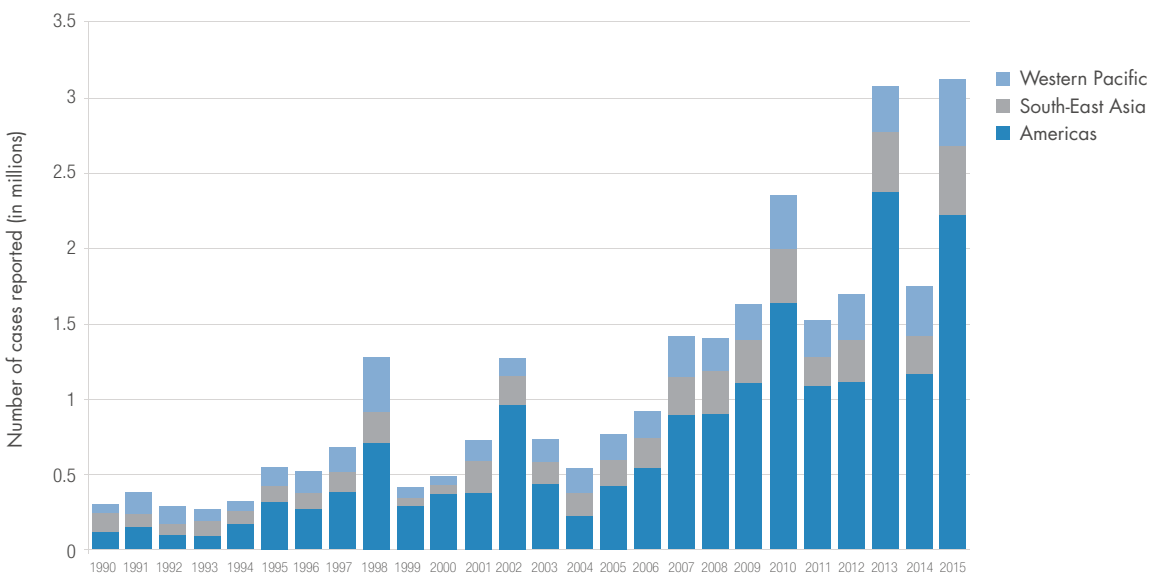
Burden and distribution

Improved estimates of dengue incidence and mortality, and their longer term trends, will help public health officials, academics and policy-makers to assess and identify cost–effective control strategies to reduce transmission of dengue viruses and the disease burden. Two reporting systems are currently being used by WHO. Member States in three WHO regions regularly report the annual number of cases to the Secretariat; since 1991, on average 1.1 million cases have been reported yearly but the numbers have increased significantly in the past few years with 3.2 million cases reported in 2015 alone (Fig. 5.5).

While the full global burden of the disease is uncertain, its epidemiological patterns are alarming for both human health and the global economy (5). Dengue is widespread throughout the tropics, with local spatial variations in risk influenced strongly by rainfall, temperature, relative humidity, degree of urbanization and the quality of vector control services in urban areas. The actual numbers of cases are underreported and many cases are misclassified. Moreover, over 70% of the mild dengue cases do not seek medical care. It is therefore a challenge to capture the true number of cases.

Modelling studies have been undertaken to ascertain the global burden of dengue, and two studies have established estimates using different methods. One study used global point estimates of the occurrence of dengue from previously collated estimates (6) and combined these with dengue transmission risk factors to estimate 390 million dengue infections per year (95% credibility interval 284–528 million), of which 96 million (95% credibility interval 67–136 million) manifest clinically (with any severity of disease) (7). Another study, on the global burden of the disease, used mortality data to estimate 58·4 million clinical manifestations of dengue globally (95% credibility interval 23.6 million–121.9 million), including 13 586 fatal cases (95% uncertainty interval 4200–34 700) (1). From these latter estimates, a further study estimated the total annual global cost of dengue illness at US$ 8.9 billion, (95% uncertainty interval 3.7 billion–19·7 billion) based on dengue cases admitted to hospital (18%), ambulatory cases (48%) and non-medical cases (34%) (8). Although these figures are estimates, they highlight the staggering epidemiological and economic burden that endemic countries face.

Fig. 5.5. Dengue cases notified to WHO, by region, 1990–2015



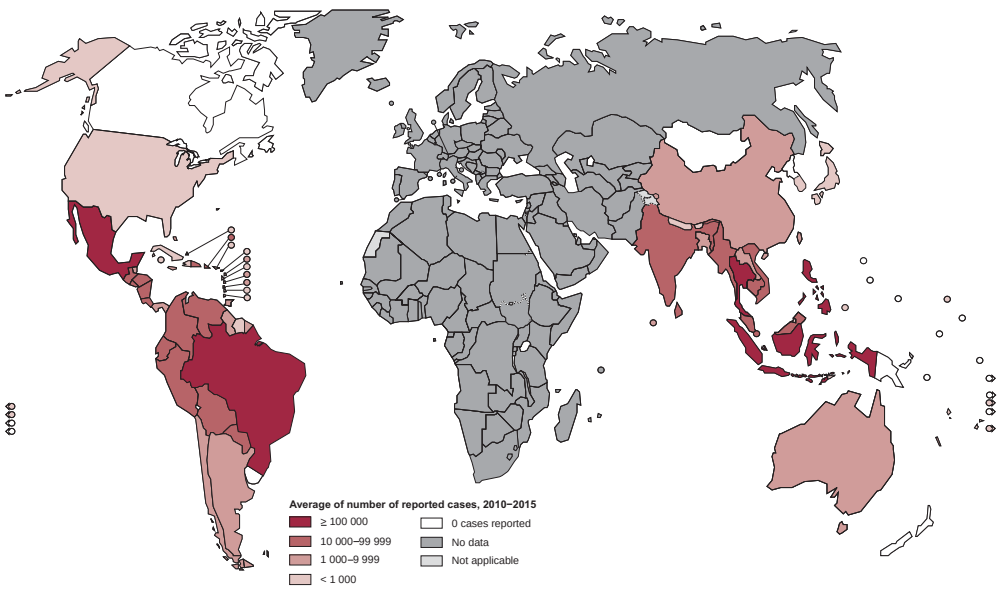
Source: WHO Dengue data application http://www.who.int/denguecontrol/epidemiology/dengue_data_application/en/

The wide discrepancy between the dengue burden estimated by academic groups and that notified to WHO results from a lack of resources and capacity to survey dengue effectively and the fact that many countries report only laboratory-confirmed cases, which represent only a small majority of the total number of cases that are recorded and reported. Importantly, not all affected countries notify dengue cases to WHO (Fig. 5.6). No cases are reported from sub-Saharan Africa (African Region) or the Eastern Mediterranean Region; both regions are estimated to contribute significantly to the global burden of dengue.

Regional updates

African Region. Outbreaks of dengue have been reported from 22 countries in the African Region. The presence of the disease and the high prevalence of antibodies to dengue viruses in serological surveys suggest that dengue virus infection is endemic in many parts of the continent (6). Dengue continues to be underreported in Africa owing to a lack of awareness among health-care providers, the presence of other febrile illnesses (especially malaria) and insufficient clinical diagnosis, laboratory testing and case-reporting, all of which also hinders systematic surveillance. Outbreaks of dengue have been reported in Angola, Mauritius, Mozambique and the United Republic of Tanzania since 2013. An outbreak with high mortality in Burkina Faso in 2016 highlighted the need to strengthen case management in the region.

Fig. 5.6. Distribution of average numbers of dengue cases reported to WHO annually, worldwide, 2010–2015



Region of the Americas. Transmission of dengue viruses was interrupted in much of the Region of the Americas in the 1970s following the campaign to eradicate *Ae. aegypti*. However, because vector surveillance was not sustained, mosquitoes thrived and dengue outbreaks recurred in the Caribbean and in Central and South America. These regions are now in a hyperendemic state, with indigenous transmission in almost all countries. A regional initiative that uses an integrated management strategy for prevention offers the most promising approach for control. The initiation of activities to record all dengue cases and improve surveillance partly explains the sharp increase in the number of cases reported in recent years.

The Region the Americas continues to report the highest number of dengue cases; a total of 2 227 677 cases were reported in 2015. Since the first report of autochthonous transmission of dengue in Uruguay in 2016, all countries in the region now notify dengue cases annually, albeit at different intensities of burden. Importantly, this region reports the lowest case–fatality rate (0.05%) of all WHO regions.

South-East Asia Region. Dengue is endemic in the South-East Asia Region, although its incidence varies significantly among countries and within each country. Asia Pacific countries bear the heaviest burden, where more than 1.8 billion people are estimated to be at risk. In 2015, a total of 451 442 cases were reported to WHO from the region. The epidemiology of dengue is rapidly evolving as outbreaks occur with increasing frequency and expand to new, previously unaffected geographical areas, mainly in semi-urban suburbs. The progressive worsening of the dengue situation in the region is attributed to unplanned urban development, poor water storage practices and unsatisfactory sanitary conditions, all of which contribute to the proliferation of the main vector, the *Ae. aegypti* mosquito.

European Region. *Ae. albopictus* has rapidly spread to more than 25 countries of the Eastern Mediterranean Region, mainly through the global trade in used tyres and lucky bamboo. The threat of dengue outbreaks therefore exists in Europe. Local transmission of the virus was reported for the first time in Croatia and in France in 2010; imported cases were detected in several other European countries. An outbreak in Madeira island (Portugal) in 2012 resulted in more than 2200 cases and importation of cases into 17 other European countries. Autochthonous transmission of dengue was reported twice in southern France in 2015.

Eastern Mediterranean Region. Dengue is considered an emerging disease in the Eastern Mediterranean Region because laboratory-confirmed cases have been reported for only two decades. Generally, cases have been detected along the coasts of countries bordering the Red Sea and the Arabian Sea. Dengue is emerging as a major public health problem in Pakistan, Saudi Arabia and Yemen, with repeated outbreaks in urban centres and spread of the disease to rural areas (in Pakistan and Yemen). Dengue outbreaks occurred in 2016 in Djibouti, Somalia, Sudan and Yemen, where multiple virus serotypes co-circulate and where the disease is probably expanding its geographical reach. Oman reported imported cases in 2016 (*9*).

Western Pacific Region. The Western Pacific Region reported 443 163 dengue cases in 2015, including 996 deaths (case–fatality rate, 0.22%). The incidence was highest in the Philippines, Cambodia and Malaysia. Australia and the Pacific Island nations are also susceptible to epidemics. During 2013–2014, the DEN-3 virus serotype was recorded in Fiji and in several other islands, inflating the number of reported cases. Malaysia and Singapore indicated sustained epidemic activity during the same period. Since late 2013, a few countries in the Pacific have reported concurrent outbreaks of dengue, chikungunya and Zika viruses. In 2016 an outbreak of DEN-2 and DEN-3 virus serotypes was reported in the Solomon Islands.

Progress towards Roadmap targets

The Roadmap's targets for intensified control can be achieved by fully implementing the *Global strategy for dengue prevention and control 2012–2020* (*10*). The goal of the strategy is to reduce the burden of dengue worldwide, with specific objectives to reduce mortality by at least 50% and morbidity by at least 25% (2020) as well as to estimate the true burden of the disease (2015). The strategy relies on five technical elements: diagnosis and case management; integrated surveillance and outbreak preparedness; sustainable vector control; future vaccine implementation; and basic, operational and implementation research. Regions and Member States have adopted the strategy and work plans have been developed at regional level in alignment with global objectives.

Fig. 5.7 shows the trend in the number of deaths reported, and the targeted 50% reduction in mortality by 2020. In 2015 a total of 3805 deaths were reported to WHO compared with 4255 in 2010 (baseline), an 11% decrease in mortality. Progress has been made globally in reducing the case–fatality rate from 0.18% in 2010 to 0.12% in 2015. Reducing mortality from dengue continues to be a priority for WHO, and achieving the 50% reduction in mortality by 2020 is on track. To support this objective, guidance is being prepared to strengthen case management in countries and regions; updated clinical guidelines on care of dengue patients in the Region of the Americas were published in 2016 that include specific case management of severe dengue in children and during pregnancy (*11*). The importance of case management is evident when considering dengue outbreaks in countries where clinical awareness is limited and case–fatality rates are high.

The incidence of morbidity from dengue per 100 000 population was higher in 2015 (67/100 000) than in 2010 (50/100 000), although year to year variation means progress towards achieving the 25% reduction in morbidity will need to be measured over a prolonged period of time (Fig. 5.8). An integrated approach to dengue control is essential in reducing morbidity, and WHO is working with its regional offices to strengthen control strategies and redress deficiencies in vector control and other preventive measures. Reducing morbidity also relies on early detection of outbreaks. To support this aim, WHO/TDR published a technical handbook in 2016 to assist countries with implementing national early warning systems and contingency plans (*12*); five countries have implemented this system.

Vaccines could also play a role in reducing morbidity and severe dengue in the future as part of an integrated strategy for dengue control. The first dengue vaccine (CYD-TDV) was licensed in 2015, and two additional vaccine candidates moved into Phase III trials in 2016 (*3*).

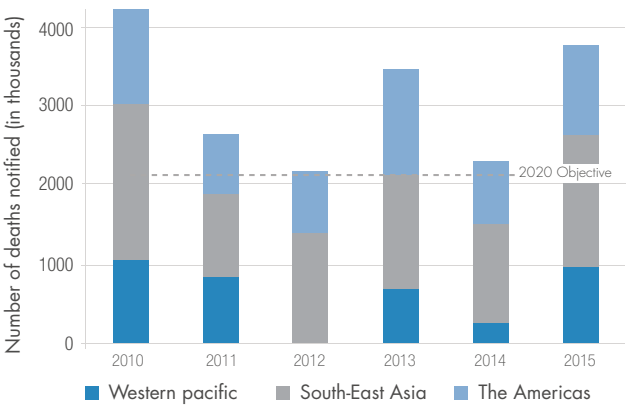
Determining the true burden of dengue

The third objective of the strategy (to estimate the true burden of dengue) is arguably the most important, given the large discrepancy between the number of cases captured by surveillance systems and reported to WHO and the published modelling estimates. Understanding the true burden of the disease will not only allow countries to design targeted control strategies but also allow WHO and stakeholders to target advocacy.

WHO has undertaken several studies to address this issue and has convened a consortium of institutions to develop a method for estimating the burden of the disease. This method, based on extrapolation of surveillance data and additional studies, has been piloted in two countries in the Region of the Americas (Brazil and Mexico), two countries in the South-East Asia Region (Sri Lanka and the Maldives) and one country in the Western Pacific Region (Cambodia); progress is being made in the African Region. A toolkit for countries to estimate their own disease burden based on this method is being developed

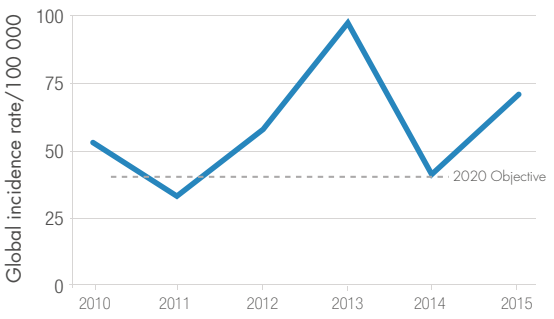
Fig. 5.7. Mortality from dengue infection, worldwide, 2010–2015

(the dashed line represents the objectives of the global dengue control strategy (*10*))



Source: http://www.who.int/denguecontrol/epidemiology/dengue_data_application/en/

Fig. 5.8. Incidence of morbidity from dengue infection, 2010–2015, and objective for 2020 of the global dengue control strategy (*10*)



Source: http://www.who.int/denguecontrol/epidemiology/dengue_data_application/en/

for publication in 2017. To complement the disease burden estimation toolkit, a method for estimating the economic impact of dengue at local and national levels has also been developed, and will be published in 2017.

To enrich the use of data collected and reported by governments, WHO will publish the first Global Dengue Report at the end of 2017. This annual document will present detailed analyses of the epidemiological and economic burdens of dengue as well as success stories of country control and prevention strategies.

As with prevention and control of other vector-borne diseases, effective surveillance, prevention and outbreak response as well as tools (vector control) must continue to complement each other in reducing the burden of dengue. The scientific community, donors, vaccine producers and all stakeholders have concluded that new dengue vaccines should be integrated with existing vector control activities; and that all prevention activities can control infection rates and systematic targeted vaccine introduction can raise herd immunity over time.

Sustained vector control against Aedes also helps to control outbreaks of dengue and other arboviral diseases such as chikungunya (**Box 5.1**) and Zika (**Box 5.2**), in accordance with WHO's global vector control response (discussed in detail in **section 2** of this report). The impact of dengue outbreaks on health systems and the associated costs to other sectors and the community at large are difficult to predict. However, dengue has been identified as a disease of the future owing to increased urbanization, scarce water supplies (resulting in water storage) and, possibly, environmental and climate change. Control of dengue is technically feasible with coordinated international technical and financial support for national programmes.

Box 5.1. Chikungunya virus

Chikungunya virus, an arbovirus of the genus alphavirus, has significantly expanded its geographical reach and invaded new territories. In 2013, an Asian lineage was introduced into the Caribbean island of Saint Martin and established the first mosquito–human cycle in the Region of the Americas (*16*). Subsequently, cases of autochthonous transmission were reported throughout the Caribbean, Central America, South America, East Africa and in Florida. In Brazil, two different lineages have been detected (*2*). The Asian lineage reported in North Brazil possibly originated in travellers from the Caribbean, while the index case for the ECSA lineage reported in the northeastern state of Bahia was probably introduced by a resident returning from Angola (*17*). During the outbreak in 2015–2016, a total of 693 489 suspected cases and 74 deaths were recorded in the Region of the Americas.

Box 5.2. Zika virus disease

Some 84 countries and territories have reported transmission of Zika virus since 2007; active transmission has been reported by 61 countries since 2015. The virus continues to gain territory in Asia, Africa and Latin America.

The zika virus was first isolated from the Zika forest in Uganda. Only sporadic cases of human infection were documented until the first epidemic was reported from the Pacific Island of Yap in 2007 (*18*). Transmission by sylvatic mosquitoes is almost unknown. A few studies have found species of sylvatic mosquitoes positive for the virus (*19*), but the specific detection of the virus in the salivary gland, which is a prerequisite of transmission to mosquitoes, has been confirmed only in two Aedes species (*20*).

The first urban epidemic occurred in French Polynesia in 2013; the main vector was *Aedes aegypti* and a suspected secondary vector was *Ae. polynesiensis* (*21*). In 2015, zika virus was reported for the first time in Brazil. Epidemic transmission is reported to occur mainly in urban settings via *Ae. aegypti* mosquitoes, as evidenced by limited field surveillance (*22,23*) and experimental studies (*24–26*). However, in Gabon in 2007 urban transmission was associated with *Ae. albopictus*. Further experimental studies (*27*) supported a role for Asian populations of *A. albopictus* as vectors of transmission concomitantly with *Ae. aegypti* (*26*). Given its invasive nature and extensive geographical distribution in tropical as well as temperate settings, *Ae. albopictus* has the potential to become a vector of the zika virus in Europe.

In the Region of the Americas, laboratory studies conducted in 2016 of *Ae. aegypti* and *Ae. albopictus* have proven the competencies of these vectors in amplifying and transmitting the virus (*28*). *Ae. aegypti* populations from Guadeloupe and French Guiana exhibited a higher dissemination of the virus than the other *Ae. aegypti* populations examined.

Current knowledge of the vectors of zika virus in all reported studies, from Africa, Asia, the Pacific and the Region of the Americas point to *Aedes* mosquitoes as the main vectors. In urban settings, in particular, the evidence strongly suggests that *Ae. aegypti* is the main vector because this species is highly anthropophilic (*29*). *Ae. albopictus* may play a secondary role as vector. To further strengthen knowledge on the vectors that transmit the zika virus, some institutions such as Fiocruz (Brazil) and the Pasteur Institute (France) are testing other mosquito species such as *Culex* for their potential competency in transmission. Zika virus infections and their associated complications have directly affected individuals and families, and caused social and economic disruption.

Dengue vector control

Control of the *Aedes* mosquito should lead to control of the disease. There are well-documented historical examples of both yellow fever and dengue being eliminated or significantly reduced through *Ae. aegypti* control (*13*). Construction of the Panama Canal was made possible only after transmission of yellow fever had been interrupted among workers by eliminating *Ae. aegypti* breeding sites. More recently, Cuba and Singapore greatly reduced the risk of dengue transmission by controlling *Ae. aegypti*. Use of the predatory crustacean mesocyclops is preventing dengue transmission in areas of Viet Nam (*14*).

The results of the "Camino Verde" (Green Path, a pesticide-free, evidence-based community mobilization) studies conducted in Mexico and Nicaragua in 2015 empowered communities to select and combine dengue prevention actions based on local vector reservoirs and community resources. The project had a positive impact on serological evidence of dengue virus infection in children, reported illness at all ages and all dengue vector control indices. This was the first report of serological evidence of impact of community interventions (*15*).

Beyond 2020

WHO needs to further coordinate activities, including quality assurance of dengue diagnostics; strengthen capacity for case management and vector control; develop an evidence base for integration of preventive strategies, such as vaccination and sustained vector control, including integration and expansion of novel tools; and enhance integrated surveillance. Dengue in the African Region is of serious concern and must be included in existing surveillance systems in order to map the distribution of the disease and its vectors, and to formulate national policies. Outbreaks of dengue should be prevented by 2025 and eliminated by 2030 to meet the goals of SDG 3.

References

1. Stanaway JD, Shepard DS, Undurraga EA, Halasa YA, Coffeng LE, Brady OJ et al. The global burden of dengue: an analysis from the Global Burden of Disease Study 2013. Lancet Infect Dis. 2016;16:712–23. doi:10.1016/S1473-3099(16)00026-8.
2. Dengue: guidelines for diagnosis, treatment, prevention and control. New edition. Geneva: World Health Organization; 2009 (WHO/HTM/NTD/DEN/2009.1; http://www.who.int/tdr/publications/documents/dengue-diagnosis.pdf).
3. Dengue vaccine: WHO position paper – July 2016. Wkly Epidemiol Rec. 2016;91:349–64 (http://www.who.int/wer/2016/wer9130.pdf).
4. Banerjee S, Aditya G, Saha GK. Household wastes as larval habitats of dengue vectors: comparison between urban and rural areas of Kolkata, India. PLoS One. 2015;10:e0138082. doi:10.1371/journal.pone.0138082.
5. Atlas of health and climate. Geneva: World Health Organization, World Meteorological Organization; 2012 (WMO-No. 1098; http://www.who.int/globalchange/publications/atlas/report/en/).
6. Brady OJ, Gething PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG et al. Refining the global spatial limits of dengue virus transmission by evidence-based consensus. PLoS Negl Trop Dis. 2012;6:e1760. doi:10.1371/journal.pntd.0001760.
7. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL et al. The global distribution and burden of dengue. Nature. 2013;496:504–7. doi:10.1038/nature12060.;496:504-507.
8. Shepard DS, Undurraga EA, Halasa YA, Stanaway JD. The global economic burden of dengue: a systematic analysis. Lancet Infect Dis. 2016;16:935–41. doi:10.1016/S1473-3099(16)00146-8.
9. Humphrey JM, Cleton NB, Reusken CB, Glesby MJ, Koopmans MP, Abu-Raddad LJ. Dengue in the Middle East and North Africa. PLoS Negl Trop Dis. 2016;10:e0005194. doi:10.1371/journal.pntd.0005194.
10. Global strategy for dengue prevention and control 2012–2020. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/VEM/2012.5; http://apps.who.int/iris/bitstream/10665/75303/1/9789241504034_eng.pdf).
11. Dengue: guidelines for patient care in the Region of the Americas. 2nd ed. Washington (DC): Pan American Health Organization; 2016 (http://iris.paho.org/xmlui/bitstream/handle/123456789/31207/9789275118900-eng.pdf?sequence=1&isAllowed=y).
12. Technical handbook for dengue surveillance, dengue outbreak prediction/detection and outbreak response ("model contingency plan"). Geneva: World Health Organization, Special Programme for Research and Training in Tropical Diseases; 2016 (http://apps.who.int/iris/bitstream/10665/250240/1/9789241549738-eng.pdf).

13. Ooi EE, Goh KT, Gubler DJ. Dengue prevention and 35 years of vector control in Singapore. Emerg Infect Dis. 2006;12:887–93. doi:10.3201/10.3201/eid1206.051210.

14. Kay B, Nam VS. New strategy against Aedes aegypti in Vietnam. Lancet. 2005;365:613–7. doi:10.1016/S0140-6736(05)17913-6.

15. Andersson N, Nava-Aguilera E, Arosteguí J, Morales-Perez A, Suazo-Laguna H, Legorreta-Soberanis J et al. Evidence based community mobilization for dengue prevention in Nicaragua and Mexico (Camino Verde, the Green Way): cluster randomized controlled trial. BMJ. 2015;351:h3267. doi:10.1136/bmj.h3267.

16. Leparc-Goffart I, Nougairede A, Cassadou S, Prat C, de Lamballerie X. Chikungunya in the Americas. Lancet. 2014;383:514. doi:10.1016/S0140-6736(14)60185-9. (Comment on Lancet. 2014;383:488. doi:10.1016/S0140-6736(14)60167-7.)

17. Nunes MR, Faria NR, de Vasconcelos JM, Golding N, Kraemer MU, de Oliveira LF et al. Emergence and potential for spread of Chikungunya virus in Brazil. BMC Med. 2015;13:102. doi:10.1186/s12916-015-0348-x.

18. Weaver SC, Costa F, Garcia-Blanco MA, Ko AI, Ribeiro GS, Saade G et al. Zika virus: history, emergence, biology, and prospects for control. Antiviral Res. 2016;130:69–80. doi:10.1016/j.antiviral.2016.03.010.

19. Diallo D, Sall AA, Diagne CT, Faye O, Faye O, Ba Y et al. Zika virus emergence in mosquitoes in southeastern Senegal, 2011. PLoS One. 2014;9:e109442. doi:10.1371/journal.pone.0109442.

20. Diagne CT, Diallo D, Faye O, Ba Y, Faye O, Gaye A et al. Potential of selected Senegalese *Aedes* spp. mosquitoes (Diptera: Culicidae) to transmit Zika virus. BMC Infect Dis. 2015;15:492. doi:10.1186/s12879-015-1231-2.

21. Ioos S, Mallet HP, Leparc Goffart I, Gauthier V, Cardoso T, Herida M. Current Zika virus epidemiology and recent epidemics. Med Mal Infect. 2014;44:302–7. doi:10.1016/j.medmal.2014.04.008.

22. Marchette NJ, Garcia R, Rudnick A. Isolation of Zika virus from *Aedes aegypti* mosquitoes in Malaysia. Am J Trop Med Hyg. 1969;18:411–5. PMID:4976739.

23. Olson JG, Ksiazek TG, Suhandiman, Triwibowo. Zika virus, a cause of fever in central Java, Indonesia. Trans R Soc Trop Med Hyg. 1981;75:389–93. doi:doi.org/10.1016/0035-9203(81)90100-0.

24. Boorman JP, Porterfield JS. A simple technique for infection of mosquitoes with viruses: transmission of Zika virus. Trans R Soc Trop Med Hyg. 1956;50:238–42. doi:10.1016/0035-9203(56)90029-3.

25. Cornet M, Robin Y, Adam C, Valade M, Calvo MA. Transmission expérimentale comparée du virus amaril et du virus Zika chez *Aedes aegypti* [Comparison between experimental transmission of yellow fever and Zika viruses in *Aedes aegypti*]. Cah Orstom. 1979;17:47–53 (in French).

26. Li MI, Wong PS, Ng LC, Tan CH. Oral susceptibility of Singapore *Aedes (Stegomyia) aegypti* (Linnaeus) to Zika virus. PLoS Negl Trop Dis. 2012;6:e1792. doi:10.1371/journal.pntd.0001792.

27. Wong P-SJ, Li M-zI, Chong CS, Ng LC. *Aedes (Stegomyia) albopictus* (Skuse): a potential vector of zika virus in Singapore. PLoS Negl Trop Dis. 2013;7:e2348. doi:10.1371/journal.pntd.0002348.

28. Chouin-Carneiro T, Vega-Rua A, Vazeille M, Yebakima A, Girod R, Goindin D et al. Differential susceptibilities of *Aedes aegypti* and *Aedes albopictus* from the Americas to Zika virus. PLoS Negl Trop Dis. 2016;10:e0004543. doi:10.1371/journal.pntd.0004543.

29. McBride CS. Genes and odors underlying the recent evolution of mosquito preference for humans. Curr Biol. 2016;26:R41–6. doi:10.1016/j.cub.2015.11.032.

5.4 Dracunculiasis

Dracunculiasis (commonly known as guinea-worm disease) is a crippling parasitic disease caused by *Dracunculus medinensis*. This long, thread-like worm is transmitted exclusively when people drink stagnant water contaminated with parasite-infected water fleas. The water fleas are killed in the stomach but the infective larvae are liberated, penetrate the wall of the intestine and migrate through the body. The fertilized female worm (which measures 60–100 cm long) migrates under the skin tissues until it reaches its exit point, 90% of the time on the lower limbs, forming a painful blister or swelling. One or more worms emerge accompanied by a burning sensation. To soothe the burning pain, people often immerse the infected limb in water. The worm then releases thousands of larvae into the water, which become infective after being ingested by tiny crustaceans or copepods and thus completing the transmission cycle.

Dracunculiasis is rarely fatal, but infected people become non-functional for weeks. The disease affects people in rural, deprived and isolated communities who depend mainly on open surface water sources such as ponds for drinking-water (*1,2*). No vaccine or medication is available to prevent or treat the disease. However, effective preventive strategies exist, and the disease is on the verge of eradication. The eradication strategy recommended by WHO and adopted by all national programmes combines the following approaches:

- heightened surveillance through a combination of strategies, including active village-based surveillance in at-risk villages, nationwide passive surveillance, through the Integrated Disease Surveillance and Response system, supplemented by a cash reward for voluntary reporting of cases, and house-to house case searches during national immunization days and other health programmes;
- intensified case-containment measures;
- vector control of potential sources of unsafe water with temephos (Abate) and distribution of filters to strain water;
- advocacy for increased access to improved drinking-water sources; and
- behavioural change and awareness, by providing information and education.

Once a country claims to have interrupted transmission, it becomes eligible for certification of eradication after completing a 3-year precertification period. An intensive process of assessment is carried out as recommended by the International Commission for the Certification of Dracunculiasis Eradication.

Burden and distribution

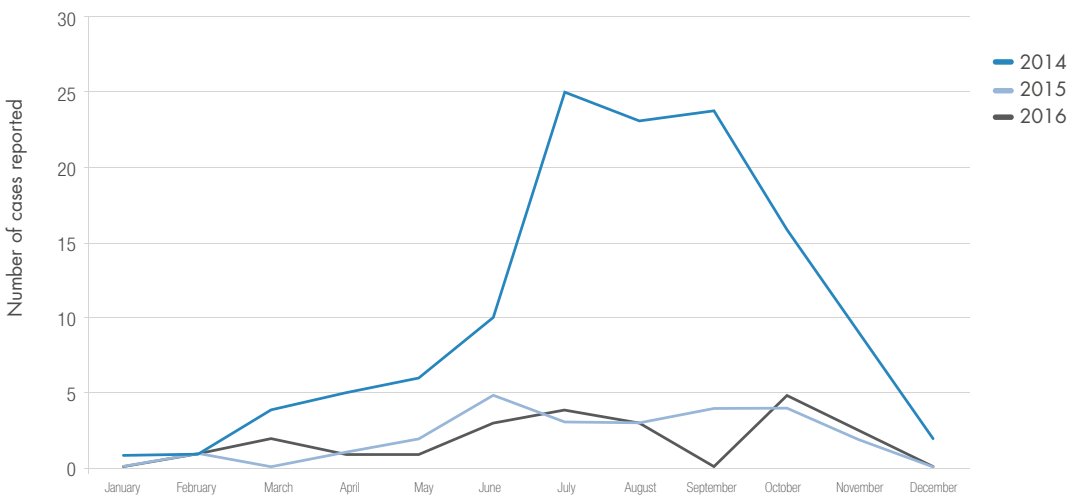
During the 1980s, dracunculiasis was endemic in 21[1] countries in WHO's African, Eastern Mediterranean and South-East Asia regions. In 1989, a total of 892 055 cases in 13 682 villages were reported from the 15 countries that submitted reports from village-based case searches. In 2015, a total of 22 cases were reported from 20 villages in four countries: 9 cases in nine villages (Chad); 5 cases in five villages (South Sudan); 5 cases in three villages (Mali); and 3 cases in three villages (Ethiopia) (*3*).

The number of cases reported monthly has steadily decreased (*4*) (**Fig. 5.10**). The unprecedented overall reduction (83%) in the number of cases reported in 2015 from the 126 cases recorded in 2014 is mainly due to the decreasing numbers of cases reported in South Sudan (93%) and Mali (88%).

During 2016, a total of 25 cases were reported from 19 villages: 16 cases in 12 villages (Chad); 6 cases in four villages (South Sudan) and 3 cases in three villages (Ethiopia) (**Fig. 5.9**). Mali reported zero human cases for the first time ever, since the start of its eradication programme in 1991.

1. Prior to South Sudan's independence in 2011, the disease was endemic in 20 countries.

Fig. 5.9. Number of dracunculiasis cases reported to WHO, by month, 2014–2016



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	1	1	4	5	6	10	25	23	24	16	9	2
2015	0	1	2	1	1	3	4	3	0	5	2	0
2016	0	1	0	1	2	5	3	3	4	4	2	0

Source: reference *4*

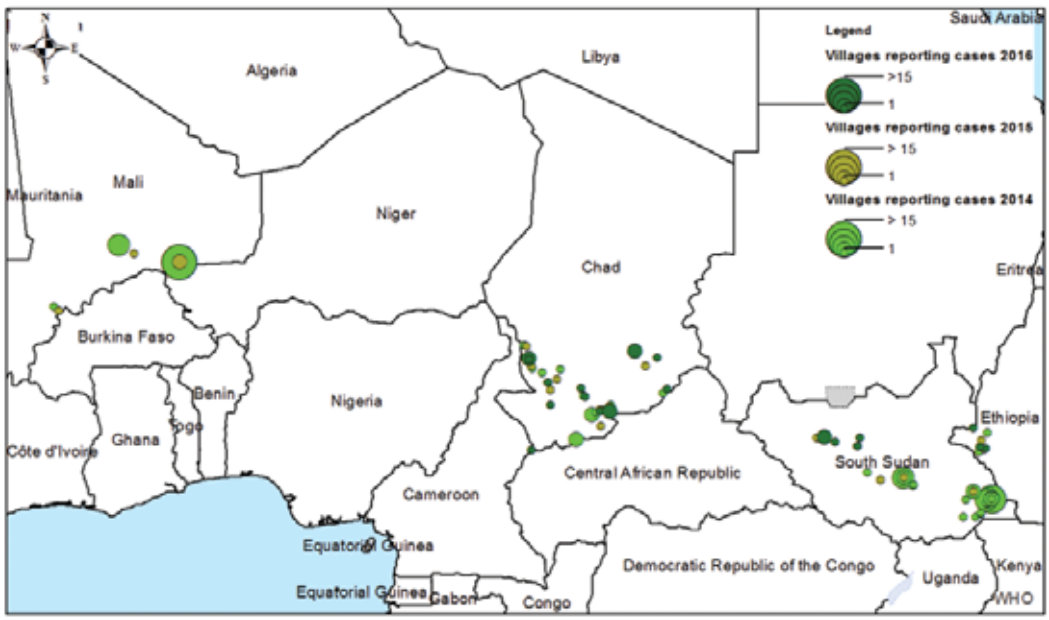
Progress towards Roadmap target

The Roadmap targeted the eradication of eradication by 2015. However, because of security concerns and an unusually large number of dogs infected with *D. medinensis*, especially in Chad and Ethiopia, the target was not met. Nonetheless, with only 22 cases reported in 2015 (*5*), the lowest ever recorded, dracunculiasis is poised for eradication. Once eradicated, dracunculiasis will be the first parasitic disease of humans to be eradicated without a medicine or a vaccine.

In 2015, a record decline (83%) in the annual number of human cases (22) was registered from the 126 cases reported in 2014. This decrease largely resulted from the 93% decline in the number of cases in South Sudan (from 70 cases in 2014 to 5 cases in 2015); the 88% decline in Mali (from 40 cases in 2014 to 5 cases in 2015); and the 35% decline in Chad (from 14 cases in 2014 to 9 cases in 2015). While Ethiopia reported the same number of cases (3) in 2014 and 2015. The cases were limited to a few foci. In 2016, the number of cases remained almost the same as in 2015.

Also in 2016, all endemic countries and those in the precertification stage implemented monetary reward schemes for voluntary reporting of cases. Surveys indicated that the level of awareness of the reward among the population varied between 10% and 95% in endemic and at-risk districts with active surveillance and between less than 1% and 56% in non-endemic districts with no active surveillance. The Commission has recommended that at least 50% of the general population should be aware of the reward and its exact amount.

Fig. 5.10. Distribution of villages reporting dracunculiasis cases to WHO, 2014 and 2016 (January–October)



NB: Geocoordinates from 12/12 villages in Chad, 3/3 villages in Ethiopia, and 2/4 villages in South Sudan in 2016.

With the certification of Ghana in 2015, WHO has certified a total of 198 countries, territories and areas belonging to 186 Member States as free of dracunculiasis transmission. Only eight countries remain to be certified.

Despite the progress made, impediments to eradication include the insecurity arising from conflicts in Mali and South Sudan. That which erupted in South Sudan in December 2013 spared much of the region where the majority of cases and the height of transmission occur. However, access to conflict zones remains difficult, and programme activities are often interrupted. In Mali, security concerns in the north of the country have, since 2012, hampered the national eradication programme, although United Nations bodies involved in humanitarian support to the northern regions have facilitated intermittent surveillance. Conflicts have led also to population displacements both within and outside the borders of these countries, further hampering surveillance efforts. Surveillance has been intensified in the Malian refugee camps in Burkina Faso, Mauritania and Niger in an effort to prevent the spread of infection and disease. The Ethiopian dracunculiasis eradication programme is likewise reinforcing surveillance in areas bordering South Sudan.

Chad was re-designated as an endemic country in 2012, after transmission had continued for 3 consecutive years following the outbreak detected in 2010, more than 10 years after the last known case had occurred in 2000. Investigation revealed the presence of large numbers of infected dogs during 2012–2016 (*5–7*). To a lesser extent, infected dogs have been reported in Ethiopia and Mali. The worms emerging from dogs have been found to be indistinguishable genetically from those emerging in humans. The occurrence of the infection in dogs constitutes an important challenge for the global eradication programme.

In response to this unusual mode of transmission, WHO convened a group of experts (Geneva, January 2015 and April 2016) to make recommendations on priority research to understand the situation and adapt interventions accordingly. An operational research programme is being undertaken, notably in Chad.

Because the life-cycle of the parasite includes an obligatory intermediate copepod host, vector control remains a vital element in the future elimination of *D. medinensis* transmission, especially in Chad. Therefore, the Commission has recommended the implementation of an effective vector control strategy along with other important measures to prevent contamination of water bodies by infected dogs and people as well as infection in dogs and people.

"Ending" the epidemic

In accordance with resolution WHA64.16 on neglected tropical diseases, which the Sixty-fourth World Health Assembly adopted in 2013, WHO has monitored its implementation and reported progress on the eradication of dracunculiasis to the Health Assembly every year since 2012. An informal meeting of the ministers of health of affected countries is held every year during the Assembly. The side-event held during the Sixty-eighth World Health Assembly (Geneva, 23–28 May 2016) was attended by 15 country delegations that included the health ministers of Ethiopia and Mali as well as high-level ministerial delegations from Burkina Faso, Cameroon, Chad, the Democratic Republic of the Congo, Nigeria and South Sudan, as well as ambassadors, partners and donors. The Regional Director of the WHO African Region chaired the meeting.

During its 11th meeting in 2016 the Commission proposed that timelines for eradication should take into account new challenges posed by the epidemiological complexity of transmission in Chad, the possible role of dogs as a source of infections in humans, and the insecurity in some endemic areas making access difficult and causing programme disruptions. As long as the worms emerging from dogs and other animals remain indistinguishable from those emerging from humans, the endgame of eradication will have to consider dogs in achieving the last mile to zero transmission. This has the potential to delay the timeline for eradication by a few more years. As a result, the Commission strongly endorsed the need for increased research, and for appropriate and innovative solutions to accelerate the interruption of transmission in both humans and animals. Delays may also be caused by other variables, several of which are not within the control of the national programmes or supporting partners. The Commission has expressed its confidence that despite these challenges, global eradication is technically feasible.

All the ministers and their representatives who attended the informal meeting held during the 2016 Health Assembly reiterated their resolve to interrupting transmission at the earliest possible. It was suggested that WHO continue to engage Member States to advocate for steadfast resolve until global eradication is declared. Table 5.2 shows the revised milestones for eradicating dracunculiasis, based on current epidemiological evidence and programmatic assumptions.

Table 5.2. Programmatic planning to eradicate dracunculiasis

Milestone	2016	2017	2018	2019	2020
Additional countries where transmission has been interrupted			Mali and South Sudan	Ethiopia	Chad
Total number of countries targeted for certification	186 Member States	2 Member States (Kenya and Sudan)	2 Member States (Angola and the Democratic Republic of the Congo)		
Total number of countries certified	186 Member States	188 Member States	190 Member States	190 Member States	

References

1. Hopkins DR, Ruiz-Tiben E, Downs P, Withers PC Jr, Maguire JH. Dracunculiasis eradication: the final inch. Am J Trop Med Hyg. 2005;73:669–75. PMID: 16222007.
2. Kim A, Tandon A, Ruiz-Tiben E. Cost–benefit analysis of the global dracunculiasis eradication campaign (GDEC). Washington (DC): World Bank; 1997 (Policy Research Working Paper No. 1835; http://documents.worldbank.org/curated/en/667061468759552975/pdf/multi0page.pdf).
3. Dracunculiasis eradication: global surveillance summary, 2015. Wkly Epidemiol Rec. 2016;91:219–36 (http://www.who.int/wer/2016/wer9117.pdf).
4. Monthly report on dracunculiasis cases, January–November 2016. Wkly Epidemiol Rec. 2017;92:35–6 (http://apps.who.int/iris/bitstream/10665/253462/1/WER9203.pdf).
5. Renewed transmission of dracunculiasis – Chad, 2010. MMWR Morb Mortal Wkly Rep. 2011;60:744–8. PMID: 21659983.
6. Eberhard ML, Ruiz-Tiben E, Hopkins DR, Farrell C, Toe F, Weiss A et al. The peculiar epidemiology of dracunculiasis in Chad. Am J Trop Med Hyg. 2014;90:61–70. doi:10.4269/ajtmh.13-0554.
7. Hopkins DR, Ruiz-Tiben E, Downs P, Withers PC Jr, Maguire JH. Dracunculiasis eradication: the final inch. Am J Trop Med Hyg. 2005;73:669–75. PMID: 16222007.

5.5 Cystic and alveolar echinococcosis

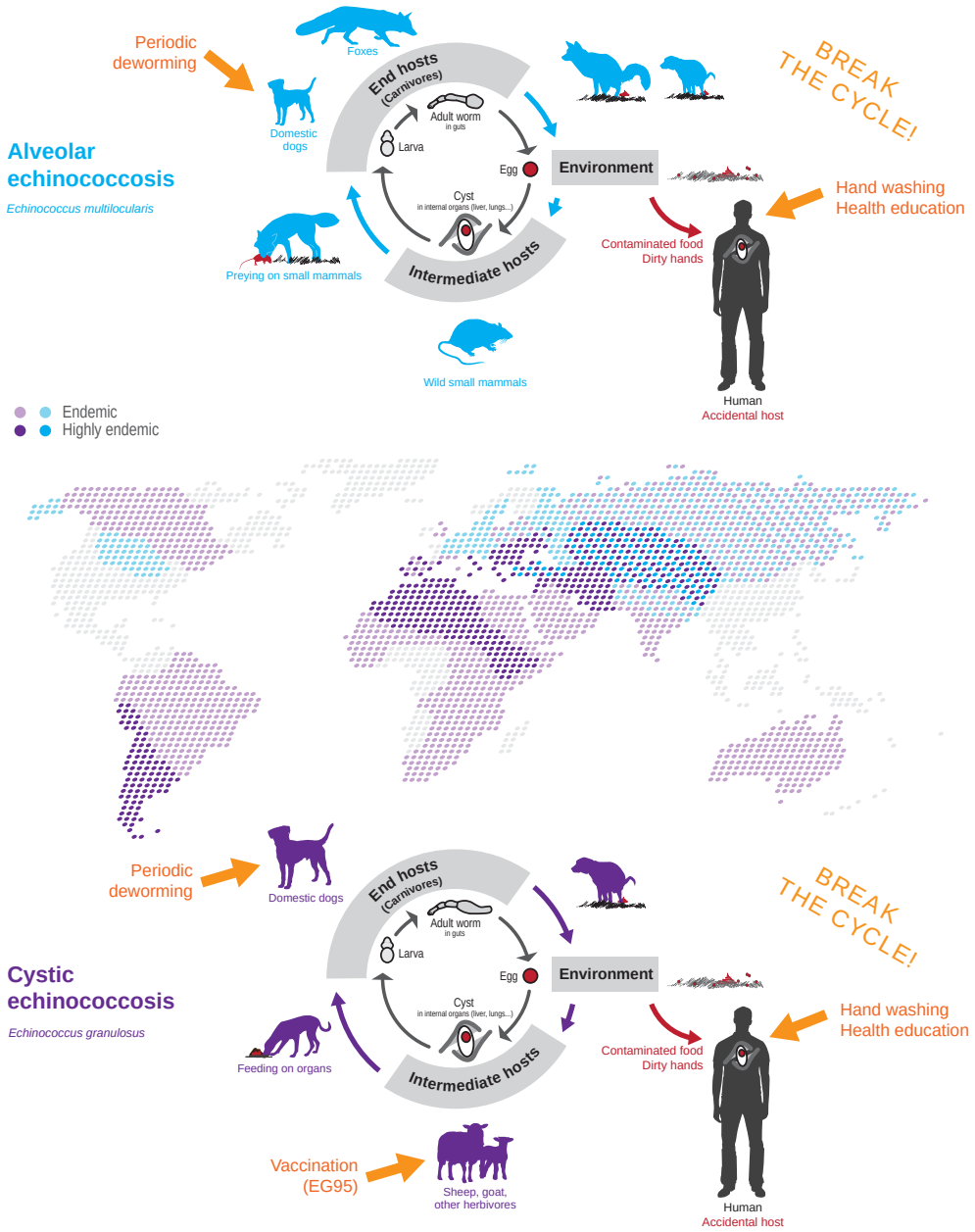
Human echinococcosis is a zoonotic disease caused by tapeworms of the genus *Echinococcus*. Echinococcosis occurs in four forms, the two most important forms in humans being cystic echinococcosis due to *E. granulosus sensu lato* (for the rest of this text) infection, and alveolar echinococcosis due to *E. multilocularis* infection. These are two different diseases with distinct biological cycle, symptoms and treatment. The definitive hosts for both parasites, domestic and wild carnivores, harbour the adult parasite in the intestines. The intermediate hosts (various farm animals and wild ungulates for *E. granulosus* and rodents and other small mammals for *E. multilocularis*) harbour the larval stages. Humans are accidental intermediate hosts who become infected by ingesting *Echinococcus* eggs.

- *E. granulosus* infection leads to the development of one or several fluid-filled cysts (hydatid cysts) located mainly in the liver and lungs and, less frequently, in other parts of the body including the central nervous system, bones, kidneys, spleen, muscles and behind the eye. The incubation period can last many years. Symptoms depend on the location of the cyst and the pressure exerted on the surrounding tissues and organs. Some infections resolve without treatment while chemotherapy with albendazole is an effective treatment in about a third of cases; surgical intervention is indicated in other cases (*1*).The infection, cystic echinococcosis, is 100% preventable when key interventions are implemented to lower transmission, namely periodic treatments of dogs with praziquantel, ensuring control measures in the slaughter of livestock and safe destruction of contaminated offal, livestock vaccination, and engaging in public education.

  Cystic echinococcosis control benefits from strengthened veterinary systems and cross-sectoral strategy development and implementation. Living in endemic rural areas, in which free roaming dogs have access to offal and being a dog-owner, seem to be among the most significant risk factors for acquiring this parasitic infection (*2*).

- *E. multilocularis* infection leads to the formation of a multi-vesiculated tumour, mainly in the liver. Alveolar echinococcosis is characterized by an asymptomatic incubation period over 5 years. Larval metastases may form in organs adjacent to the liver or in distant locations following dissemination of the parasite by the haematogenous or lymphatic routes. Early diagnosis in humans is key to successful treatment. Radical surgery can be performed on confined lesions followed by anti-infective prophylaxis with albendazole. Advanced lesions that are deemed inoperable can be treated with albendazole to achieve stabilization (*3*). Liver transplantation remains a final option. Prevention and control are more complex because the parasite's life-cycle involves wild animal species as definitive and intermediate hosts (Fig. 5.11). Regular anthelminthic treatment of domestic carnivores that have access to wild rodents should help to reduce the risk of infection to humans. Anthelminthic treatment of wild and stray definitive hosts using baits has proven effective, drastically reducing the prevalence of infection in Europe (*4*) and Japan (*5*).

Fig. 5.11. *Echinococcus* transmission cycle and possible intervention points



Source: reference *21*
© A.M. Labouche - WHO

Burden and distribution

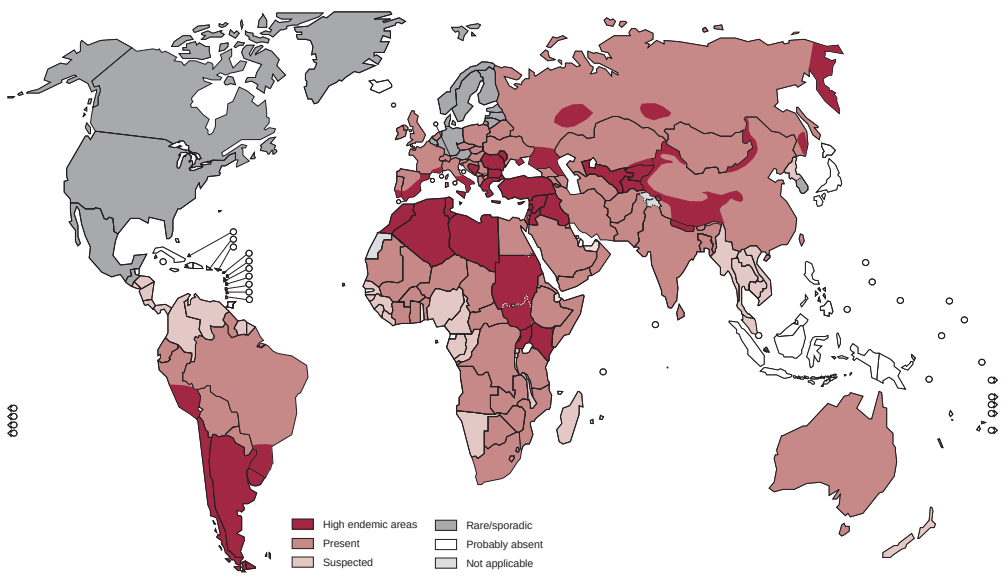
There is a lack of systematic surveillance on echinococcosis, but available data suggest that it is re-emerging as an important public health problem, with more than 1 million people worldwide being affected at any one time (*6,7,8*).

The reported global distribution of cystic echinococcosis has changed little since 2012 (Fig. 5.12). The highly endemic areas comprise the Eastern Mediterranean Region, northern Africa, southern and eastern Europe, the southern tip of South America, and Central Asia, Siberia and western China. In regions where the disease is endemic, its incidence in humans can exceed 30/100 000 person-years, while prevalence rates as high as 5–10% may occur in parts of South America, Central Asia, China and Africa (*9,10*).

In 2015, Argentina, Chile, Peru, Uruguay and southern Brazil formed a Regional Initiative for the Control of Cystic Echinococcosis. Together, these five countries reported nearly 5000 new cases per year (2009–2014). The average case–fatality rate (2.9%) suggests that approximately 880 deaths occurred in the region during this six-year period. Cases requiring secondary or tertiary health care spent an average of 10.6 days in hospital, leading to a significant burden on those countries' health systems (*11*).

Alveolar echinococcosis is confined to the northern hemisphere, in particular to regions of China, Central Asia, the Russian Federation and countries in continental Europe (*12*), and in North America. In certain communities on the Tibetan Plateau of China, as many as 5–10% of the population may be infected with *E. multilocularis*, while the annual incidence of cases possibly exceeds 16 000 in this region (*8*). Additionally, millions of

Fig. 5.12. Distribution of *Echinococcus granulosus* and cystic echinococcosis, worldwide, 2012



people are estimated to be at risk of the infection in Central Asia and western China (*6*). There are indications that alveolar echinococcosis represents a serious and steadily increasing threat to a significant proportion of the European population (*13*).

Further insight into the disease burden imposed by echinococcosis is provided by the WHO Foodborne disease burden Epidemiology Reference Group. It presented the first global and regional estimates of the burden of foodborne diseases and identified echinococcosis as a serious cause of deaths from foodborne diseases, amounting to an estimated more than 19 000 deaths per year and around 870 000 disability-adjusted life-years globally (*14*) (Table 5.3).

Cystic echinococcosis also imposes a significant economic burden in developing countries by affecting livestock, causing an estimated US$ 2 billion in livestock losses alone (*15*). The prevalence of cystic echinococcosis in slaughterhouses in hyperendemic areas of Latin America varies from 20% to 95% of slaughtered animals. The highest rates have been found in rural areas where older animals are slaughtered (*16*). In Sardinia (Italy) during 2005–2010, in the absence of specific control measures the prevalence of the infection in sheep was 65% (*17*). Livestock production losses attributable to cystic echinococcosis include the liver and lungs being condemned as unfit for consumption, a reduction in the weight of carcasses, a decrease in the value of the animal's hide, a decrease in milk production and reduced fecundity (*18*).

Table 5.3. Median number of total and foodborne illnesses, deaths and disability-adjusted life years, with 95% uncertainty intervals, 2010

Hazard (cestodes)	Illnesses (95% UI)	Deaths (95% UI)	DALYs (95% UI)
Echinococcus granulosus	188 079 (156 848–177 405)	2 225 (749–19 627)	183 573 (88 082–1 590 846)
Echinococcus multilocularis	18 451 (11 384–29 619)	17 118 (10 184–27 346)	687 823 (409 190–1 106 320)

DALY, disability-adjusted life-year; UI, uncertainty interval.

Progress towards Roadmap target

The Roadmap target for 2015 for echinococcosis was to have conducted pilot projects to validate effective echinococcosis control strategies in selected countries. The 2020 target is to have a validated control and elimination strategy available for echinococcosis and hydatidosis and expanded in selected countries.

Projects and research include:

- A project in Mongolia, supported through funds by the Special Programme for Research and Training in Tropical Diseases, which comprises retrospective studies based on hospital records to establish a baseline, and efforts to establish current clinical practices for case detection and management.
- A project in Morocco, supported by the Ministry of Health of Italy and the WHO Collaborating Centre in Pavia, on screening in endemic communities using ultrasound and serology and training for appropriate management. The project, which has been completed, aimed to decentralize diagnostic and therapeutic techniques and promote the PAIR (puncture, aspiration, injection, reaspiration) strategy in rural and hyperendemic areas.
- A mapping project on cystic echinococcosis in Palestine, supported by the WHO Collaborating Centre for the epidemiology, detection and control of cystic and alveolar echinococcosis (in humans and animals), Istituto Superiore di Sanità, Rome, Italy.
- An echinococcosis control project in the highly endemic regions on the Tibetan Plateau and surrounding regions, with expanded support from China (*19*).
- Valuable data have been obtained on the use of the EG95 vaccine for the control of cystic echinococcosis in the Rio Negro province of Argentina. The vaccine is being trialled in lambs to impede *E. granulosus* infection and has led to a statistically significant reduction in the number and size of hydatid cysts from the situation before the vaccine was introduced. This could supplement control measures such as the treatment of dogs and culling of older sheep.
- The launch in October 2014 of the European Register of Cystic Echinococcosis[1] in the context of the HERACLES project. This prospective, observational, multicentre register of patients with probable or confirmed cystic echinococcosis aims to collect standardized clinical data to support a more rational stage-specific approach for the clinical management and to help public authorities to harmonize its reporting (*20*).
- The EMIA project (*Echinococcus multilocularis* infection in animals), which aims to identify and collate the current knowledge and data on the epidemiology, risk factors, diagnosis and control programmes of *E. multilocularis* in Europe and adjacent countries. This completed study was aiming to generate baseline data to support the review the EU Regulation 1152/2011 on *E. multilocularis* through the systematic reviews of literature and data.[2]

1. http://www.heracles-fp7.eu/erce.html
2. http://onlinelibrary.wiley.com/doi/10.2903/sp.efsa.2015.EN-882/abstract

- The HERACLES collaborative and translational project (Human cystic Echinococcosis ReseArch in Central and Eastern Societies, which aims to quantify the real burden of human cystic echinococcosis in central and eastern Europe through extended ultrasound surveys; create the European Register of Cystic Echinococcosis (ERCE); validate new point-of-care lab-on-a-chip kits for diagnosis and follow-up; accelerate biomarker discovery through taxon studies; and synthesize new benzimidazole-based medicines; create an extended network of experts comprising centres from Europe and Asia.

Further progress on echinococcosis includes:

- Establishing two new WHO Collaborating Centres on Echinococcosis in China and Italy in addition to the currently existing three centres.
- Re-establishing the WHO Informal Working Group on Echinococcosis Geneva, 15–16 December 2016 to focus on updating clinical and control procedures and integrating cystic and alveolar echinococcosis into mainstream clinical medicine and public health (*21*). The steering group has initiated thematic Working Groups on cystic and alveolar cysticercosis with the aim of delivering concise technical manuals.

Progress towards the 2020 goal will depend on:

- A process to establish operational guidelines for a stepwise approach to the control of *T. solium* taeniasis and cysticercosis.
- A strong network of collaboration within the NTD community to integrate echinococcosis-related efforts with similar areas of work within and outside WHO, including coordination of programme implementation, medicines negotiation and exploiting funding opportunities
- Allocation of minimum critical resources to implement further proof-of-concept studies to attain validated best-bet strategies. The investments required by the public sector would appear to be affordable. For example, the cost of implementing pilot projects in three countries over a 5-year period has been estimated at about US$ 10 million, or less than US$ 0.20 per year per person at risk (*22*).
- A One Health approach combining animal, food and human health and environmental sectors, as well as partner agencies such as the Food and Agriculture Organization of the United Nations and the World Organisation for Animal Health to meet the needs for interdisciplinary collaboration to control echinococcosis; ideally, this would include integrated control packages for major dog-related zoonoses such as rabies and echinococcosis. As with the other dog-transmitted NTDs, management of waste has a direct impact on roaming dog populations and therefore the source of the disease. The involvement of other sectors – including veterinary and water, sanitation and hygiene – is critical.

1. http://www.heracles-fp7.eu/
2. http://www.heracles-fp7.eu/erce.html
3. http://www.heracles-fp7.eu/interactive_map.html

Besides the identification of best-bet strategies, further priorities for echinococcosis include:

- Updated WHO guidance on appropriate treatment options.
- Early detection of *E. granulosus* and *E. multilocularis* infections especially in low-resource settings, mainstreaming of diagnostic analysis (e.g. ultrasound) to the lowest possible administrative level of health care.
- Investment in veterinary public health measures, including implementation and careful evaluation of pilot control programmes on cystic echinococcosis utilizing state-of-the-art tools for diagnosis of infection in the definitive host and vaccination of livestock intermediate hosts.
- Development and validation of improved methods for diagnosis of cystic echinococcosis in livestock animals.
- Further assessment and development of strategies to increase the adoption of livestock vaccination for control of *E. granulosus*.
- Evaluation of interventions in dogs, e.g. development and validation of a standardized, commercial coproantigen test for *E. granulosus* infection in dogs.

References

1. Junghanss T et al Clinical management of cystic echinococcosis: state of the art, problems, and perspectives. Am J Trop Med Hyg 2008;79:301–11.
2. Possenti A, Manzano-Román R, Sánchez-Ovejero C, Boufana B, La Torre G, Siles-Lucas M et al. Potential risk factors associated with human cystic echinococcosis: systematic review and meta-analysis. PLoS Negl Trop Dis. 2016;10:e0005114. doi:10.1371/journal.pntd.0005114.
3. Torgerson PR, Schweiger A, Deplazes P, Pohar M, Reichen J, Ammann RW et al. Alveolar echinococcosis: from a deadly disease to a well-controlled infection. Relative survival and economic analysis in Switzerland over the last 35 years. J Hepatol. 2008;49:72–7. doi:10.1016/j.jhep.2008.03.023.
4. Hegglin D, Deplazes P. Control strategy for Echinococcus multilocularis. Emerg Infect Dis. 2008;14:1626–8. doi:10.3201/eid1410.080522.
5. Tsukada H, Hamazaki K, Ganzorig S, Iwaki T, Konno K, Lagapa JT et al. Potential remedy against *Echinococcus multilocularis* in wild red foxes using baits with anthelmintic distributed around fox breeding dens in Hokkaido, Japan. Parasitology. 2002;125(Pt 2):119–29. doi:10.1017/S0031182002001968.
6. Zhang W, Zhang Z, Wu W, Shi B, Li J, Zhou X et al. Epidemiology and control of echinococcosis in central Asia, with particular reference to the People's Republic of China. Acta Trop. 2015;141(Pt B):235–43. doi:10.1016/j.actatropica.2014.03.014.
7. Budke CM, Deplazes P, Torgerson PR. Global socioeconomic impact of cystic echinococcosis. Emerg. Infect. Dis. 2006;12: 296–303. Doi:10.3201/eid1202.050499.

8. Torgerson PR, Keller K, Magnotta, Ragland N. The global burden of alveolar echinococcosis. PLoS Negl Trop Dis. 2010;4:e722. doi:10.1371/journal.pntd.0000722.

9. Wahlers K, Menezes CN, Wong ML, Zeyhle E, Ahmed ME, Ocaido M et al. Cystic echinococcosis in sub-Saharan Africa. Lancet Infect Dis. 2012;12:871–80. doi:10.1016/S1473-3099(12)70155-X.

10. Craig PS, McManus DP, Lightowlers MW, Chabalgoity JA, Garcia HH, Gavidia CM et al. Prevention and control of cystic echinococcosis. Lancet Infect Dis. 2007;7:385–94. doi:10.1016/S1473-3099(07)70134-2.

11. Pavletic CF et al. Cystic echinococcosis in South America: a call for action. Rev Panam Salud Publica. 2017 [in press].

12. Oksanen A, Siles-Lucas M, Karamon J, Possenti A, Conraths FJ, Romig T et al. The geographical distribution and prevalence of *Echinococcus multilocularis* in animals within the European Union and adjacent countries: a systematic review and meta-analysis. Parasites & Vectors. 2016; 9(519).

13. Gottstein B, Stojkovic M, Vuitton DA, Millon L, Marcinkute A, Deplazes P. Threat of alveolar echinococcosis to public health — a challenge for Europe. Trends Parasitol. 2015;31:407–12. doi:10.1016/j.pt.2015.06.001.

14. Torgerson P, Devleesschauwer B, Praet N, Speybroeck N, Willingham AL, Kasuga F et al. World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: a data synthesis. PLoS Med. 2015;12:e1001920. doi:10.1371/journal.pmed.1001920.

15. People, pathogens and our planet. Vol. 2: The economics of One Health. Washington (DC): World Bank; 2012 (Report number 69145-GLB; http://documents.worldbank.org/curated/en/612341468147856529/pdf/691450ESW0whit0D0ESW120PPPvol120web.pdf).

16. Zoonoses and communicable diseases common to man and animals. Vol. III: Parasitoses 3rd ed. Washington (DC): Pan American Health Organization; 2003 (Scientific and Technical Publication No. 580; http://iris.paho.org/xmlui/bitstream/handle/123456789/711/ZoonosesVol-3.pdf?sequence=1).

17. Conchedda M, Seu V, Capra S, Caredda A, Pani SP, Lochi PG et al. Cystic echinococcosis in sheep in Sardinia: changing pattern and present status. Acta Trop. 2012;122:52–8. doi:10.1016/j.actatropica.2011.11.016.

18. Singh BB, Dhand NK, Ghatak S, Gill JP. Economic losses due to cystic echinococcosis in India: need for urgent action to control the disease. Prev Vet Med. 2014;113:1–12. doi:10.1016/j.prevetmed.2013.09.007.

19. Feng X, Qi X, Yang L, Duan X, Fang B, Gongsang Q et al. Human cystic and alveolar echinococcosis in the Tibet Autonomous Region (TAR), China. J Helminthol. 2015;89:671–9. doi:10.1017/S0022149X15000656.

20. Rossi P, Tamarozzi F, Galati F, Pozio E, Akhan O, Cretu CM et al. The first meeting of the European Register of Cystic Echinococcosis (ERCE). Parasit Vectors. 2016; 9:243. doi:10.1186/s13071-016-1532-3.

21. Meeting of the WHO Informal Working Group on Echinococcosis (WHO-IWGE). Geneva, Switzerland, 15–16 2017. Geneva: World Health Organization; 2017 (WHO/HTM/NTD/NZD/2017.01; http://apps.who.int/iris/bitstream/10665/254869/1/WHO-HTM-NTD-NZD-2017.01-eng.pdf).

22. Interagency meeting on planning the prevention and control of neglected zoonotic diseases (NZDs). Geneva: World Health Organization; 2011 (WHO/HTM/NTD/NZD/2011.3; http://www.oie.int/doc/ged/D11558.PDF).

5.6 Endemic treponematoses (yaws)

Yaws is a chronic, disfiguring and debilitating disease caused by infection with bacteria of the genus *Treponema*. Of the three endemic treponematoses, yaws is the most prevalent; the other two are endemic syphilis (bejel) and pinta (*1*). The disease is found primarily in poor communities in warm, humid and tropical forest areas of Africa, Asia, Latin America and the Pacific. The majority of affected populations live beyond the "end of the road" and therefore have limited access to basic social amenities and health care. Poor socioeconomic conditions, including lack of access to improved water and sanitation facilitate the disease's spread. The infection is transmitted through direct (person-to-person) non-sexual contact of minor injuries of an uninfected person with the fluid from the yaws lesion of an infected person. Most lesions occur on the limbs. The incubation period is 9–90 days (average, 21 days). While not fatal, if left untreated yaws can lead to severe, crippling deformities. About 75–80% of cases are children aged under 15 years. The peak incidence occurs in children aged 6–10 years; boys are affected more often than girls.

Diagnosis is often made on a clinical basis, but recent reports show that ulcers caused by *Haemophilus ducreyi* coexist in areas endemic for yaws and can confound diagnosis (*2*). Rapid treponemal syphilis tests are widely used to screen for yaws, but are unable to distinguish between current active infection and previously treated cases. A new, rapid, point-of-care dual syphilis test appears to have excellent sensitivity (95%) and specificity (97%) (*3*) and will doubtless boost yaws eradication efforts. Molecular techniques such as polymerase chain reaction (PCR) can also be used to confirm yaws and monitor resistance to azithromycin (*4*). Studies are in progress to develop multiplex-based antibody tests for use in large-scale population surveys, especially in the previously endemic countries where no recent data are available (*5*).

Between 1952 and 1964, WHO and UNICEF led a global eradication campaign using injectable benzathine benzylpenicillin. Although the campaign reduced the prevalence of the treponematoses from 50 million to 2.5 million (*6*), it was not pursued to eradication and the diseases resurged in the 1970s. In response, the Thirty-first World Health Assembly adopted resolution WHA31.58 on control of endemic treponematoses in 1978. Member States were requested to formulate and implement integrated control programmes with a focus on active surveillance so as to: interrupt transmission of the diseases at the earliest possible time in areas where they were still endemic; and to prevent their recurrence in areas from which they had been eliminated or where they had never been endemic. Since then yaws has been targeted for eradication (2020), both in resolution WHA66.12 on neglected tropical diseases and in the Roadmap. The criteria for eradication are: absence of new indigenous cases for 3 consecutive years; absence of evidence of transmission for 3 continuous years measured with sero-surveys among children aged 1–5 years (for example, no young children with seroreactivity to RPR (rapid plasma regain); and negative for *Treponema pallidum* subspecies *pertenue* in suspected lesions by PCR.

WHO's renewed eradication strategy – the *Morges strategy* – relies on the use of oral azithromycin as the main intervention (*7*). The strategy is based on two new treatment policies: (i) delivering mass treatment to entire endemic communities, irrespective of the number of active clinical cases, followed by regular surveillance until clinical cases are no longer identified; and (ii) delivering targeted treatment to all active clinical cases and their contacts, an approach that requires support from existing health-care services.

Burden and distribution

An estimated 89 million people are at risk of yaws in 13 countries where treponematoses are endemic (*8*). However, there are 85 countries that were endemic for yaws in the 1950s for which no information about the status of the disease is available after 1990 (Table 5.4 and Fig. 5.13). Importantly, the number of cases reported annually is neither consistent nor accurate, and most of the reported cases are not laboratory-confirmed. Fig. 5.14 shows the most recent data on yaws, based on routine surveillance. In 2015, there were 42 660 reported cases, a reduction of 15% from the 50 415 cases reported in 2014; most of the cases occurred in Côte d'Ivoire, Cameroon, Ghana, Papua New Guinea, the Solomon Islands and Vanuatu. No additional countries have reported cases of the disease since 2012. Since reporting of yaws is not mandatory, these figures are no more than indicative of ongoing transmission and, going forward, mandatory reporting of the disease will be essential. In May 2016, WHO declared India as the first country to have eradicated yaws. This recognition has boosted yaws eradication efforts, especially in the remaining two endemic countries (Indonesia and Timor-Leste) in the South-East Asia Region (*9*). Ecuador has interrupted transmission but has yet to be certified.

Table 5.4. Status of countries endemic for yaws, by WHO region

WHO region	Group A.1 Interrupted transmission and verified	Group A.2 Interrupted transmission Pending verification	Group A.3 Currently endemic countries	Group B Previously endemic countries	Group C Countries with no history of yaws	Total no. of countries and territories
African	0	0	8	28	11	47
Americas	0	1[b]	0	32	14	47
South-East Asia	1[a]	0	2	3	5	11
Western Pacific	0	0	3	20	14	37
Eastern Mediterranean	0	0	0	2	20	22
European	0	0	0	0	54	54
Total	1	1	13	85	118	218

a India was certified by WHO in May 2016 (*9*).
b Ecuador reported interruption of transmission in 1998 but has not been certified (*10*).

Source: reference *13*

Fig. 5.13. Distribution of yaws, worldwide, 2008–2015

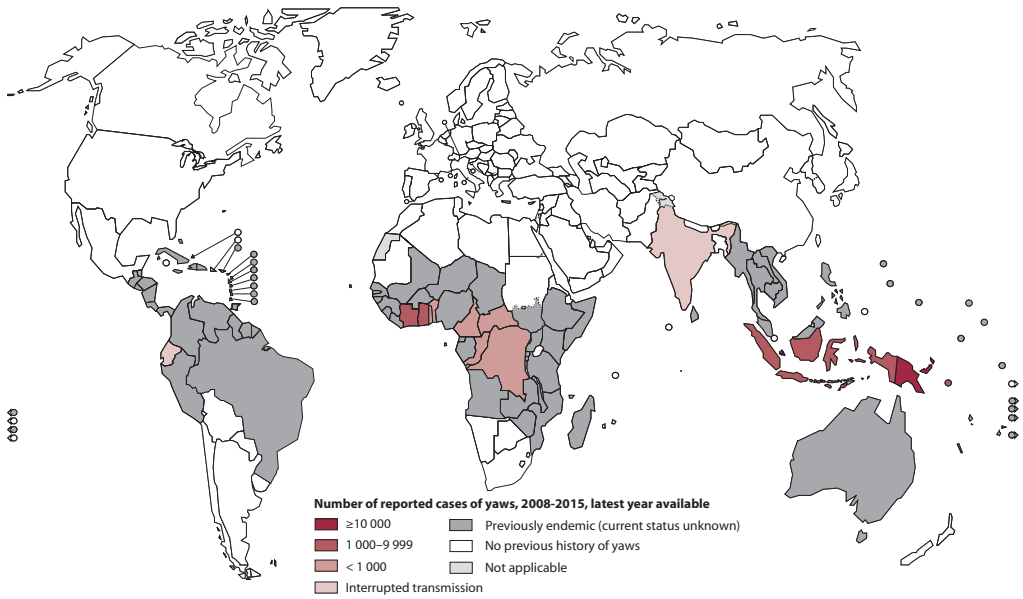
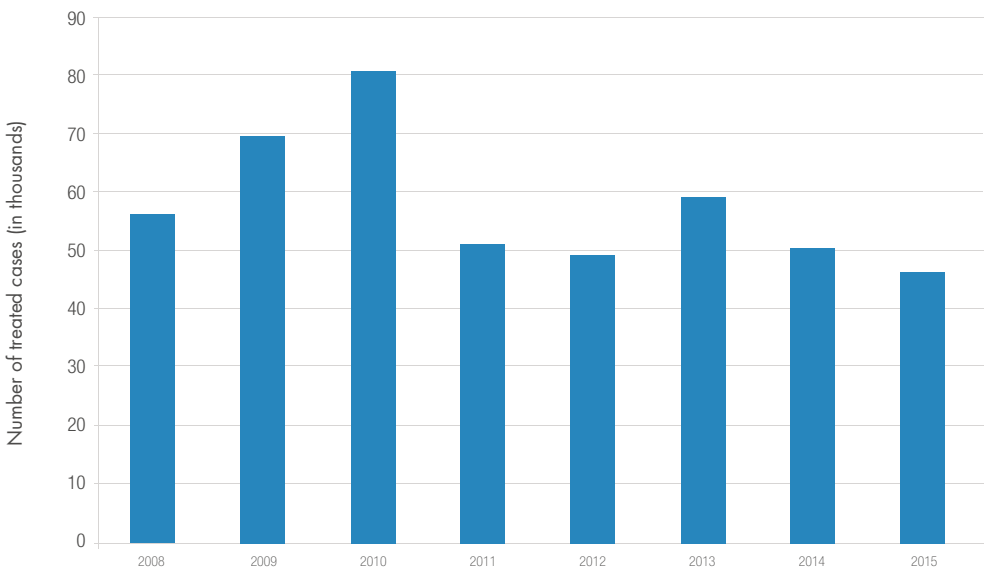


Fig. 5.14. Countries reporting data on yaws, by WHO region, 2008–2015



Progress towards Roadmap target

Studies have validated the Morges strategy and the tools required to eradicate yaws. However, while the discovery of the efficacy of treatment with single-dose azithromycin raised hopes that eradication could be achieved by 2020, it is unlikely that this target will be met for three reasons: (i) the absence of azithromycin donations; (ii) the lack of funding for azithromycin purchases (in the absence of donated medicine); and (iii) the lack of financial support to countries to implement eradication activities in the 13 endemic countries. WHO has been in discussion with potential generic manufacturers of azithromycin since early 2016 and progress has been made. However, even if ultimately successful, these negotiations will not lead to the attainment of eradication by the target date.

WHO and the Task Force for Global Health convened in November 2014 to review the progress made since 2012 and devise a strategy to expand the Morges strategy (*11*). The meeting concluded that the eradication of yaws was technically feasible but that WHO needed to develop a comprehensive plan and timelines for expansion. It was further recommended that an International Coalition for Yaws Eradication be established to assist WHO with coordination, advocacy and resource mobilization.

In support of the eradication agenda, several research priorities have been identified by a group of experts (*12*). One is to compare the efficacy of 20 mg/kg versus 30 mg/kg of azithromycin. A clinical trial to undertake this comparaison, carried out in Ghana and Papua New Guinea, is due for completion in 2017. If the trial results in a lower dose of azithromycin being used, there will be a reduction in the cost of yaws eradication efforts.

The third WHO consultation on yaws eradication (Geneva, March 2014) identified four priorities for research:

- Develop a non-treponemal bead-based immunoassay as part of a multiplex testing system for NTDs in general and as a more refined tool to determine the prevalence of infection at baseline and impact assessment stages of the programme.
- Continue to type *T. pallidum* subsp. *pertenue* strains from different geographical areas and closely monitor the emergence of resistance to azithromycin.
- Attempt culture of *H. ducreyi* from leg ulcerations of children and determine antimicrobial susceptibilities.
- Try to determine the etiology of non-yaws/*H. ducreyi* lesions using advanced molecular techniques.

In 2016, the global trachoma programme implemented MDA of azithromycin in Vanuatu. The impact on yaws is being assessed. WHO has prepared guidance for programme managers to complement the Morges strategy as well as procedures for verification and certification of interruption of transmission to assist national programmes and international verification teams (*13*).

Beyond 2020

The interruption of yaws transmission in India lends support to the long-held belief that eradication of yaws is technically feasible. Going forward, a resolution on eradication of yaws for adoption by the World Health Assembly should be considered in order to mobilize political and financial support. The achievement of eradication of dracunculiasis and poliomyelitis by 2020 may attract more attention to yaws eradication after this time. However, new targets will have to be set for 2020–2030 in order to achieve the interruption of transmission in the 13 endemic countries and complete the verification of interruption of transmission in the 85 previously endemic countries. The risk of drug resistance remains, and close monitoring should continue through the collaboration of national programmes and research scientists. Surveillance efforts can be integrated into other programmes, including the skin-NTD strategy and will very probably be boosted by large-scale screening using multiplex antibody testing.

References

1. Giacani L, Lukehart SA. The endemic treponematoses. Clin Microbiol Rev. 2014;27:89–115. doi:10.1128/CMR.00070-13.
2. Mitjà O, Lukehart SA, Pokowas G, Moses P, Kapa A, Godornes C et al. *Haemophilus ducreyi* as a cause of skin ulcers in children from a yaws-endemic area of Papua New Guinea: a prospective cohort study. Lancet Glob Health. 2014;2:e235–41. doi:10.1016/S2214-109X(14)70019-1.
3. Marks M, Yin Y-P, Chen X-S, Castro A, Causer L, Guy R et al. Metaanalysis of the performance of a combined treponemal and nontreponemal rapid diagnostic test for syphilis and yaws. Clin Infect Dis. 2016;63:627–33. doi:10.1093/cid/ciw348.
4. Chen CY, Chi KH, Pillay A, Nachamkin E, Su JR, Ballard RC. Detection of the A2058G and A2059G 23S rRNA gene point mutations associated with azithromycin resistance in *Treponema pallidum* by use of a TaqMan real-time multiplex PCR assay. J Clin Microbiol. 2013;51:908–13. doi:10.1128/JCM.02770-12.
5. Cooley GM, Mitjà O, Goodhew B, Pillay A, Lammie PJ, Castro A et al. Evaluation of multiplex-based antibody testing for use in large-scale surveillance for yaws: a comparative study. J Clin Microbiol. 2016;54:1321–5. doi:10.1128/JCM.02572-15.
6. Marks M. Yaws: towards the WHO eradication target. Trans R Soc Trop Med Hyg. 2016;110:319–20. doi:10.1093/trstmh/trw032.
7. Eradication of yaws – the Morges strategy. Wkly Epidemiol Rec. 2012;87:189–94 (http://www.who.int/wer/2012/wer8720.pdf).
8. Mitjà O, Marks M, Konan DJP, Ayelo G, Gonzalez-Beiras C, Boua B et al. Global epidemiology of yaws: a systematic review. Lancet Glob Health. 2015;3:e324–31. doi:10.1016/S2214-109X(15)00011-X.
9. Friedrich MJ. WHO declares India free of yaws and maternal and neonatal tetanus. JAMA. 2016;316:1141. doi:10.1001/jama.2016.12649.

10. Anselmi M, Moreira J-M, Caicedo C, Guderian R, Tognoni G. Community participation eliminates yaws in Ecuador. Trop Med Int Health. 80:634–8. doi/10.1046/j.1365-3156.2003.01073.x/pdf.

11. Yaws strategy development: report of a meeting, 27–28 October 2014, Atlanta, GA, USA. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/IDM/2015.6; http://apps.who.int/iris/bitstream/10665/170990/1/9789241508810_eng.pdf).

12. Marks M, Mitjà O, Vestergaard LS, Pillay A, Knauf S, Chen CY et al. Challenges and key research questions for yaws eradication. Lancet Infect Dis. 2015;15:1220–5. doi:10.1016/S1473-3099(15)00136-X.

13. Eradication of yaws: procedures for verification and certification of interruption of transmission. Geneva: World Health Organization; 2017 [in press] (WHO/HTM/NTD/IDM/2017.01).

5.7 Foodborne trematodiases

The foodborne trematodiases are a group of helminth infections acquired by eating food contaminated with the larvae of trematode worms (flukes). Typically, people become infected through ingestion of raw or poorly cooked fish, crustaceans and vegetables that harbour the larval stages of the parasites. More than 100 species of foodborne trematodes are known to parasitize humans; the most common species are *Clonorchis sinensis* (which causes clonorchiasis), *Opisthorchis viverrini* and *O. felineus* (which cause opisthorchiasis), Fasciola hepatica and *F. gigantica* (which cause fascioliasis) and *Paragonimus* spp. (which cause paragonimiasis). These parasites have complex life-cycles involving intermediate reservoir hosts (Table 5.6).

The public health burden of the foodborne trematodiases is predominantly related to morbidity rather than mortality. In the early stages of infection, or in light infections, there may be no symptoms or symptoms may be slight, becoming more severe as the number of worms increases through subsequent rounds of infection. Where the worm load is high, general malaise is common and severe pain may result, especially in the abdominal region; this occurs most frequently in fascioliasis. Chronic infections are invariably associated with severe morbidity. Symptoms are mainly organ-specific and reflect the final location of the adult worms in the body.

In clonorchiasis and opisthorchiasis, the adult worms lodge in the smaller bile ducts of the liver, causing inflammation and fibrosis of the adjacent tissues and eventual cholangiocarcinoma, a severe and fatal form of bile duct cancer. *C. sinensis* and *O. viverrini* are classified as carcinogenic to humans by the International Agency for Research on Cancer (*1*).

Table 5.6. Epidemiological characteristics of the most common foodborne trematode infections

Disease	Infectious agent	Acquired through consumption of	Natural final host	Primary organ affected
Clonorchiasis	*Clonorchis sinensis*	Fish	Dogs and other fish-eating carnivores	Liver
Opisthorchiasis	*Opisthorchis viverrini; O. felineus*	Fish	Dogs and other fish-eating carnivores	Liver
Fascioliasis	*Fasciola hepatica; F. gigantica*	Vegetables	Sheep, cattle and other herbivores	Liver
Paragonimiasis	*Paragonimus* spp.	Crustacea (crabs and crayfish)	Cats, dogs and other crustacean-eating carnivores	Lungs

In fascioliasis, the adult worms lodge in the larger bile ducts and the gall bladder, where they cause inflammation, fibrosis, blockage, colic pain and jaundice. Liver fibrosis and anaemia are also frequent. In paragonimiasis, the final location of the worms is the lung tissue where they cause symptoms that can be mistaken for those of tuberculosis: chronic cough with blood-stained sputum, chest pain, dyspnoea and fever. The most severe sequelae result when the worms migrate to the cerebrum of the brain.

The main interventions for control focus on reducing the risk of infection and providing treatment with anthelminthic medicines. Veterinary public health measures and food safety practices are recommended to reduce the risk of infection. Deworming treatment can be offered through preventive chemotherapy or individual case management, and involves the treatment of people with confirmed or suspected infection.

Burden and distribution

The burden of disease associated with these infections is unclear. For example, paragonimiasis is known to be transmitted in central and western Africa, but information about its epidemiological status is limited. Clonorchiasis and opisthorchiasis are confined to Asia, and paragonimiasis is found in Africa, Asia and Latin America. Fascioliasis is a global disease that affects a number of countries worldwide. Although cases of foodborne trematodiases have been reported from more than 70 countries worldwide, countries in Asia and Latin America are those worst affected. Estimates referring to a selected group of 17 countries indicate that in 2005 more than 56 million individuals were infected with foodborne trematodes, of whom 7.9 million suffered severe sequelae and more than 7000 died (*2*).

Estimates for 2015 from the WHO Foodborne disease burden Epidemiology Reference Group assessing the global burden of 31 bacteria, viruses, parasites, toxins and chemicals, identified the four species of foodborne trematodes as important causes of disability especially in the Western Pacific Region (**Fig. 5.15**), contributing a total of 2 024 592 (confidence interval: 1 652 243–2 483 517) foodborne DALYs globally (*3*).

Information regarding the economic burden imposed by foodborne trematode infections is also scarce. Livestock and aquaculture industries are clearly affected, with losses in animal production and trade. Although estimates are not currently available, the cost of these losses is likely to be significant.

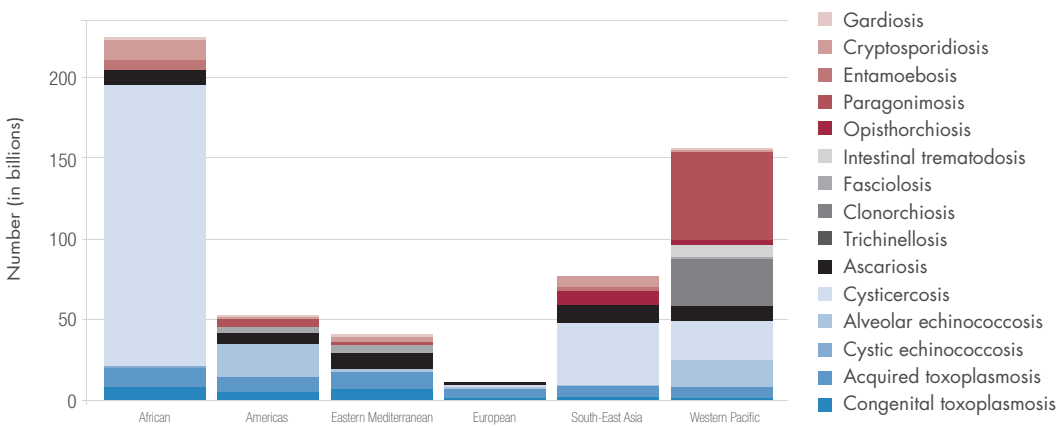
Progress towards Roadmap target

The Roadmap set two implementation milestones for foodborne trematodiases by 2015: to include these diseases in mainstream preventive chemotherapy according to the currently recommended WHO strategy developed in 2009–2011 (*4*); and to ensure that control interventions are implemented in the most endemic countries in order to control morbidity associated with these diseases, ensuring implementation in high-burden settings where feasible. The Roadmap target for 2020 is to ensure coverage with preventive chemotherapy of at least 75% of the global population requiring it.

Ensuring that medicines are available for national control programmes will be central to achieving these targets. Triclabendazole is recommended for fascioliasis and paragonimiasis, and praziquantel is the treatment of choice for clonorchiasis, opisthorchiasis and paragonimiasis. Triclabendazole is donated through WHO, and several countries have benefitted from these donations. In contrast, donations of praziquantel for foodborne trematode infections have not been secured, although it is available for treating schistosomiasis.

A number of countries have been scaling up coverage of treatment and contributing to the achievement of the 2015 milestones (Table 5.7).

Fig. 5.15. Contribution of causative pathogen to foodborne disability-adjusted life-years (DALYs), by WHO region, 2010



Source: reference *3*

Table 5.7. Expansion of treatment coverage of triclabendazole, by country, 2006–2015

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Madagascar	0	0	0	200	1500	0	0	0	0	0
South Africa	0	0	0	16	12	0	0	0	0	0
Uganda	0	0	0	0	0	40	0	0	0	0
Aruba	0	0	0	0	0	16	0	0	0	0
Bolivia (Plurinational State of)	0	160 760	0	500 000	400 000	300 000	0	300 000	400 000	0
Brazil	0	0	0	0	0	0	0	0	92	0
Chile	0	0	0	0	0	0	0	0	80	0
Colombia	0	0	0	0	120	0	100	0	0	0
Costa Rica	0	0	0	0	0	0	0	16	0	0
Cuba	0	0	0	0	0	0	120	0	0	0
Ecuador	0	0	0	0	0	0	600	20	40	0
Panama	0	0	0	0	0	0	0	0	0	28
Peru	0	201 200	0	250 000	0	0	50 000	0	50 000	0
USA	0	40	0	40	0	60	0	40	40	0
Venezuela (Bolivarian Republic of)	0	0	0	32	0	0	0	0	0	0
Egypt	10 000	3 000	2500	0	200	1000	1000	400	400	1500
Iran (Islamic Republic of)	2000	0	2400	4000	0	2000	2000	2000	0	1680
Yemen	0	16 000	0	24 000	42 000	24 000	0	0	0	0
Georgia	0	0	320	800	0	600	0	800	580	0
Italy	0	0	0	0	0	0	0	0	12	8
Tajikistan	0	0	0	3000	0	0	0	0	0	0
Russian Federation	0	0	0	60	0	0	0	0	0	0
Switzerland	0	0	0	0	0	0	0	200	0	0
India	0	0	0	0	0	12	16	0	100	0
Myanmar	0	0	0	0	0	0	200	0	0	0
Australia	0	0	0	0	0	0	0	20	0	0
Cambodia	0	0	0	0	0	0	0	2000	2000	2000
China	0	0	0	0	0	0	1200	0	860	0
Korea (Republic of)	0	0	0	0	0	40	40	0	0	24
Malaysia	0	0	0	0	0	0	0	0	0	0

Beyond 2020

While considerable progress has been made in improving access to preventive chemotherapy for diseases such as lymphatic filariasis, onchocerciasis, schistosomiasis and soil-transmitted helminthiases, populations affected by foodborne trematode infections may have limited access to adequate assistance. There are several reasons for this and, going forward, progress, including progress in focusing international attention on these diseases, will depend on:

- delineating endemic areas and defining the global burden due to foodborne trematodiases in order to understand the epidemiological parameters of the disease and identify those that are highly focalized (2);
- developing and standardizing serological and molecular diagnostic tools to allow better identification of affected individuals;
- operationalizing a strategic approach to complement preventive chemotherapy with other interventions (veterinary public-health services and environmental management); and
- devising practical recommendations and guidance for use by disease control programme managers.

References

1. A review of human carcinogens. Part B: Biological agents. Lyon: International Agency for Research on Cancer; 2012 (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans v. 100B; http://monographs.iarc.fr/ENG/Monographs/vol100B/mono100B.pdf).
2. Fürst T, Keiser J, Utzinger J. Global burden of human food-borne trematodiasis: a systematic review and meta-analysis. Lancet Infect Dis. 2012;12:210–21. doi:10.1016/S1473-3099(11)70294-8.
3. Torgerson PR, Devleesschauwer B, Praet N, Speybroeck N, Willingham AR, Kasuga F et al. World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: a data synthesis. PLoS Med. 2015;12:e1001920. doi:10.1371/journal.pmed.1001920.
4. Report of the WHO expert consultation on foodborne trematode infections and taeniasis/cysticercosis. Geneva: World Health Organization; 2011 (WHO/HTM/NTD/PCT/2011.3; http://www.who.int/neglected_diseases/preventive_chemotherapy/WHO_HTM_NTD_PCT_2011.3.pdf).

5.8 Human African trypanosomiasis

Human African trypanosomiasis (also known as sleeping sickness) is a vector-borne, parasitic disease caused by infection with protozoan parasites belonging to the genus *Trypanosoma*. The parasites are mostly transmitted to humans through the bites of tsetse flies (*Glossina* genus) that have been infected by human pathogenic parasites hosted by humans or animals. Tsetse flies are found solely in sub-Saharan Africa. For reasons not yet explained, in many regions where the tsetse flies are found, sleeping sickness is not. Rural populations living in regions where transmission occurs and that depend on agriculture, fishing, animal husbandry or hunting are the most exposed to tsetse flies and therefore to the disease.

The disease has two forms, depending on the parasite involved: *Trypanosoma brucei gambiense*, in central and western Africa, which currently accounts for more than 97% of reported cases of sleeping sickness and causes a chronic infection; and *Trypanosoma brucei rhodesiense*, which is found in eastern and southern Africa and causes an acute infection. Only in Uganda are both forms of the disease present, each occurring in a separate zone.

During the first (haemo-lymphatic) stage of the disease, the trypanosomes multiply in the subcutaneous tissues, blood and lymph. In the second (neurological or meningo-encephalic) stage, the parasites cross the blood–brain barrier to infect the central nervous system. The more obvious signs and symptoms of the disease include disturbance of the sleep cycle, hence its name. Without treatment, sleeping sickness is generally fatal, although cases of healthy carriers have been reported.

Diagnosis and treatment of the disease are complex and require specific skills. The type of treatment depends on the disease stage. Treatment success in the second stage depends on the efficacy of medicines in crossing the blood–brain barrier to reach the parasite. Five antitrypanosomal medicines are used to treat sleeping sickness. These are donated to WHO by manufacturers and distributed free of charge to countries where the disease is endemic.

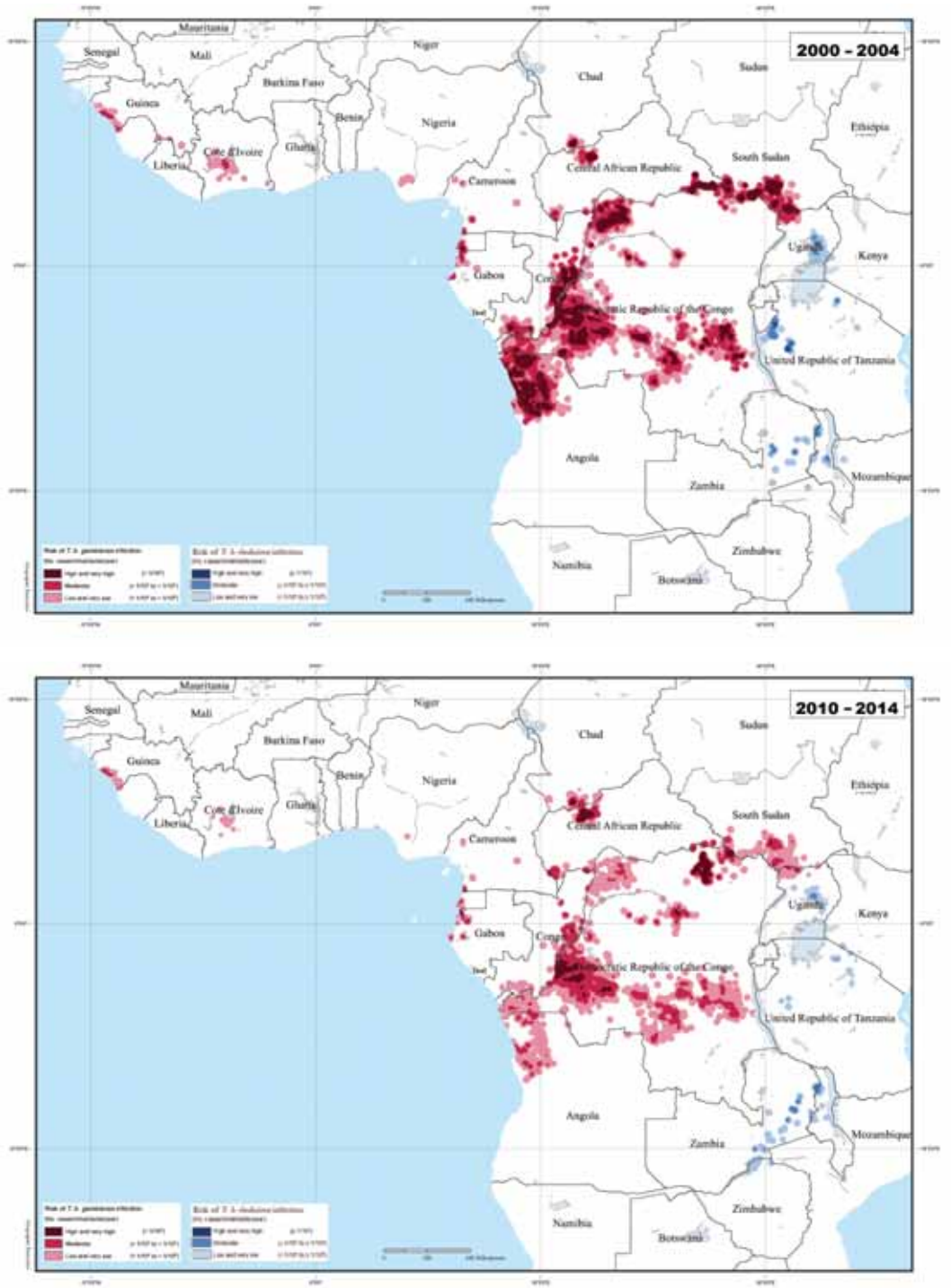
Burden

The primary indicator used to monitor the elimination of the disease is the number of new cases reported every year. In 2015, a total of 2804 new cases were reported, a reduction of 89% from the 26 574 cases reported in 2000. The Democratic Republic of the Congo continues to suffer the largest number of infections (*1*) and in 2015 accounted for 84% of the total number of cases (2351 cases).

Another indicator used to monitor the progress of elimination is "areas at risk of HAT" (*2*). Risk is estimated over a period of 5 years, which smoothes artificial variations in incidence caused by the irregularity of programme activities during any specific year. The level of risk is stratified into five categories, based on the annual number of cases in the exposed population (*3*). According to the established criteria (*4*), the categories of "low" and "very low" risk apply to areas where the disease is not considered a public health problem.

During the five-year period 2010–2014 there were an estimated 1.18 million km^2 of land area where populations were exposed to different levels of risk of infection: those in almost 60 000 km^2 were at very high and high risk, and those in almost 290 000 km^2 were at moderate risk. The total area in which the disease remains a public health problem (that is, areas at high or very high or moderate risk) halved from 2004 to 2014

Fig. 5.16. Distribution of areas at different levels of risk of gambiense and rhodesiense infection, 2000–2004 and 2010–2014

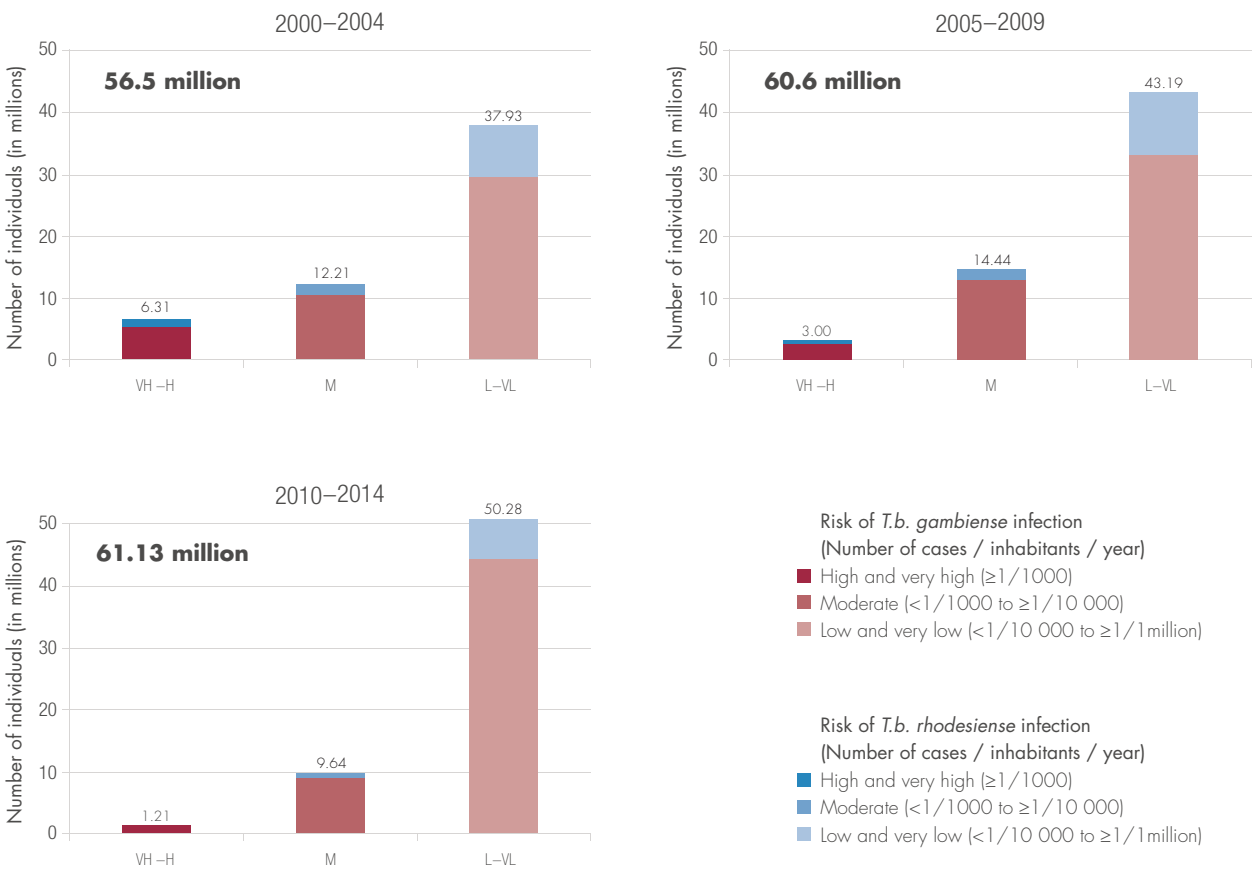


(from approximately 709 000 km^2 to less than 360 000 km^2. Fig. 5.16 shows the distribution of areas in which the population was exposed to risk of gambiense infection during the five-year periods 2000–2004 and 2010–2014.

For rhodesiense sleeping sickness, people living in an estimated area of 100 000 km^2 are at risk of infection, with most of these in the low and very low risk categories (90 000 km^2), where the disease is not considered a public health problem.

Of the population at risk, 61.1 million people were estimated to be at risk of both forms of infection for the period 2010–2014. The number of people at very high and high risk has significantly decreased (from 6.3 million in 2000–2004 to 1.2 million in 2010–2014) as has the population at moderate risk (from 12.2 million to 9.6 million people during the same periods). During 2010–2014, some 50.3 million people out of the total of 61.1 million at risk (i.e. 82%) lived in areas at low or very low risk of infection and this population has therefore already met the criterion of elimination as a public health problem (Fig. 5.17).

Fig. 5.17. Population exposed to different levels of risk of gambiense and rhodesiense infection, 2000–2004, 2005–2009 and 2010–2014



Source: reference *2*

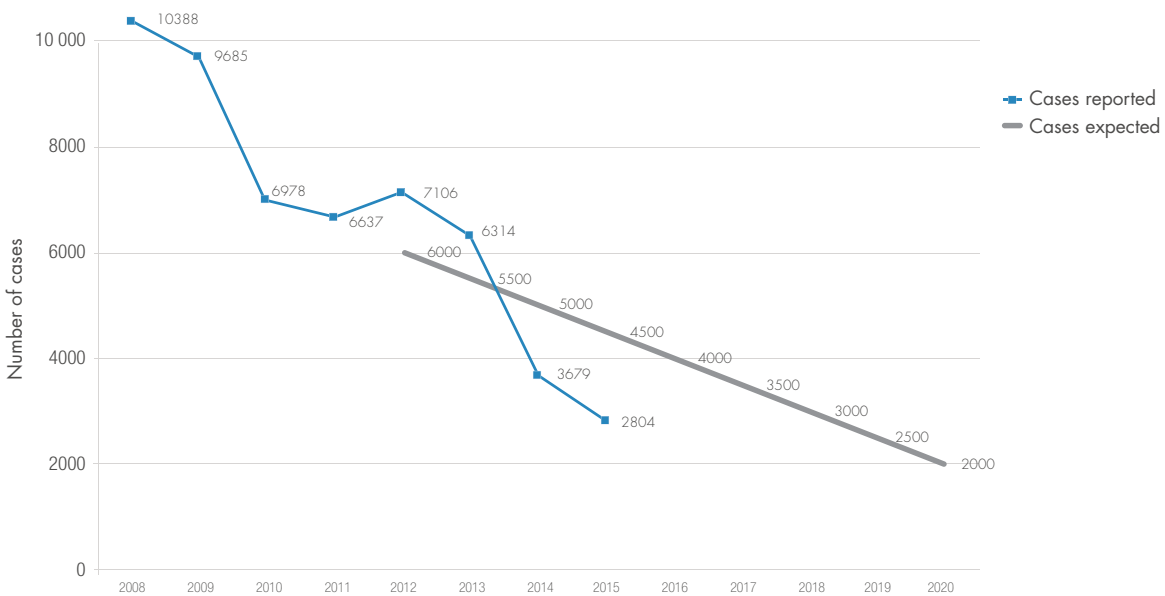
The "coverage of the population at risk of HAT" by control and surveillance activities is a proxy indicator of access to health services for the disease. Here, too, trends are positive. A survey completed in March 2016 identified 993 fixed health facilities with capacity for diagnosis (882 for gambiense infection, up from 622 in 2013, and 111 for rhodesiense infection) and 548 for treatment (516 for gambiense infection, up from 495 in 2013, and 32 for rhodesiense infection) (*5*).

Progress towards Roadmap targets

The trends cited suggest that progress has been steady and on track with the elimination goal of the Roadmap. The target for elimination of human African trypanosomiasis as a public health problem (2020) is fewer than 2000 reported cases. The current trend suggests that this will be attained. Indeed, in 2015 cases dipped below the intermediate milestone of 4500 cases (Fig. 5.18).

Epidemiological knowledge of the disease has increased and global coordination among stakeholders (national programmes, international organizations, bilateral cooperation and different donors mainly from the private sector) has strengthened. Since 2014, the response to the disease has been coordinated through the WHO-led "Network for HAT elimination". Under this umbrella a number of meetings are held every year by groups and subgroups that tackle key themes and coordinate control or elimination activities.

Fig. 5.18. Progress in reducing the number of cases of human African trypanosomiasis reported to WHO, 2008–2015, and benchmark for 2020



The programme of elimination is therefore on track. It is important to emphasize that these results have been achieved through the efforts of the National Sleeping Sickness Control Programmes, with the support of different stakeholders.

Beyond 2020

Despite progress, many challenges lie ahead. Insecurity in some areas (for example in Central African Republic and South Sudan) still prevents populations from accessing diagnosis and treatment, while access to some remote areas remains difficult. The gradual loss of expertise and motivation in medical staff is another concern, being an unavoidable negative effect of the reduction in the numbers of cases. Continued awareness, commitment and coordination of the different partners are essential to maintaining momentum.

For the 2030 elimination goal to be reached, a number of challenges must be overcome. For gambiense sleeping sickness, key knowledge gaps exist regarding the epidemiological relevance of human asymptomatic carriers and animal reservoirs, particularly their role in the maintenance, resurgence or reintroduction of the disease in certain areas. Effective and sustainable long-term surveillance will be crucial. For rhodesiense sleeping sickness, a zoonotic disease where the life-cycle in wild and domestic animals is more important than in humans, interrupting transmission will depend on an integrated One Health approach.

As the elimination process advances, it will be necessary to adapt control activities and progressively reinforce the surveillance system. Those areas at different levels of risk of transmission have been mapped and interventions can therefore be targeted and monitored accordingly. Sustainable elimination (defined as interruption of transmission) will require integrating control and surveillance activities in the health system, taking into account the weaknesses of the peripheral health system in countries where the disease is endemic.

Efforts to strengthen health-system capacities, especially in rural areas, will not only reinforce the capacities of health systems in general but also support the sustainable elimination of the disease.

Coordination of support for endemic countries will continue to be crucial, as will increased ownership of the elimination process by the countries themselves. To maintain awareness of a disease that is no longer a public health problem is not easy. Neither is maintaining the commitment of stakeholders to ensure the investment needed to reach the 2030 goal.

Further advances in diagnostic and therapeutic tools could considerably help in the process of elimination, mainly by making it sustainable. Advances in the control of tsetse flies could also contribute. Finally, social stability in the affected countries will be critical.

References

1. Lumbala C, Simarro PP, Cecchi G, Paone M, Franco JR, Mesu VKBK et al. Human African trypanosomiasis in the Democratic Republic of the Congo: disease distribution and risk. Int J Health Geogr. 2015;14: 20. doi:10.1186/s12942-015-0013-9.
2. Simarro PP, Cecchi G, Franco JR, Paone M, Diarra A, Ruiz-Postigo JA et al. Estimating and mapping the population at risk of sleeping sickness. PLoS Negl Trop Dis. 2012;6: e1859. doi.org/10.1371/journal.pntd.0001859.
3. Simarro PP, Cecchi G, Franco JR, Paone M, Diarra A, Priotto G et al. Monitoring the progress towards the elimination of Gambiense human African trypanosomiasis. PLoS Negl Trop Dis. 2015;9:e0003785. doi:10.1371/journal. pntd.0003785.
4. Control and surveillance of human African trypanosomiasis. Geneva: World Health Organization; 2013 (WHO Technical Report Series, No. 984; (http://apps.who.int/iris/bitstream/10665/95732/1/9789241209847_eng.pdf).
5. Report of the second WHO stakeholders meeting on gambiense human African trypanosomiasis elimination. Geneva, 21–23 March 2016. Geneva: World Health Organization; 2016 (http://apps.who.int/iris/bitstream/10665/254067/1/9789241511520-eng.pdf).

5.9 Leishmaniasis

Leishmaniasis refers to a treatable and curable group of diseases that affect some of the poorest people on earth. They are associated with malnutrition, population displacement, poor housing, a weak immune system and lack of financial resources. The disease has three main forms: (i) visceral leishmaniasis, also known as kala-azar, the most serious form, is fatal in more than 95% of cases if left untreated and is characterized by irregular bouts of fever, weight loss, enlargement of the spleen and liver, and anaemia; (ii) cutaneous leishmaniasis, the most common form, causes skin lesions, mainly ulcers, on exposed parts of the body, leading to permanent scarring and serious disability; and (iii) mucocutaneous leishmaniasis, which causes devastating partial or total destruction of the mucous membranes of the nose, mouth and throat.

Recurrent epidemics of visceral leishmaniasis in East Africa (Ethiopia, Kenya, South Sudan and Sudan) have caused high morbidity and mortality in affected communities. Major epidemics of cutaneous leishmaniasis have affected different parts of Afghanistan and the Syrian Arab Republic. About 95% of cutaneous cases occur in the Region of the Americas, the Mediterranean basin, the Middle East and Central Asia. Almost 90% of mucocutaneous cases occur in Brazil, Peru and the Plurinational State of Bolivia.

Leishmania parasites are transmitted through the bites of infected female phlebotomine sandflies. The epidemiology of the disease depends on the characteristics of the parasite species, the ecological characteristics of the transmission sites, the current and previous exposure of the human population to the parasite, and the behaviour of humans. Some 70 animal species, including human beings, have been identified as natural reservoir hosts of *Leishmania* parasites.

Visceral disease is diagnosed by using a combination of clinical signs with parasitological or serological tests, such as rapid diagnostic tests. Serological tests have limited value in diagnosing cutaneous and mucocutaneous disease. Parasitological tests can confirm clinical manifestations of cutaneous disease. Highly effective and safe antileishmanial medicines are available for treatment particularly of visceral disease, and access to them has improved significantly. Early diagnosis and effective case management prevent disability and death, and contribute to reducing transmission and monitoring the spread and burden of the disease. Vector control helps to reduce or interrupt transmission by controlling sandflies, especially in domestic environments. Control methods include insecticidal spraying, insecticide-treated nets, environmental management and personal protection. Controlling animal reservoir hosts is complex and context-specific. Collaborating with different stakeholders and control programmes for other vector-borne disease is critical, as are mobilizing and educating the community about effective behavioural change interventions.

Burden

In 2016, WHO updated information on the epidemiology and case management of leishmaniasis using the data from routine surveillance provided by 25 countries in which the burdens of the disease are highest (*1*). Fig. 5.19 shows for each WHO region the distribution of leishmaniasis in countries with the highest burdens of visceral and cutaneous disease.

According to the updated data the countries with a high burden of visceral disease reported a total of 30 758 cases in 2014 and 21 909 cases in 2015 (including new primary cases and relapse cases) (*2*). Countries with a high burden of cutaneous disease reported a total of 153 027 cases in 2014 and 138 575 cases in 2015 (including both new cases and relapse cases) (*2*). The highest incidence of visceral leishmaniasis was 35.63/10 000 inhabitants (range: 0.012–35.63) and the highest incidence of cutaneous leishmaniasis was 22.74/10 000 inhabitants (range: 0.33–22.74).

Fig. 5.19. Distribution of countries with a high burden of leishmaniasis, based on data reported to WHO in 2016

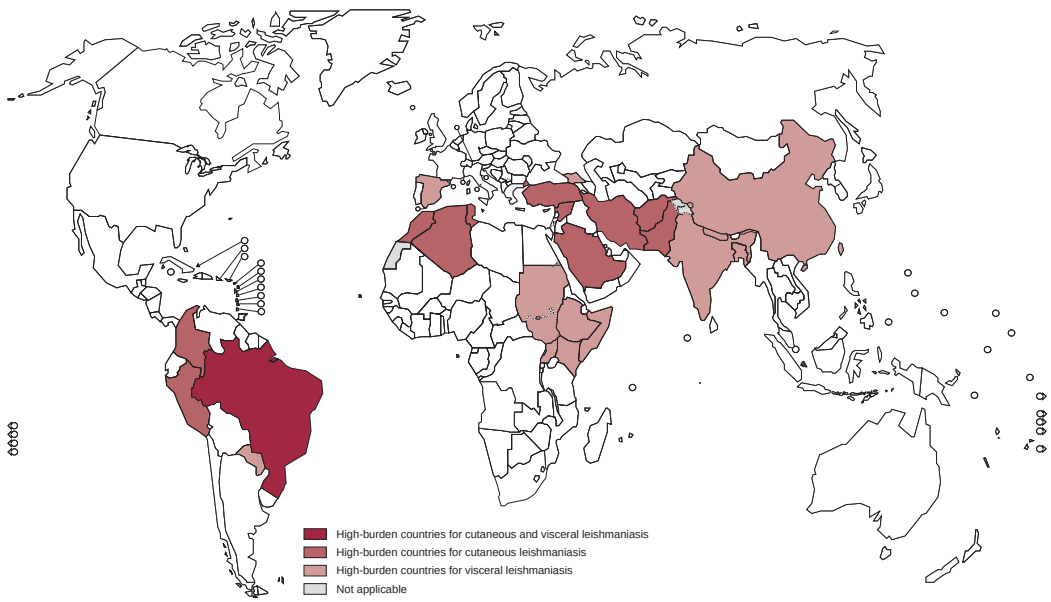


Fig. 5.20 shows the trends in the numbers of cases of visceral leishmaniasis reported by selected countries in each WHO region during 1998–2015.

The upward trend in the numbers of cases of visceral leishmaniasis in the high-burden countries of the South-East Asia Region (Bangladesh, India, Nepal) is mainly due to the higher number of new cases of visceral disease being reported generally, but also to the dramatic increase in the number of cases reported up to the peak of cases in 2007. Since then the incidence has fallen sharply and in 2015 had reduced by 82%. The overall trend in the other regions is fairly stable or fluctuates within a relatively narrow range over the period covered.

The numbers of new cases of cutaneous leishmaniasis reported in the high-burden countries of the WHO Eastern Mediterranean Region are increasing significantly, but the trend is relatively stable in high-burden countries of other endemic regions.

Fig. 5.20. Trends in the burden of visceral leishmaniasis, 14 countries, 1998–2015

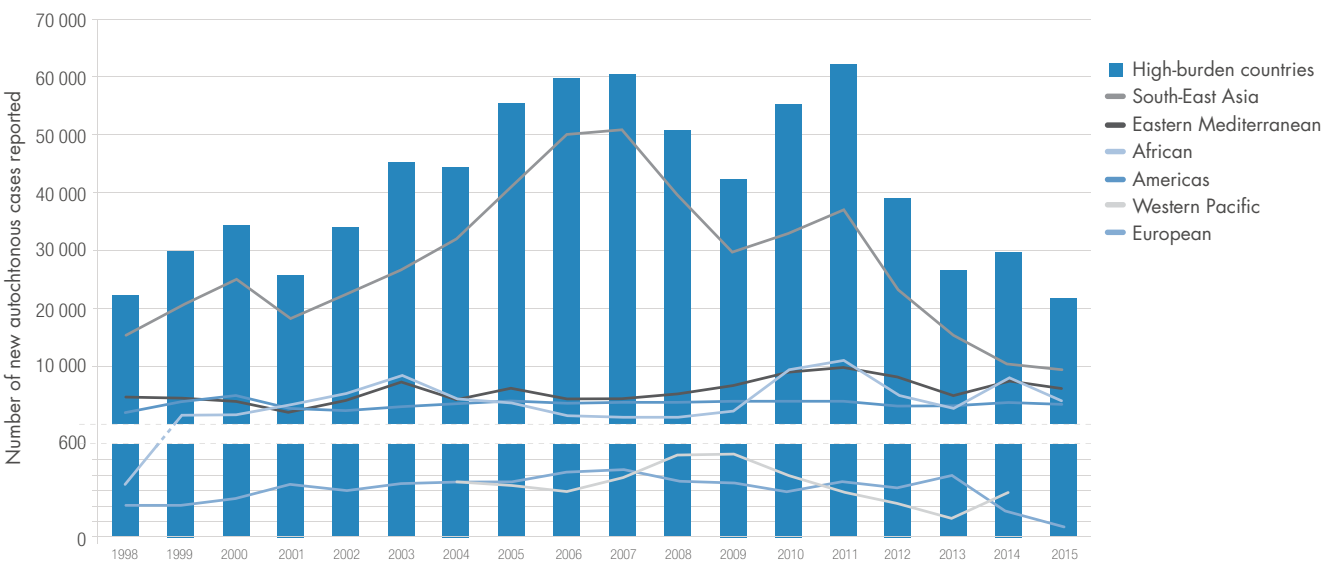


Fig. 5.21 shows the changing trends in the numbers of new cases of cutaneous leishmaniasis reported by selected countries in each WHO region during 1998–2015.

Progress towards targets

The Roadmap target for visceral leishmaniasis is to achieve 100% case detection and treatment. Achieving this target is feasible by 2020 if efforts are sustained on the Indian subcontinent. Regional elimination is targeted by 2020. Substantial progress was made towards that target in 2015 and the numbers of reported cases decreased in Bangladesh (by 67%), India (by 61%) and Nepal (by 46%) from those reported in 2012 (Fig. 5.22).

Within this broad trend, it important to note the achievement of the target of less than 1 case per 10 000 population at district level in Nepal (Fig. 5.23). Nepal reached the elimination target at district level in 2012. There is a significant increase in the number of sub-districts that have achieved the elimination target in Bangladesh and India from, respectively, 90% and 67% in 2014 to 97% and 82% in 2015. In 2016, Bangladesh reached the elimination target in 99% (99/100) of the sub-districts, and India in 85% (539/634) of the sub-districts.

Fig. 5.21. Trends in the burden of cutaneous leishmaniasis, 12 countries, 1998–2015

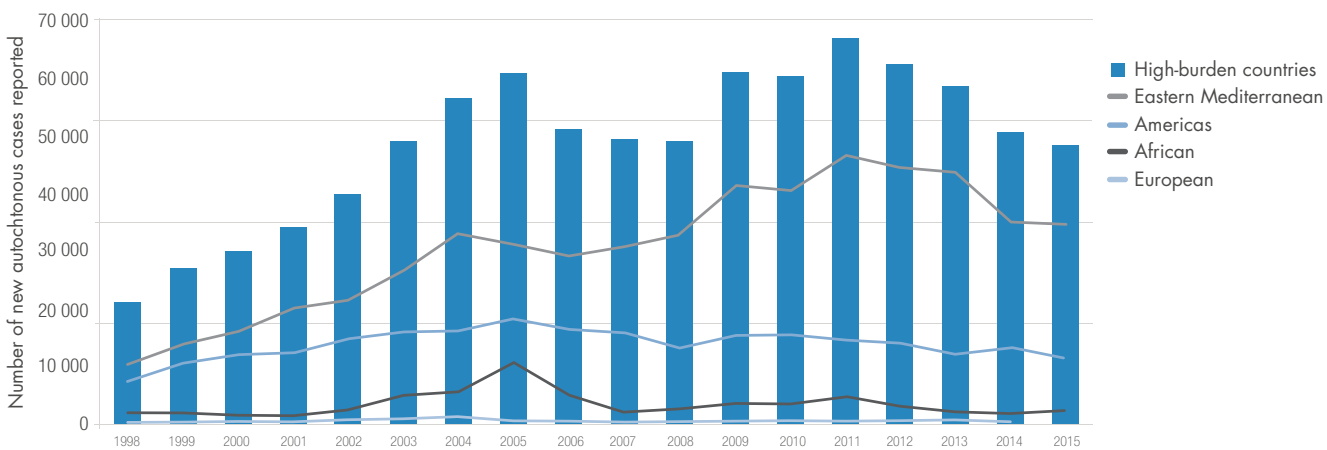


Fig. 5.22. Number of visceral leishmaniasis (kala-azar) cases, WHO South-East Asia Region, 1998–2015

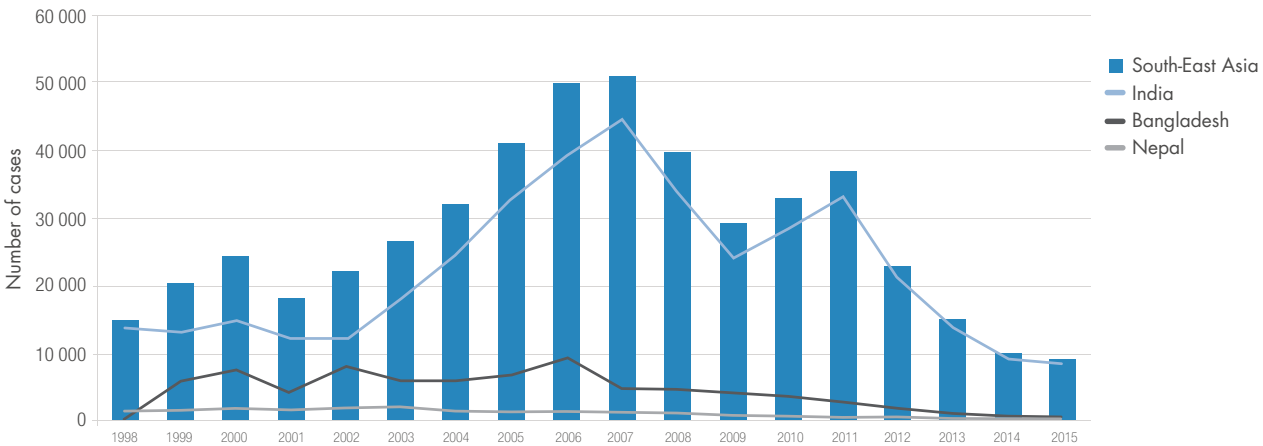
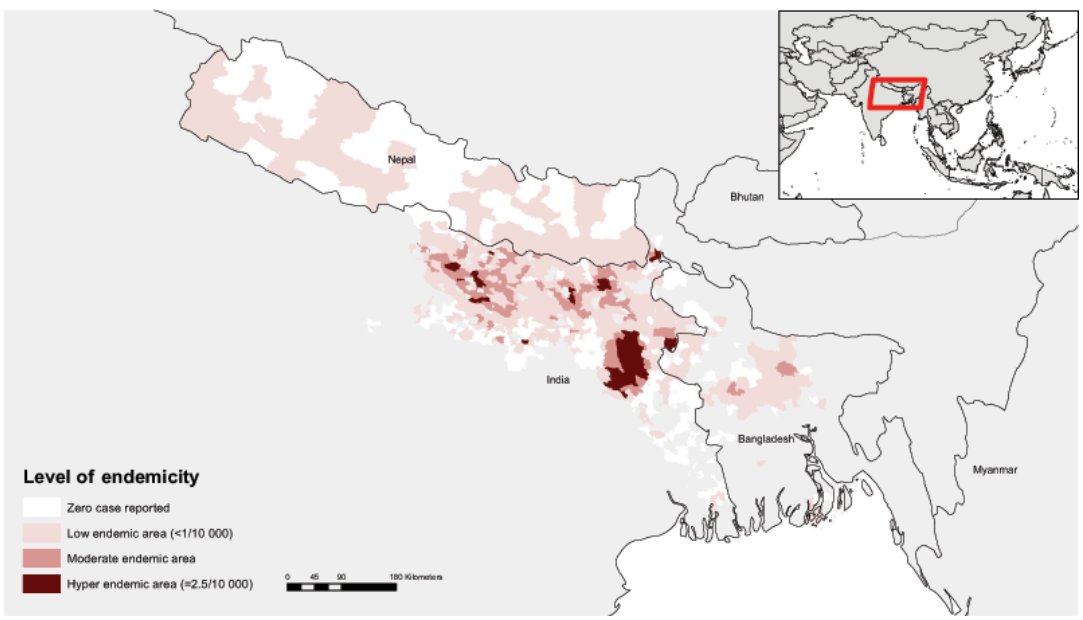


Fig. 5.23. Incidence of visceral leishmaniasis at the district level (Nepal) and subdistrict level (Bangladesh and India), 2015



In 2014, India adopted single-dose liposomal amphotericin B as the first-line treatment, which has advanced the elimination of visceral disease. In 2015, around 66% of the total numbers of reported cases were treated with this medicine. Bangladesh and Nepal have also adopted single-dose liposomal amphotericin B as first-line treatment. To sustain the progress made in eliminating visceral leishmaniasis on the Indian subcontinent, WHO has signed a new 5-year (2016–2021) agreement (*3*) to secure medicines and resources to implement activities at regional and country levels. The signing of a Memorandum of Understanding by the health ministers from Bangladesh, Bhutan, India, Nepal and Thailand reflects their continued commitment to achieving the ambitious 2020 target (*4*).

The Roadmap target for control of cutaneous leishmaniasis is to have detected at least 70% of all cases and treated at least 90% of all detected cases in the Eastern Mediterranean Region by 2015. Progress towards meeting these targets is unclear, mainly because of the monitoring challenges they present. Monitoring the first target requires large-scale field surveys in each country to evaluate the level of underreporting. At present none of the endemic countries has the resources or the support from donors to conduct such assessments. Similarly, monitoring the second target would require analysis of clinical records in health facilities and active survey reports to quantify the proportion of patients that did not benefit from treatment despite having been diagnosed with the disease.

In order to improve the standardization of case management and surveillance of cutaneous leishmaniasis in the Eastern Mediterranean Region, in 2015 and 2016 WHO provided three opportunities to take an online interactive course in collaboration with the Catalan Open University. Some 47 students from Afghanistan, Algeria, Chad, Morocco, the Syrian Arab Republic, Tunisia and Yemen participated. To facilitate the collection and analysis of data from health facilities in countries where the disease is endemic, WHO has prepared a set of standardized electronic data collection forms that will automate both the transfer of data from the peripheral level to the central level as well as the analysis of data. WHO is in liaison with endemic countries to conduct a series of on-the-job trainings to implement the electronic system, where feasible.

2020 and beyond

Given the epidemiological and political momentum that the programmes to eliminate visceral leishmaniasis in South-East Asia have achieved, an opportunity exists for countries to upgrade their target from elimination of the disease as a public health problem (less than 1 case per 10 000 population) to elimination of transmission (that is, reducing to zero the incidence of infection caused by the parasite). A major impediment to achieving this target is that many people living in endemic areas are infected but do not present symptoms. Indeed, some field studies have shown that the ratio of asymptomatic *L. donovani* infection to cases of visceral leishmaniasis can range from 4:1 to 10:1 (*5*). The WHO control strategy does not advise treatment of healthy (asymptomatic) carriers, and the potential infectiousness of humans with asymptomatic *L. donovani* infection thus has unknown implications for control (*6*).

Going forward, an appropriate and effective vector-control strategy is needed in response to the various epidemiological elements and uncertainties in order to make it technically feasible to interrupt human-to-human transmission from the bites of infective sandflies. Unfortunately, the control of *Phlebotomus argentipes* is proving highly challenging under field conditions. The effect of indoor residual spraying on transmission in Bangladesh, India and Nepal is unclear. On the Indian subcontinent, spraying has been shown to be effective in reducing densities of sandflies when conducted under strict supervision. However, spraying has not achieved optimal results in national control programmes implemented on the subcontinent, as confirmed by a study conducted in 2015 (*7*,*8*). Although elimination of transmission appears to be the most feasible target to be achieved after 2020, countries will face formidable challenges in obtaining adequate levels of human and financial resources once an incidence of less than 1 case per 10 000 population has been reached.

In East Africa, which has the second largest area endemic for visceral leishmaniasis in the world according to the number of cases reported in 2015, control efforts continue to face challenges. The unstable social context, which includes several armed conflicts, high levels of malnutrition, large population movements between non-endemic and endemic areas and the inaccessibility of key areas during the rainy season, is a significant obstacle to progress. At the same time inadequate or absent vector-control programmes are having to confront the fact that up to four different sandfly species have been identified as vectors, and animal reservoirs may have a role in maintaining the transmission cycle (*9*,*10*). All of these factors preclude the possibility of eliminating the disease in East Africa for now.

The difficulties in assessing progress towards the targets for control of cutaneous leishmaniasis in the Eastern Mediterranean Region suggest that consideration should be given to setting new targets that could be in principle easier to measure. Indicators worthy of consideration include the amount of time elapsed between the onset of symptoms and the diagnosis, the size of the lesion at the time of the diagnosis, or treatment outcome, and these would also provide information on the performance of the control programmes. Such indicators would be valid for all endemic regions worldwide and baseline values could be established for each country or sub-region in order to measure progress.

Finally, it is crucial to ensure that all patients in whom leishmaniasis has been diagnosed have access to treatment. A number of countries, including Afghanistan and Pakistan, lack the mechanisms required to procure the necessary antileishmanial medicines, and major donors, including pharmaceutical companies, have shown little interest in offering their support.

References

1. Leishmaniasis in high-burden countries: an epidemiological update based on data reported in 2014. Wkly Epidemiol Rec. 2016;91:287–96 (http://www.who.int/wer/2016/wer9122.pdf).
2. Leishmaniasis: situation and trends. In: WHO, Global Health Observatory Data [online database]. Geneva: World Health Organization; 2016 (http://www.who.int/gho/neglected_diseases/leishmaniasis/en/, accessed 9 March 2017). (Data for China, Pakistan, Saudi Arabia, Spain, Turkey and Uganda not available as of 22 November 2016.)
3. WHO and Gilead Sciences extend collaboration against visceral leishmaniasis. Geneva: World Health Organization; 2016 (http://www.who.int/neglected_diseases/news/WHO_and_Gilead_Sciences_extend_collaboration/en/, accessed 9 March 2017).
4. Health ministers commit to eliminating kala-azar. Dhaka: WHO Regional Office for South-East Asia; 2014 (http://www.searo.who.int/mediacentre/releases/2014/pr1581/en/, accessed 9 March 2017).
5. Elimination of kala-azar: report of the fourth meeting of the Regional Technical Advisory Group, Kathmandu, Nepal, 12–14 July 2011. New Delhi: WHO Regional Office for South-East Asia; 2012 (http://apps.searo.who.int/pds_docs/B4811.pdf).
6. Control of the leishmaniases: report of a meeting of the WHO Expert Committee on the Control of Leishmaniases, Geneva, 22–26 March 2010. Geneva: World Health Organization; 2010 (WHO Technical Report Series, No. 949; http://apps.who.int/iris/bitstream/10665/44412/1/WHO_TRS_949_eng.pdf).
7. Chowdhury R, Kumar V, Mondal D, Das ML, Das P, Dash AP et al. Implication of vector characteristics of *Phlebotomus argentipes* in the kala-azar elimination programme in the Indian sub-continent. Pathog Glob Health. 2016;110:87–96. doi:10.1080/20477724.2016.1180775.
8. Coleman M, Foster GM, Deb R, Pratap Singh R, Ismail HM, Shivam P et al. DDT-based indoor residual spraying suboptimal for visceral leishmaniasis elimination in India. Proc Natl Acad Sci USA. 2015;112:8573–8. doi:10.1073/pnas.1507782112.
9. Gadisa E, Tsegaw T, Abera A, Elnaiem DE, den Boer M, Aseffa A et al. Eco-epidemiology of visceral leishmaniasis in Ethiopia. Parasit Vectors. 2015;8:381. doi:10.1186/s13071-015-0987-y.
10. Kassahun A, Sadlova J, Dvorak V, Kostalova T, Rohousova I, Frynta D et al. Detection of *Leishmania donovani* and *L. tropica* in Ethiopian wild rodents. Acta Trop. 2015;145:39–44. doi:10.1016/j.actatropica.2015.02.006. doi.org/10.1371/journal.pntd.0001859.

5.10 Leprosy

Leprosy is a communicable disease caused by infection with *Mycobacterium leprae*. The course and manifestations of the disease depend on the response of the immune system to the infection. *M. leprae* multiplies slowly: the incubation period is about 5 years, and symptoms can take as long as 20 years to appear. The disease mainly affects the skin, the peripheral nerves, the mucosa of the upper respiratory tract and the eyes. Although not highly infectious, the infection is transmitted via droplets from the nose and mouth during close and frequent contacts with untreated cases.

Untreated leprosy can cause progressive and permanent damage to the skin, nerves, limbs and eyes. However, the disease is curable and treatment provided in the early stages averts disability. Thus, early detection of cases and prompt treatment with multidrug therapy for 6–12 months are the key strategies used to stop transmission to healthy individuals. Since 1983, multidrug therapy has been made available free of charge, through WHO, by The Nippon Foundation (1995–2000) and Novartis (since 2000).

Burden

Elimination of leprosy as a public health problem (defined as the number of cases on treatment less than 1 per 10 000 population) was achieved globally in 2000 and at national level in most countries by 2005 (*1*). However, pockets of high endemicity remain in several countries, including in low-burden countries. Some countries or areas have very high case-detection rates, intense transmission and a related high proportion of paediatric cases.

By the end of 2015, 136 countries and territories (in all six regions) had submitted reports on leprosy to WHO (*2*). Data were reported from 28 countries in the African Region, 23 countries in the Region of the Americas, 11 countries in the South-East Asia Region, 20 countries in the Eastern Mediterranean Region, 26 countries in the Western Pacific Region and 28 countries in the European Region. Mid-year population estimates for 2015 were derived from data published by the United Nations Department of Economic and Social Affairs/Population Division.

The general trend is of a steady decline. A total of 210 758 new cases (reported by 136 countries) was detected in 2015 (**Table 5.8**). Globally, a total of 174 608 cases were receiving treatment at the beginning of 2016. **Table 5.9** shows that during

2014–2015 the number of new cases slightly increased in the African Region from 18 597 to 20 004, and in the South-East Asia Region from 154 834 to 156 118. In other regions there was a continuing decrease. The increase in the African and South-East Asia regions may be partly explained by the active case-detection campaigns that have taken place in several Member countries.

Three countries account for more than 80% of the global leprosy burden, namely Brazil, India and Indonesia. In 2016 the WHO Global Leprosy Programme developed a list of 22 priority countries using a composite indicator and taking into account the absolute number of cases, the new case-detection rate and the proportions of paediatric cases and cases with grade-2 disabilities among new cases.

Table 5.10 shows the trends in the numbers of new leprosy cases reported with grade-2 disabilities and the rates per million population during 2007–2015. In 2015, the global rate was 2.5. Also in 2015, a total of 14 059 new cases with grade-2 disabilities were detected, a slight reduction compared with 2014. In 2015, the rate of grade-2 disability ranged from 0.2 (Western Pacific Region) to 4.4 (South-East Asia Region) (Table 5.11).

Relapse cases of leprosy may indicate treatment failure. In 2015, a total of 103 countries reported on relapses in leprosy, of which 46 countries (45%) reported 3039 relapses. Leprosy programmes are encouraged to study each relapse case in order to understand the adequacy of treatment prescribed, adherence to treatment regimens and general health factors that could have provoked treatment failure. Such studies can sometimes also confirm reinfection.

Table 5.8. Registered prevalence of leprosy and number of new cases detected, by WHO region, 2015

WHO region	Registered prevalence at end of 2015	Rate/ 10 000 population	New cases detected during 2015	Rate/ 100 000 population
African	20 564	0.2	20 004	2.1
Americas	27 955	0.3	28 806	2.9
Eastern Mediterranean	2865	0.0	2167	0.3
European			18	0.0
South-East Asia	117 451	0.6	156118	8.1
Western Pacific	5773	0.0	3645	0.2
Total	**174 608**	**0.2**	**210 758**	**2.9**

Source: reference *2*

Progress towards Roadmap targets

In 2016, WHO launched the *Global leprosy strategy 2016–2020: accelerating towards a leprosy-free world* (*1*), which was developed through consultation with national programmes, partner organizations, donor agencies and people affected by the disease. The strategy is built on three pillars:

- strengthening government ownership and partnerships;
- stopping leprosy and its complications; and
- stopping discrimination and promote inclusion.

The targets of the global strategy for 2020 are to achieve: (i) zero disabilities among new paediatric patients, (ii) a grade-2 disability rate of less than 1 case per 1 million people; and (iii) zero countries with legislation allowing discrimination against people with leprosy.

Many endemic countries have already adapted this strategy to their national contexts. Implementation of the strategy is guided by an operational manual (*3*) and a monitoring guide. The manual describes for each of the three pillars how to implement core activities in settings with high or low burdens of leprosy for each specific intervention in the strategy; examples of good practice are included for most interventions. Most proposed interventions are illustrated with examples of good practices from different countries.

Table 5.9. Number of new cases of leprosy detected, by WHO region, 2006–2015

WHO region	Number of new cases detected									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
African	34 480	34 468	29 814	28 935	25 345	20 213	20 599	20 911	18 597	20 004
Americas	47 612	42 135	41 891	40 474	37 740	36 832	36 178	33 084	33 789	28 806
Eastern Mediterranean	3 261	4 091	3 938	4 029	4 080	4 357	4 235	1 680	2 342	2 167
South-East Asia	174 118	171 576	167 505	166 115	156 254	160 132	166 445	155 385	154 834	156 118
Western Pacific	6 190	5 863	5 859	5 243	5 055	5 092	5 400	4 596	4 337	3 645
European										18
Total	**265 661**	**258 133**	**249 007**	**244 796**	**228 474**	**226 626**	**232 857**	**215 656**	**213 899**	**210 758**

Source: reference *2*

Table 5.10. Numbers of new leprosy cases detected in countries reporting more than 1000 new cases in 2015

Country	Number of new cases detected									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bangladesh	6 280	5 357	5 249	5 239	3 848	3 970	3 688	3 141	3 622	3 976
Brazil	44 436	39 125	38 914	37 610	34 894	33 955	33 303	31 044	31 064	26 395
Democratic Republic of the Congo	8 257	8 820	6 114	5 062	5 049	3 949	3 607	3 744	3 272	4 237
Ethiopia	4 092	4 187	4 170	4 417	4 430	NR	3 776	4 374	3 758	3 970
India	139 252	137 685	134 184	133 717	126 800	127 295	134 752	126 913	125 785	127 326
Indonesia	17 682	17 723	17 441	17 260	17 012	20 023	18 994	16 856	17 025	17 202
Madagascar	1 536	1 644	1 763	1 572	1 520	1 577	1 474	1 569	1 617	1 487
Mozambique	3 637	2 510	1 313	1 191	1 207	1 097	758	NR	NR	1 335
Myanmar	3 721	3 637	3 365	3 147	2 936	3 082	3 013	2 950	2 877	2 571
Nepal	4 235	4 436	4 708	4 394	3 118	3 184	3 492	3 225	3 046	2 751
Nigeria	3 544	4 665	4 899	4 219	3 913	3 623	3 805	3 385	2 983	2 892
Philippines	2 517	2 514	2 373	1 795	2 041	1 818	2 150	1 729	1 655	1 617
Sri Lanka	1 993	2 024	1 979	1 875	2 027	2 178	2 191	1 990	2 157	1 977
United Republic of Tanzania	3 450	3 105	3 276	2 654	2 349	2 288	2 528	2 005	1 947	2 256
Total (%)	244 632	237 432	229 748	224 152	211 144	208 039	217 531	202 925	200 808	199 992
	92%	92%	92%	92%	92%	92%	93%	94%	94%	95%
Global total	265 661	258 133	249 007	244 796	228 474	226 626	232 857	215 656	213 899	210 758

Table 5.11. Number of cases of leprosy (rate/1 000 000 population) with grade-2 disabilities detected among new cases, by WHO region, 2006–2015

WHO region	Year									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
African	3 244 (4.6)	3 570 (5.1)	3 458 (5.1)	3 146 (4.1)	2 685 (4.0)	2 300 (2.6)	2 709 (4.0)	2 552 (4.3)	2 726 (3.6)	2 887 (4.1)
Americas	2 302 (2.7)	3 431 (4.2)	2 512 (2.9)	2 645 (3.0)	2 423 (2.7)	2 382 (2.7)	2 420 (2.8)	2 168 (2.5)	2 222 (2.5)	1 973 (3.5)
Eastern Mediterranean	384 (0.8)	466 (1.0)	687 (1.4)	608 (1.1)	729 (1.2)	753 (1.2)	700 (1.2)	191 (0.5)	300 (0.5)	315 (0.5)
South-East Asia	5 791 (3.5)	6 332 (3.7)	6 891 (3.9)	7 286 (4.1)	6 912 (3.9)	7 095 (3.9)	8 012 (4.3)	7 964 (4.3)	8 525 (4.5)	8 572 (4.4)
Western Pacific	671 (0.4)	604 (0.3)	592 (0.3)	635 (0.4)	526 (0.3)	549 (0.3)	568 (0.3)	386 (0.2)	337 (0.2)	312 (0.2)
Total	12 392 (0.2)	14 403 (2.6)	14 140 (2.5)	14 320 (2.5)	13 275 (2.3)	13 079 (2.2)	14 409 (2.5)	13 289 (2.3)	14 110 (2.5)	14 059 (2.5)

Source: reference *2*

Sustained and committed efforts by national programmes and continued support from national and international partners have led to a declining global burden of leprosy. However, the decline has been less steep (about 4% per year) during the past 10 years (2007–2016) than previously. Empowering persons affected by leprosy and their communities and increasing their involvement in services will bring us closer to a leprosy-free world. In order to reach all patients, treatment must be optimally integrated into general health services. Moreover, political commitment must be sustained in all countries even after achieving elimination as a public health problem at the national level. Governments and partners also need to ensure that adequate human and financial resources continue to be made available.

The age-old stigmatization of the disease is unacceptable and efforts must be extended to implement the Guidelines on eliminating discrimination against people affected by leprosy and their families (*4*,*5*). Without the needed commitment and actions to ensure implementation of these efforts and the other activities tackling the social and psychological aspects of the disease, accelerating towards a leprosy-free world will remain challenging because stigmatization and discrimination are significant obstacles to self-reporting and early treatment. The image of leprosy must be changed at global, national and local levels. A new environment in which patients do not hesitate to come forward for diagnosis and treatment at any health facility must be created to ensure that discrimination is ended and true inclusion promoted.

References

1. Global leprosy strategy 2016–2020: accelerating towards a leprosy-free world. New Delhi: WHO Regional Office for South-East Asia; 2016 (http://apps.who.int/iris/bitstream/10665/208824/1/9789290225096_Eng.pdf); available in English, French, Spanish and Portuguese.
2. Global leprosy update, 2015: time for action, accountability and inclusion. Wkly Epidemiol Rec. 2016;91:405–20 (http://apps.who.int/iris/bitstream/10665/249601/1/WER9135.pdf).
3. Global leprosy strategy 2016–2020 operational manual. New Delhi: WHO Regional Office for South-East Asia; 2016 (http://apps.who.int/iris/bitstream/10665/250119/5/9789290225256-Eng.pdf); available in English, French, Spanish and Portuguese.
4. Resolution 29/5. Elimination of discrimination against persons affected by leprosy and their family members. In: Twenty-ninth session of the Human Rights Council, 15 June–3 July 2015. New York: United Nations, Office of the High Commissioner for Human Rights; 2015 (https://documents-dds-ny.un.org/doc/UNDOC/LTD/G15/138/38/PDF/G1513838.pdf?OpenElement).
5. Resolution 65/215. Elimination of discrimination against persons affected by leprosy and their family members. In: Sixty-fifth session, United Nations General Assembly, 21 December 2010. New York: United Nations; 2010 (http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/65/215).

5.11 Lymphatic filariasis

Lymphatic filariasis is caused by infection with the parasites *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori*, which are classified as nematodes (roundworms) of the family Filariodidea. *W. bancrofti*, the most widespread of the three species, is responsible for more than 90% of cases. Multiple species of mosquitoes can transmit these parasites from person to person including *Aedes*, *Anopheles*, *Culex* and *Mansonia*. Adult worms lodge in the lymphatic vessels and compromise the normal function of the lymphatic system. The worms can live for an average of 6–8 years and, during their lifetime, produce millions of microfilariae (immature larvae) that circulate in the blood. Infection is usually acquired in childhood and causes hidden damage to the lymphatic system. The painful and profoundly disfiguring visible manifestations of the disease – lymphoedema, elephantiasis and scrotal swelling (hydrocele) – occur later in life and often lead to permanent disability if proper care is not provided. Those living with the disease are not only physically disabled but suffer stigmatization and serious mental, social and financial consequences.

The Global Programme to Eliminate Lymphatic Filariasis aims to stop the spread of infection and alleviate suffering among people with chronic disease. The strategies that WHO recommends to achieve these aims are large-scale annual treatment MDA of all eligible people in all areas where infection is present to stop transmission, and managing morbidity through a minimum package of care to alleviate and prevent the disabling manifestations of the disease.

MDA involves the provision of a dose of antifilarial medication every year to entire populations at risk. When conducted annually for 4–6 years the intervention can reduce the density of parasites circulating in the blood of infected persons as well as the prevalence of infection in the community to such low levels that transmission cannot be sustained and new infections eventually cease. When infection prevalence has been reduced to below these threshold levels, MDA is considered no longer required (*1*). It is estimated that at least 65% of the total population living in areas where lymphatic filariasis is endemic require coverage in order for MDA to be effective against transmission (*2*). An area becomes eligible for a transmission assessment survey (TAS) to assess whether to stop MDA once at least five rounds with at least 65% coverage have been completed and infection levels in sentinel and spot-check communities are below coverage thresholds. Administration of diethylcarbamazine-fortified salt to at-risk communities is also one of WHO's recommended strategies (*3*) but implementation challenges have meant that few countries have been able to sustain the strategy and have changed to annual MDA.

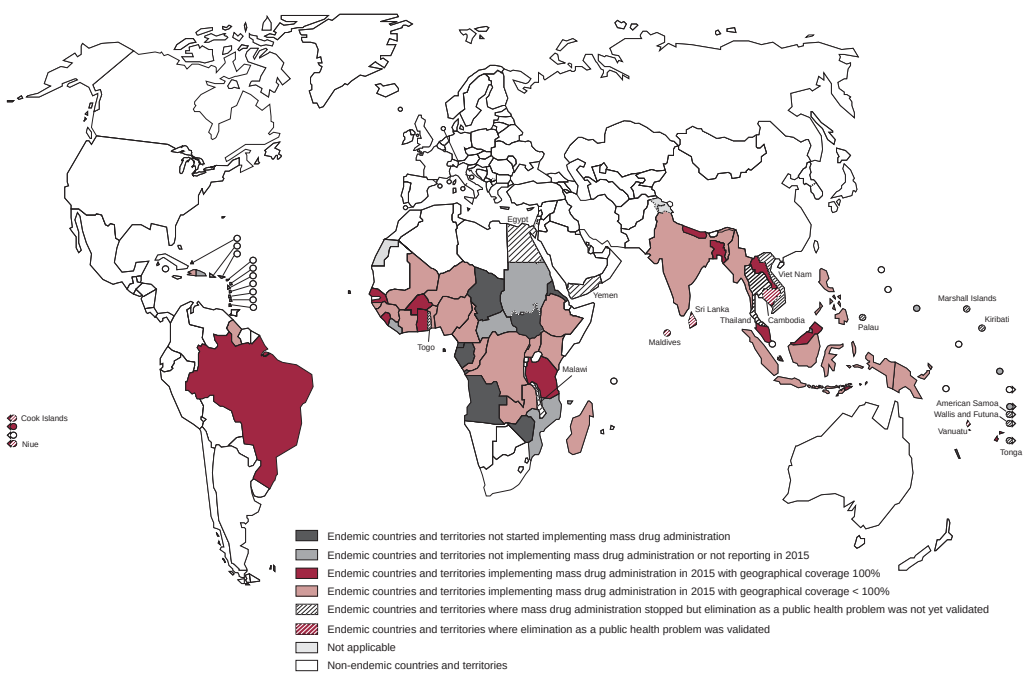
WHO recommends vector control as a complementary strategy to MDA in stopping the spread of infection (*4,5*). Before the advent of the Global Programme, transmission was likely eliminated in the Solomon Islands and the Gambia through vector control measures against malaria. Currently, WHO recommends a coordinated approach with vector borne disease control programmes to identify areas of integration in vector management (*6*). This involves identifying the major vectors responsible for transmission in each country and prioritizing relative vector control activities in endemic areas. Vector control in certain endemic settings can be advantageous during MDA and once MDA has stopped.

A package of recommended health-care services is required to manage morbidity and prevent disability in patients with lymphoedema, elephantiasis and hydrocele in order to alleviate suffering and prevent further progression of disease (*7*). Clinical severity and progression of the disease caused by repeated bouts of adenolymphangitis (acute attacks of debilitating pain, inflammation and fever) can be prevented with simple skin hygiene measures and wound care. Movement and elevation of affected limbs is recommended to improve lymph flow and control swelling. People with lymphoedema must have access to continuing care throughout their lives to prevent and treat adenolymphangitis. Surgery can remove the burden of most cases of hydrocele. The goal is to ensure these basic services are available in all areas where the disease is present.

Burden and distribution

At the start of 2015, a total of 73 countries were considered endemic and either requiring MDA or under surveillance to validate whether elimination targets have been achieved. Fig. 5.24 shows the distribution of filarial endemicity by country and the status of MDA. At the inception of the Global Programme in 2000, an estimated 120 million people were infected, of whom 40 million suffered from overt disease. A more recent estimate of the impact of MDA from 2000 to 2012 suggests that the burden has been almost halved to around 67 million people infected and as many as 36 million living with hydrocele and lymphoedema (*8*).

Fig. 5.24. Countries where lymphatic filariasis is endemic and status of mass drug administration in those countries, 2015



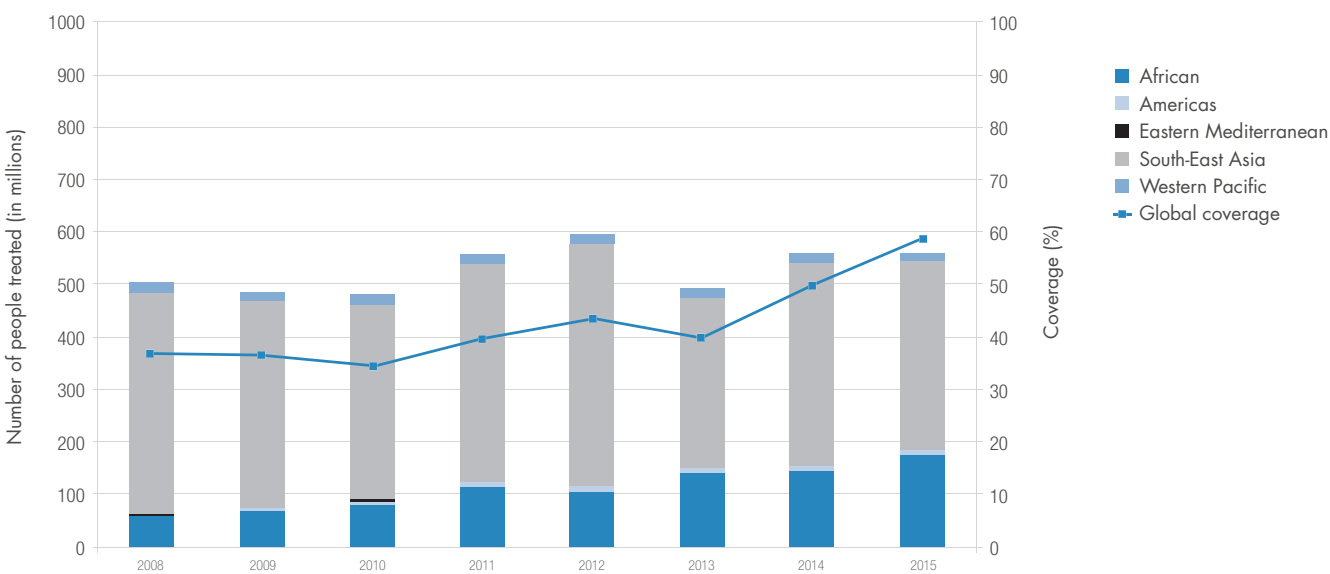
Progress towards Roadmap target

The Roadmap sets a target for global elimination of lymphatic filariasis as a public health problem by 2020. In addition to reducing its global burden, six countries (Cambodia, Cook Islands, Maldives, Niue, Sri Lanka and Vanuatu) were validated in 2016 as having achieved elimination of the disease as a public health problem according to a new standardized process to validate elimination claims (9). Including the six validated countries, 18 countries have discontinued MDA programmes and transitioned to post-elimination surveillance. MDA is still required in at least one implementation unit in 54 countries.

Some 25 countries have implemented at least one round of MDA in all endemic implementation units. If effective coverage can be achieved during consecutive rounds of MDA, these countries may be able to stop MDA by 2020. Another 20 countries are implementing MDA but they have not yet reached all endemic implementation units. MDA has not yet been reported in 10 countries, of which one was determined recently not to require MDA and epidemiological data are needed from three countries to confirm whether MDA is required.

The total cumulative number of treatments delivered in 63 countries implementing MDA now exceeds 6.2 billion, an unprecedented expansion of any NTD intervention to date. In 2015, national programmes aimed to deliver MDA to a population of 698 million, and 558 million people were treated to achieve a coverage of 59%. This represents the highest global coverage of MDA ever achieved. The number of people treated in the Global Programme by year and region are shown in Fig. 5.25. The progress in implementing MDA and confirming elimination sets the precedent for the work remaining.

Fig. 5.25. Number of people treated by, and coverage of, mass drug administration in the Global Programme to Eliminate Lymphatic Filariasis, by WHO region, 2008–2015

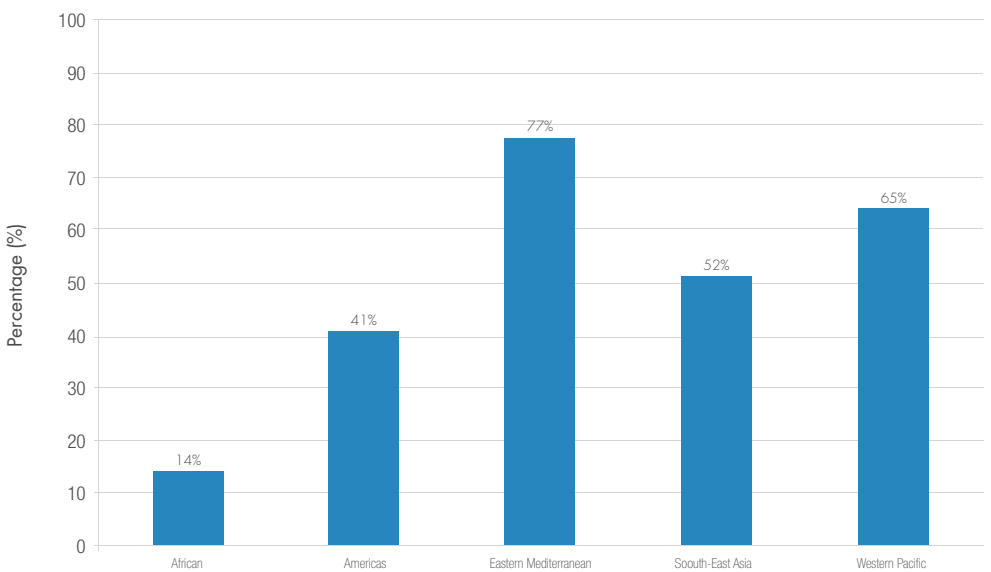


Reducing infection and discontinuing mass drug administration

Two criteria must be met before stopping MDA, namely: (i) prevalence of infection reduced to below 1% microfilaraemia or 2% antigenaemia in sentinel and spot-check communities considered at high risk; and (ii) TAS passed. The TAS is implemented to decide whether to stop MDA (TAS1) and confirm whether infection has been sustained below elimination thresholds after MDA (TAS2 and TAS3). The efficacy of MDA in stopping the spread of infection is evidenced by the continued progress of countries in implementing TAS1 successfully before stopping MDA. As of 2015, 32% of endemic implementation units (1250/3903) have implemented and passed TAS1. Fig. 5.26 shows the proportion of known endemic implementation units by regional programme that have completed TAS1 and no longer require MDA. Based on TAS implementations and additional surveys it is estimated that the total number of people now requiring MDA for lymphatic filariasis has dropped from 1.4 to 946 million.

Table 5.12 lists for each WHO region the cumulative number of countries that are expected to stop MDA by 2020, under the current trajectory of MDA implementation. It assumes that national programmes in 25 countries that have already implemented MDA in all endemic districts will sustain effective coverage in remaining rounds and observe successful results in the WHO-recommended pre-TAS and TAS evaluations. The three countries in which the need for MDA is uncertain are assumed to have established data indicating that the disease is no longer endemic. This optimistic scenario suggests that 45 endemic countries may be able to stop MDA nationally by 2020. What this country-

Fig. 5.26. Proportion of known endemic implementation units having completed TAS1 and no longer requiring mass drug administration, by programmes in WHO regions Percentage of all known endemic implementation units in countries by WHO region that have completed TAS1 or previously stopped MDA surveys and reported meeting the criterion for stopping MDA. Implementation units where endemicity is unknown have not been included



level analysis masks is the successful reduction of infection below elimination thresholds through MDA in most sub-national implementation units. Perhaps a better reflection of the progress is in the potential to demonstrate an 80% reduction (from 1.4 billion) in people requiring MDA by 2020.

Morbidity management

Lymphatic filariasis is one of the leading causes of global disability, accounting for 2 070 848 million DALYs (*10*). This excludes the significant co-morbidity of mental illness often experienced by patients and their caregivers (*11*). Provision of services will decrease morbidity and help to reduce and prevent disability. The minimum package of care recommended by WHO to alleviate suffering among those with lymphoedema and hydrocele includes: management of lymphoedema to prevent acute attacks; treatment for acute attacks; management of hydrocele including surgery; and individual treatment for persons with filarial infection. Countries claiming to have achieved elimination as a public health problem should document the number of people with lymphoedema and hydrocele at the level of the implementation unit; the number of facilities providing the minimum package of care at the implementation unit level; and the quality of available care and readiness of facilities to provide care once MDA stops.

As many countries begin to meet the targets for stopping the spread of infection, regional programme review groups have renewed emphasis on managing morbidity and preventing disability. The indicators cited above are now included in the annual

Table 5.12. Cumulative number of countries projected to stop mass drug administration for lymphatic filariasis nationally, by year 2015–2020 based on current progress

WHO region	LF endemic countries	2015	2016	2017	2018	2019	2020	Projected MDA success rate (%)
African	34[a]	2	2	4	7	9	12	35
Americas	4	0	1	1	2	3	3	75
Eastern Mediterranean	3	2	2	2	2	2	2	67
South-East Asia	9	3	4	4	5	6	7	78
Western Pacific	22	11	16	19	19	20	21	91
Total	**72**	**18**	**25**	**30**	**35**	**40**	**45**	**62**

a. Gambia considered not requiring mass drug administration (MDA).

Epidemiological Data Reporting Form of the Joint Application Package to allow national programmes to report progress towards achieving 100% geographical coverage of the minimum package of care. In 2015 the number of countries for which some morbidity management and disability prevention data have been reported increased from 30 to 41. In addition to the six countries achieving the status of elimination as a public health problem, at least a further five are documenting the availability of the minimum package of care for patients as they prepare the dossier for submission.

References

1. Monitoring and epidemiological assessment of mass drug administration in the global programme to eliminate lymphatic filariasis: a manual for national elimination programmes. Geneva: World Health Organization; 2011 (WHO/HTM/NTD/PCT/2011.4; http://apps.who.int/iris/bitstream/10665/44580/1/9789241501484_eng.pdf).
2. Plaisier AP, Stolk WA, van Oortmarssen GJ, Habbema JDF. Effectiveness of annual ivermectin treatment for *Wuchereria bancrofti* infection. Parasitol Today. 2000;16:298–302. doi:10.1016/S0169-4758(00)01691-4.
3. Preparing and implementing a national plan to eliminate lymphatic filariasis (in countries where onchocerciasis is not co-endemic). Geneva: World Health Organization; 2000 (WHO/CDS/CPE/2000.15; http://apps.who.int/iris/bitstream/10665/66702/1/WHO_CDS_CPE_CEE_2000.15.pdf).
4. Provisional strategy for interrupting lymphatic filariasis transmission in loiasis-endemic countries: report of the meeting on lymphatic filariasis, malaria and integrated vector management. Geneva: World Health Organization; 2012 (WHO/HTM/NTD/PCT/2012.6; http://apps.who.int/iris/bitstream/10665/75139/3/WHO_HTM_NTD_PCT_2012.6_eng.pdf).
5. Lymphatic filariasis: a handbook of practical entomology for national lymphatic filariasis elimination programmes. Geneva: World Health Organization; 2013 (WHO/HTM/NTD/PCT/2013.10; http://apps.who.int/iris/bitstream/10665/87989/1/9789241505642_eng.pdf).
6. Integrated vector management to control malaria and lymphatic filariasis: WHO position statement. Geneva: World Health Organization; 2011 (WHO/HTM/NTD/PCT/2011.2; http://apps.who.int/iris/bitstream/10665/70817/1/WHO_HTM_NTD_2011.2_eng.pdf).
7. Managing morbidity and preventing disability in the global programme to eliminate lymphatic filariasis: WHO position statement. Geneva: World Health Organization; 2011 (WHO/HTM/NTD/PCT/2011.8; http://apps.who.int/iris/bitstream/10665/70818/1/WHO_HTM_NTD_2011.8_eng.pdf).
8. Ramaiah KD, Ottesen EA. Progress and impact of 13 years of the global programme to eliminate lymphatic filariasis on reducing the burden of filarial disease. PLoS Negl Trop Dis. 2014;8:e3319. doi:10.1371/journal.pntd.0003319.
9. Validation of elimination of lymphatic filariasis as a public health problem. Geneva: World Health Organization; 2017 (WHO/HTM/NTD/PCT/2017.01; http://apps.who.int/iris/bitstream/10665/254377/1/9789241511957-eng.pdf).
10. Global Health Estimates. In: World Health Organization, Health Statistics and Information systems [website]. Geneva: World Health Organization; 2017 (www.who.int/evidence/bod, accessed 19 March 2017).
11. Ton TG, Mackenzie C, Molyneux DH. The burden of mental health in lymphatic filariasis. Infect Dis Poverty. 2015;4:34. doi:10.1186/s40249-015-0068-7.

5.12 Mycetoma

Mycetoma is a chronic, destructive inflammatory disease of the skin, subcutaneous and connective tissue, muscles and bone. It is caused by a large variety of microorganisms that are either bacteria or fungi. Infections with bacteria such as *Actinomadura madurae*, *Streptomyces somaliensis* and *Nocardia brasiliensis* cause actinomycetoma, and those with fungi such as *Madurella mycetomatis*, are responsible for eumycetoma (*1*). Although aetiologically distinct, bacterial and fungal infections produce an almost identical clinical presentation. Proportions may vary by country, but overall actinomycetoma is more frequent than eumycetoma (*2*). First described in Sanskrit texts dating back to 1000 years BCE, mycetoma was first reported in the medical literature in 1694 and is commonly known as "Madura foot" after the description of a case reported in the mid-19th century in the Indian town of Madurae.

In May 2016 the Sixty-ninth World Health Assembly adopted resolution WHA69.21 on mycetoma, recognizing it as a neglected tropical disease. This is expected to intensify global efforts to advocate for its improved surveillance and control and for all actors to join forces to control the impact on public health of the disease. The resolution encourages Member States to accelerate efforts for early detection and treatment of cases and requests wider support to national health authorities to move forward with four key areas: epidemiology, health education, access to adequate diagnostic and medical treatment, and capacity building.

Mycetoma occurs in tropical and subtropical environments characterized by short rainy seasons and prolonged dry seasons that favour the growth of thorny bushes. Cases of the disease in this "belt", which stretches between the latitudes of 15° south and 30° north of the equator, and involves central and southern America (Mexico and the Bolivarian Republic of Venezuela), Africa (countries of the Sahel subregion from Senegal in the west to Sudan and Somalia in the east), the Middle East (Saudi Arabia and Yemen) and southern Asia (India) (3). There is currently a lack of accurate data on mycetoma's incidence, prevalence and distribution. A systematic review and meta-analysis carried out in 2013 reported a total of 8763 cases from 50 literature studies published since 1956 (**Fig. 5.27**). Most (75%) cases were reported from three countries: Mexico (2607), Sudan (2555) and India (1392) (*4*). However, more than 7600 mycetoma patients have been registered in Sudan at the national Mycetoma Research Center at the University of Khartoum, a WHO Collaborating Centre, since its establishment in 1991. In 2004, epidemiological investigations conducted in Sudan revealed that village-level prevalence of mycetoma can be as high 14.5 cases per 1000 inhabitants (*5*).

Infection is thought to be acquired by traumatic inoculation of microorganisms into the subcutaneous tissue following minor trauma, such as that caused by thorn pricks. Infection is not directly transmitted from person to person and no animal reservoir has been shown to be involved in transmission. The agents of mycetoma are commonly found on plants and in the soil, and it can be assumed that only a fraction of individuals exposed to them develop mycetoma. It is still unclear what factors predispose individuals to infection.

Young adults, particularly men aged between 20 and 40 years, are most affected. Mycetoma is characterized by a triad of painless subcutaneous masses, multiple sinuses and discharge containing visible, coloured grains (made of a hard cement substance within which microorganisms are embedded).

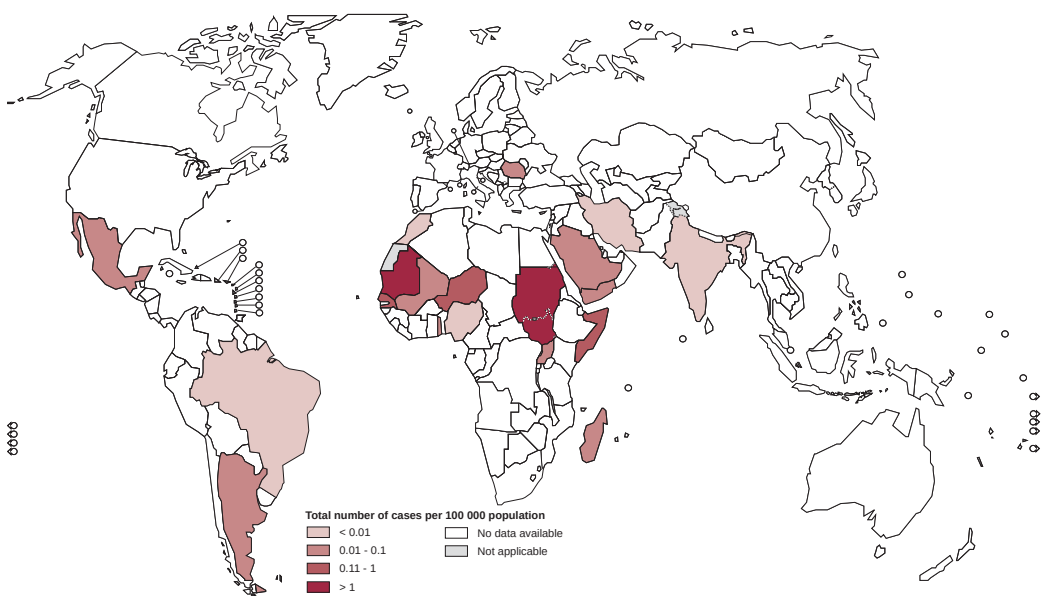
The disease usually affects the foot, but other parts of the body such as the legs, back, hands, head and neck may also be involved. Mycetoma usually spreads contiguously to involve the skin, deep structures and bone but can also spread to more distant sites through the blood and lymph. If left untreated, the disease leads to destruction, deformity and loss of function, which may be fatal. Secondary bacterial infection is common, and lesions may then cause pain, disability and, if untreated, fatal septicaemia.

The incubation period is not well established. Given its slow progression, painless nature, lack of information about the disease and its causes, and scarcity of medical and health facilities in the areas where it occurs, many patients present late with advanced disease, when amputation may be the only available treatment option, albeit symptomatic and not curative.

The causative organisms of mycetoma can be detected by examining either the discharge from sinuses or surgical tissue biopsies. Visual examination and microscopy are helpful in orienting the diagnosis as they enable the characteristic grains to be detected. The grains can then be cultured or examined by histopathology in order to identify the causative organism.

Other useful techniques for the diagnosis of mycetoma include serodiagnosis or DNA sequencing. Imaging techniques can help to determine the extent of the lesion. None of these techniques is commonly available in areas where the disease occurs. In fact, no field-adapted diagnostic tools exist today.

Fig. 5.27. Prevalence of mycetoma per 100 000 population, latest year available



Source: adapted from reference *4*. Permission from Wendy W. J. van de Sande

Preventing mycetoma is difficult. To date there are no public health tools that allow for effective prevention or even provision of clear messages about risk factors. Wearing footwear and appropriate clothing in at-risk areas can protect against puncture wounds.

Treatment options depend on the causative organisms. Bacterial mycetoma (actinomycetoma) requires long-term treatment with a combination of antibiotics, tailored to the type of bacteria involved. For the fungal type (eumycetoma), treatment is based on relatively ineffective and costly antifungal agents for prolonged periods, usually followed by surgical excision of the lesions.

Whereas actinomycetoma is largely amenable to early medical treatment, treatment of eumycetoma is frequently unsatisfactory, has many side-effects, is expensive and is not readily available in endemic areas. Recurrence rates are therefore high. Sequential amputations are a consequence.

Progress made towards addressing the burden of mycetoma since the adoption of resolution WHA69.21 in 2016

In 2016, WHO and partners circulated a questionnaire to the health ministries in endemic countries with a view to developing normative guidance. The aim is to gather baseline epidemiological information and current diagnostic and management practices. This information will be used in 2017 to identify current gaps and key actions in guiding the implementation of resolution WHA69.21 through a public health control strategy adapted to field conditions and to identify goals for monitoring progress (6). A framework for control of mycetoma will be finalized in a WHO meeting to be convened in 2017.

Efforts are also focusing on widening access to medicines currently being used, with a randomized clinical trial of fosravuconazole (an oral antifungal agent) compared with itraconazole (the commonly-used medicine) in patients with moderate-size eumycetoma caused by *Madurella mycetomatis*. Open access screening for new antifungal compounds is also currently being explored.

References

1. Zijlstra EE, van de Sande WW, Welsh O, Mahgoub ES, Goodfellow M, Fahal AH. Mycetoma: a unique neglected tropical disease. Lancet Infect Dis. 2016;16:100–12. doi:10.1016/S1473-3099(15)00359-X.
2. Hospenthal DR. Agents of mycetoma. In: Bennett JE, Dolin R, Blaser MJ, editors. Mandell, Douglas, and Bennett's principles and practice of infectious diseases. 8th ed. Philadelphia (PA): Saunders; 2015:388–9.
3. Mohamed HT, Fahal A, van de Sande WWJ. Mycetoma: epidemiology, treatment challenges and progress. Res Rep Trop Med. 2015;6:31–6. doi:10.2147/RRTM.S53115.
4. van de Sande WWJ. Global burden of human mycetoma: a systematic review and meta-analysis. PLoS Negl Trop Dis. 2013;7:e2550. doi:10.1371/journal.pntd.0002550.
5. Fahal A, Mahgoub ES, EL Hassan AM, Abdel-Rahman ME, Alshambaty Y, Hashim A et al. A new model for management of mycetoma in the Sudan. PLoS Negl Trop Dis. 2014;8:e3271. doi:10.1371/journal.pntd.0003271.
6. Resolution 69.21. Addressing the burden of mycetoma. In: Sixty-ninth session, World Health Assembly, 28 May 2016. Geneva: World Health Assembly; 2016 (http://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_R21-en.pdf).

5.13 Onchocerciasis

Human onchocerciasis is caused by infection with the parasitic worm *Onchocerca volvulus*. It is transmitted to humans through exposure to repeated bites of infected blackflies of the genus *Simulium* that breed in fast-flowing rivers and streams, hence the disease's common name "river blindness". The adult worms produce larvae (microfilariae) that migrate to the skin, eyes and other organs. Over time the inflammatory response to dying microfilariae can cause severe itching, disfiguring skin disease and visual loss or blindness. When a female blackfly bites an infected person during a blood meal, it also ingests microfilariae which develop further in the blackfly and are then transmitted to the next human host during subsequent bites. Preventive chemotherapy with ivermectin is the core strategy to eliminate the disease.

Burden and distribution

More than 99% of the at least 26 million people infected with *O. volvulus* live in 31 sub-Saharan African countries (Angola, Benin, Burkina Faso, Burundi, Cameroon, the Central African Republic, Chad, Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Equatorial Guinea, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Sierra Leone, Senegal, Sudan, South Sudan, Togo, Uganda and the United Republic of Tanzania), representing about 184.8 million people at risk in 2015 (*1*). Three of the 31 countries (Kenya, Niger and Rwanda) are not thought to require ivermectin treatment, but assessments are needed to confirm this. The infection also occurs in Yemen and in two out of six countries in Latin America (the Bolivarian Republic of Venezuela and Brazil) where the disease was originally endemic. Onchocerciasis contributes a total of 1 136 000 disability-adjusted life-years globally (*2*). Fig. 5.28 shows the distribution of countries where preventive chemotherapy is required and being implemented as well as the status of verification of the elimination of human onchocerciasis in 2015.

Progress towards Roadmap targets

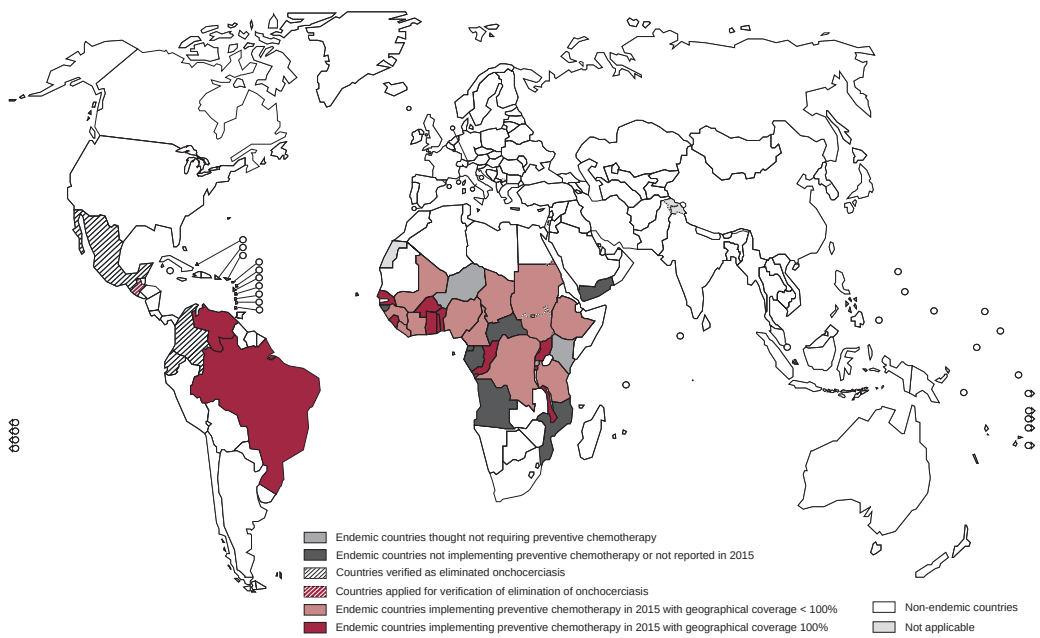
In 2015, 119 million people received ivermectin treatment, representing 64.1% coverage of those requiring it (*3*). The minimally effective coverage is 65%, although higher coverage will promote the achievement of elimination targets. The 2015 coverage figure is lower than in previous years (Fig. 5.29), partly because the total number of treatments required has increased as formerly untreated hypo-endemic areas have been added to the treatment area. Importantly, the number of treatments globally has not declined; but has increased steadily from 2008 to 2015.

The target for the WHO Region of the Americas was to achieve regional elimination by 2015. Although this target was not reached, 95% of the 556 120 people who live in endemic areas no longer require ivermectin, and a number of countries have achieved elimination. Colombia became the first country in Latin America to achieve WHO-verified elimination in 2013 (*4*), and was followed by Ecuador in 2014 (*5*) and Mexico in 2015 (*5*). Verification of the elimination of human onchocerciasis in Guatemala was announced in 2016 (*6*).

Elimination of transmission in the Yanomami area (*6*), which is believed to be the only area with ongoing transmission in the Region of the Americas, will be challenging because this remote area straddles the border between Brazil and the Bolivarian Republic of Venezuela and its population is highly mobile. However, the national onchocerciasis programmes of both countries are committed to elimination. Health ministers from Brazil and the Bolivarian Republic of Venezuela signed a bilateral agreement in 2014 aimed at enhancing coordinated cross-border health interventions required to interrupt transmission, which will include administration of 2–4 ivermectin treatments per year.

In the WHO African Region, the target for the African Programme for Onchocerciasis Control (APOC) was to achieve elimination where feasible by 2025. Although national interruption of transmission has not been recorded in any country in this region to date, mass distribution of ivermectin has been halted in some areas, including 15 out of 17 foci in Uganda; interruption of transmission has also been demonstrated in foci in Mali and Senegal (*1,7–10*). Additionally, there is some evidence that transmission may have been interrupted in Burundi and Chad, although not enough to have stopped distribution of ivermectin (*1*). Finally, Kenya, Niger and Rwanda are not considered to require treatment with ivermectin, although studies to demonstrate that the WHO criteria for verification have been met have not been performed (*1*). As of the end of 2015, a total of 821 230 people no longer received treatment with ivermectin because focal transmission of onchocerciasis had been eliminated (*1*). Modelling suggests that by the end of 2015 MDA of ivermectin in countries endemic for onchocerciasis covered by APOC would have had a substantial impact in reducing the prevalence of infection with adult female

Fig. 5.28. Status of preventive chemotherapy for onchocerciasis, worldwide, 2015



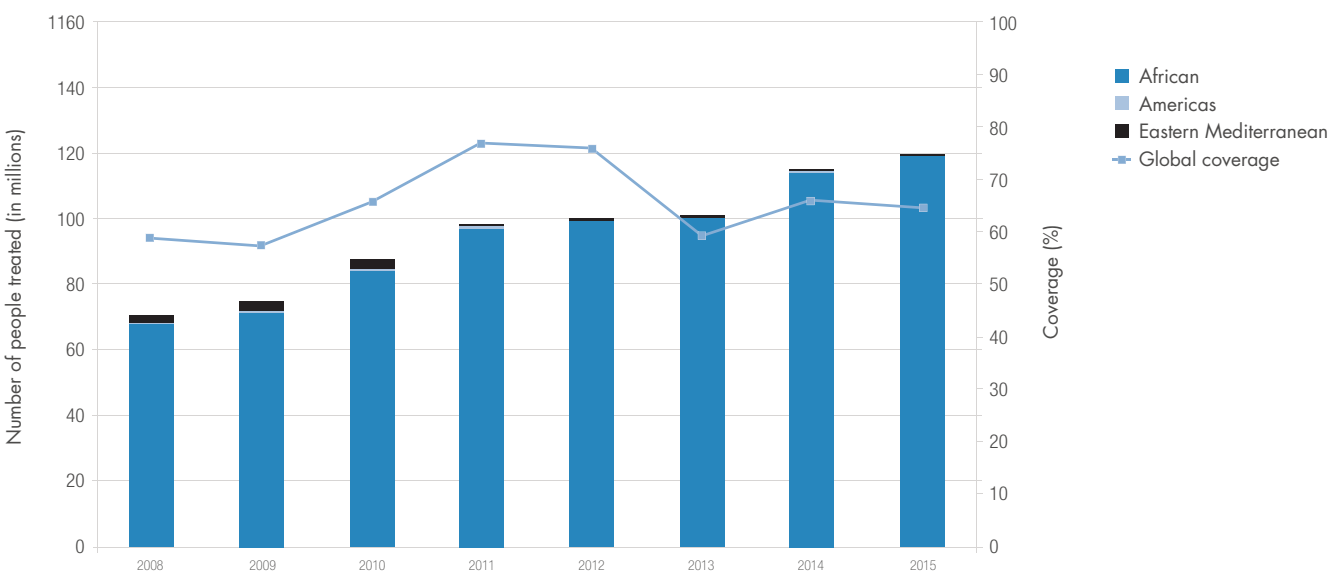
worms from 45% to 18%, of blindness from 0.6% to 0.2%, of visual impairment from 1.2% to 0.6% and of troublesome itch from 14% to 2% (*11*).

APOC came to the end of its mandate in 2015 and a new project – the Expanded Special Project for the Elimination of Neglected Tropical Diseases (or ESPEN) – was established in the African Region. WHO's African and Eastern Mediterranean regions are committed to maintaining APOC's achievements and continuing the effort to eliminate the causative parasite in both regions.

In the WHO Region of the Eastern Mediterranean, Sudan and Yemen are endemic for onchocerciasis. In Sudan the disease has been eliminated in one focus area, which recently completed 3 years of post-treatment surveillance (*12*). Elimination in Sudan resulted in the cessation of treatment for 120 000 people (*1*). A recent mapping exercise in Yemen, using Ov–16 serology, demonstrated that treatment of clinical cases will not be sufficient to eliminate the disease there. Community-based MDA began in 2016. Although Yemen did not meet the target of elimination by 2015, government commitment and enhanced support from partners will facilitate achieving elimination of human onchocerciasis in Yemen in the coming years. This achievement is remarkable given the current conflict in the area.

Going forward, achieving elimination in the African and Eastern Mediterranean regions will require efforts in four key areas.

Fig. 5.29. Countries requiring and implementing preventive chemotherapy and status of verification of elimination of human onchocerciasis, worldwide, 2015



Elimination or refinement mapping. The transition from control to elimination requires more refined delineation of limits of transmission in order to determine which areas of low prevalence require treatment. The skin snip biopsies used to establish prevalence are insufficiently sensitive in low transmission settings (*13*) and protocols have been developed using the more sensitive Ov–16 serological test. Refinement mapping (or micro-mapping) based on this test should be completed in the coming years.

Treatment strategy in areas co-endemic for *Loa loa* infection. The transition to elimination has also created a more urgent need to finalize the strategy for implementing ivermectin treatment, or alternative treatment strategies, in areas in central Africa that are co-endemic for *Loa loa* infection. Promising new technology has been developed that may make it possible to safely treat areas with a high burden *Loa loa* infections (*14*), but it still needs to be adapted for field use.

Stopping mass drug administration. New WHO guidelines for stopping MDA and verifying the elimination of human onchocerciasis were released in 2016 (*15*). These guidelines require the use of Ov–16 serology in children and PCR in blackflies before stopping ivermectin. Many countries, including some that may be able to stop ivermectin, are inexperienced in using these tests or do not have the laboratory capacity required to complete them. A network of donors is in the process of assisting with identifying and supporting programmes whose capacity could be rapidly developed to perform the necessary testing. However, some delay is expected and this could prolong treatment in some areas, even though transmission of the disease may have been interrupted. A rapid format of the Ov–16 serological test is currently available, which may also help facilitate programme evaluations once the test is validated for use in making the decision to stop ivermectin treatment.

Ongoing conflict. Several areas of transmission in the African and Eastern Mediterranean regions are located in unstable post-conflict and current conflict areas. Elimination will not be feasible in these areas in the near future. The recent political instability in the Bolivarian Republic of Venezuela and Brazil has the potential to slow progress in the remaining focus of transmission in the Region of the Americas, although the national programmes are committed to continuing despite the challenges they face.

Beyond 2020

While the available model suggests that onchocerciasis will not be eliminated worldwide in time to meet the 2030 SDG target in the absence of efforts to accelerate progress (*16*), some regional and country level elimination will be achieved. By the end of 2020, the Region of the Americas may be close to having achieved regional elimination, and 12–13 countries in the African Region may have demonstrated elimination of onchocerciasis. It is also possible that up to 30 million people will no longer require ivermectin (*17*). However, in the absence of a change in the current strategy, those countries with the highest burden of the disease will still have foci of transmission until 2037, and elimination is unlikely to be achieved in all of WHO's regions until 2040 (*16*).

Although obtaining 100% geographical coverage and maximizing therapeutic coverage are important first steps towards elimination, a change in strategy and the development of new treatments or diagnostic tests could accelerate progress. For example, modelling studies suggest that treating populations with ivermectin twice per year could shorten the time to interruption of transmission by 40% (*18*); evidence from a field study suggests that such treatment could result in interruption of transmission in 5–7 years (*19*). Scaling up wherever feasible could markedly accelerate elimination forecasts as long as the supply of the medication could be increased. Adding vector control to programmes could also accelerate progress. Vector control is not feasible in all areas and is more expensive, but could be of particular value in areas where there are issues with population compliance, in areas with sufficient funding, and as a temporary measure to accelerate progress while waiting to expand to biannual ivermectin treatment. The goal in these scenarios is not to eliminate the vector but to reduce annual biting rates, which will reduce transmission.

A programmatically friendly macrofilaricide regimen, even in the absence of perfect efficacy, would be a welcome addition to the tools for programme acceleration. If such a medication had no impact on the microfilariae of *Loa loa*, it would simplify the strategy needed to eliminate onchocerciasis in co-endemic areas. Work is ongoing to develop macrofilariacidal medications (e.g. flubendazole). Demonstration of the efficacy of a macrofilariacide would be facilitated by the development of a test for the presence of live adult female worms. Several groups have identified candidate tests, although progress has been slowed by the limited funding available. An added benefit of a test for adult live worms would be that programmes could more rapidly demonstrate the interruption of transmission.

In the absence of a change in strategy using currently available tools (e.g. ivermectin and vector control) or the tools that are under development (e.g. a macrofilaricide), it is likely that many elimination programmes will need to continue interventions after 2025. Depending on when countries are able to stop ivermectin treatment and how quickly untreated areas expand to full treatment, the peak need for ivermectin will likely be reached between 2020 and 2025. If the problems of political instability and co-endemic *Loa loa* are resolved, some of the most populous countries could stop treatment after 2025.

References

1. Progress report on the elimination of human onchocerciasis, 2015–2016. Wkly Epidemiol Rec. 2016;91:505–16 (http://apps.who.int/iris/bitstream/10665/250643/1/WER9143.pdf).
2. Global Health Estimates. In: World Health Organization, Health Statistics and Information systems [website]. Geneva: World Health Organization; 2017 (www.who.int/evidence/bod, accessed 20 March 2017).
3. Update on the global status of implementation of preventive chemotherapy [dated 8 March 2017]. Geneva: World Health Organization; 2017 (http://www.who.int/neglected_diseases/preventive_chemotherapy/PC_Update.pdf).
4. Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification by WHO of elimination of transmission in Colombia. Wkly Epidemiol Rec. 2013;88:381–5 (http://www.who.int/wer/2013/wer8836.pdf).

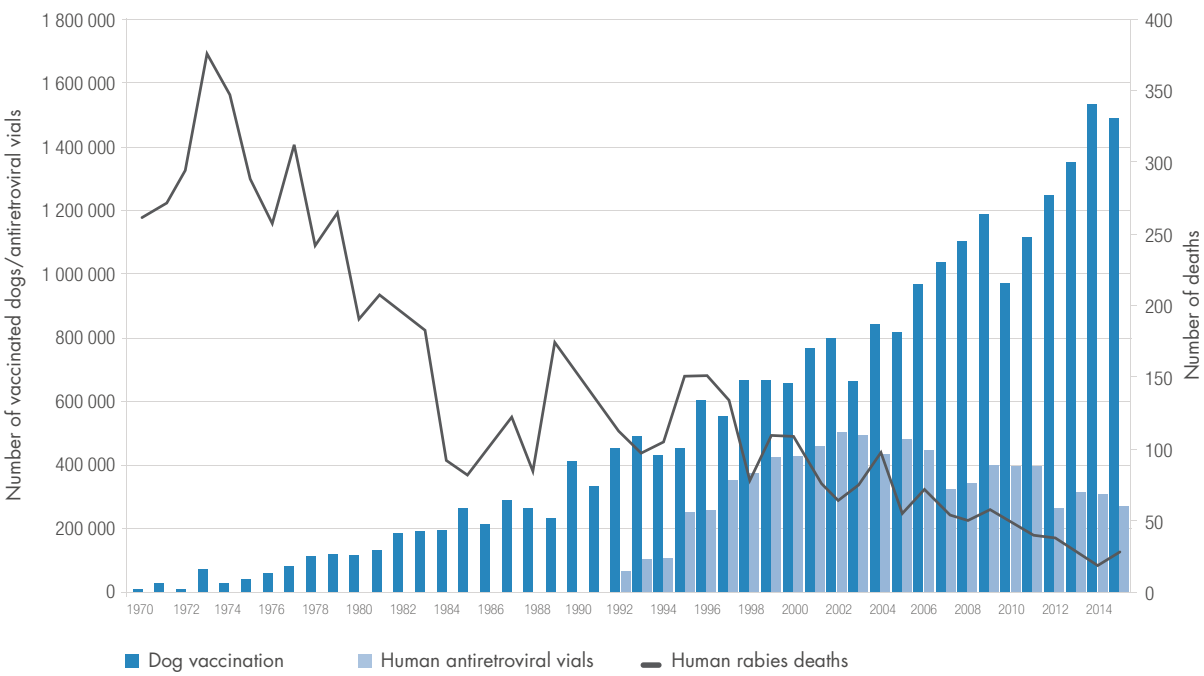
5. Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification of elimination of transmission in Mexico. Wkly Epidemiol Rec. 2015;90:577–81 (http://www.who.int/wer/2015/wer9043.pdf).
6. Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification of elimination of transmission in Guatemala. Wkly Epidemiol Rec. 2016;91:577–81 (http://www.who.int/wer/2015/wer9043.pdf).
7. Katabarwa MN, Walsh F, Habomugisha P, Lakwo TL, Agunyo S, Oguttu DW et al. Transmission of onchocerciasis in Wadelai focus of North-western Uganda has been interrupted and the disease eliminated. J Parasitol Res. 2012;2012:748540. doi:10.1155/2012/748540.
8. Lakwo TL, Garms R, Rubaale T, Katabarwa M, Walsh F. Habomugisha P et al. The disappearance of onchocerciasis from the Itwara focus, western Uganda after elimination of the vector *Simulium neavei* and 19 years of annual ivermectin treatments. Acta Trop. 2013;126:218–21. doi:10.1016/j.actatropica.2013.02.016.
9. Traoré MO, Sarr MD, Badji A, Bissan Y, Diawara L, Doumbia K et al. Proof-of-principle of onchocerciasis elimination with ivermectin treatment in endemic foci in Africa: final results of a study in Mali and Senegal. PLoS Negl Trop Dis. 2012;6:e1825. doi:10.1371/journal.pntd.0001825.
10. River blindness elimination program. In: The Carter Center [website]. Atlanta (GA): The Carter Center; 2017 (https://www.cartercenter.org/health/river_blindness/index.html, accessed 20 July 2016).
11. Coffeng LE, Stolk WA, Zoure HGM, Veerman JL, Agblewonu KB, Murdoch ME et al. African Programme for Onchocerciasis Control 1995–2015: model-estimated health impact and cost. PLoS Negl Trop Dis. 2013;7:e2031. doi:10.1371/journal.pntd.0002032.
12. Zarroug IMA, Hashim K, El Mubark WA, Shuma ZAI, Salih KAM, ElNojomi NAA et al. The first confirmed elimination of an onchocerciasis focus in Africa: Abu Hamed, Sudan. Am J Trop Med Hyg. 2016;95:1037–40. doi:10.4269/ajtmh.16-0274.
13. Thiele EA, Cama VA, Lakwo T, Mekasha S, Abanyie F, Sleshi M et al. Detection of *Onchocerca volvulus* in skin snips by microscopy and real-time polymerase chain reaction: implications for monitoring and evaluation activities. Am J Trop Med Hyg. 2016;94:906–11. doi:10.4269/ajtmh.15-0695.
14. D'Ambrosio MV, Bakalar M, Bennuru S, Reber C, Skandarajah A, Nilsson L et al. Point-of-care quantification of blood-borne filarial parasites with a mobile phone microscope. Sci Transl Med. 2015;7:286re4. doi:10.1126/scitranslmed.aaa3480.
15. Guidelines for stopping mass drug administration and verifying elimination of human onchocerciasis: criteria and procedures. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/PCT/2016.1; http://apps.who.int/iris/bitstream/10665/204180/1/9789241510011_eng.pdf).
16. Kim YE, Remme YE, Steinmann P, Stolk WA, Roungou J, Tediosi F. Control, elimination, and eradication of river blindness: scenarios, timelines, and ivermectin treatment needs in Africa. PLoS Negl Trop Dis. 2015;9:e3664. doi:10.1371/journal.pntd.0003664.
17. Tekle AH, Zoure HGM, Noma M, Boussinesq M, Coffeng LE, Stolk WA et al Progress towards onchocerciasis elimination in the participating countries of the African Programme for Onchocerciasis Control: epidemiological evaluation results. Infect Dis Poverty. 2016;5:66. doi:10.1186/s40249-016-0160-7.
18. Coffeng LE, Stolk WA, Hoerauf A, Habbema D, Bakker R, Hopkins AD et al. Elimination of African onchocerciasis: modeling the impact of increasing the frequency of ivermectin mass treatment. PLoS One. 2014;9:e115886. doi:10.1371/journal.pone.0115886.
19. Cupp EW, Cupp MS. Impact of ivermectin community-level treatments on elimination of adult *Onchocerca volvulus* when individuals receive multiple treatments per year. Am J Trop Med Hyg. 2005;73:1159–61. PMID: 16354830.

5.14 Rabies

Rabies is an infectious viral disease of humans and animals that is almost always fatal following the onset of clinical symptoms. In more than 99% of human cases the rabies virus is transmitted by domestic dogs (*1*). Human rabies is 100% preventable if post-exposure prophylaxis (PEP) is administered early and quickly to bite victims. Unfortunately, the relatively high cost of PEP (a course of PEP can cost US$ 40 in Africa and US$ 49 in Asia) can be prohibitive for the very poorest households, making rabies disease and death the burden of poor and vulnerable populations, whose deaths are rarely reported and where human rabies vaccines and immunoglobulins are not readily available or accessible. Rabies occurs mainly in remote rural settings, where 40% of people bitten by suspected rabid animals are children aged under 15 years. The substantial human suffering and cost of providing PEP treatment could be avoided if elimination of the virus were achieved. Elimination is feasible through mass vaccination of domestic dog populations (*1*), which reduces not only the number of deaths attributable to rabies but also the need for PEP as a part of dog-bite patient care (Fig. 5.30).

Government-led strategies to eliminate canine rabies have been successful in North America, Western Europe and a number of Asian and Latin American countries (*1*). Community engagement is critical to achieving and sustaining effective delivery of rabies interventions. Interventions that discourage community engagement, notably the indiscriminate culling of dogs, are not only ineffective at controlling rabies but also generate antagonism and suspicion among communities, which compromise dog vaccination efforts. The value of investment in community-based rabies action groups, and mobilizing community volunteers on a large scale to implement dog vaccination campaigns, is well documented (*2*).

Fig. 5.30. Relationship of human rabies deaths, dog rabies vaccination and human anti-rabies vaccine consumption: an example from Sri Lanka



Source: http://www.rabies.gov.lk/sub_pages/rs.html

Responses to rabies also need to be cross-sectoral, notably with regard to waste management. As with the other dog-transmitted NTDs, management of waste has a direct impact on roaming dog populations. Thus the involvement of other sectors – including the veterinary but also water, sanitation and hygiene sectors – is critical. In recognition of this, in December 2015, WHO, FAO, OIE and the Global Alliance for Rabies Control (GARC) hosted a global meeting attended by public health and veterinary government representatives of countries affected by rabies and other stakeholders to eliminate human rabies of canine origin (*3,4*). The meeting agreed a strategic framework to end human deaths from dog-mediated rabies globally by 2030 (*5*).

Burden and distribution

Rabies is endemic in most countries (*6*) and causes tens of thousands of deaths annually worldwide (**Table 13**); most deaths occur in Africa and Asia (**Fig. 5.31**). Official reporting of rabies incidence in animals and of human exposure to the virus remains inadequate, making it difficult to accurately determine the global burden of the disease. However, it is increasingly accepted that the available data underestimate the true incidence (*7*).

Methods have been developed to improve estimates of mortality attributable to rabies, including a predictive approach that uses a probability-based, decision-tree method. This approach has been used to estimate mortality in Africa and Asia, and to determine country-specific mortality estimates in Bhutan and Cambodia. Most recently, it has been adapted to estimate the global burden of endemic canine rabies (*8,9*).

Table 5.13. Estimates of human rabies deaths, exposure, post-exposure prophylaxis and disability-adjusted life-years lost through dog-transmitted human rabies

WHO region	Deaths	Exposures	Post-exposure prophylaxis	Total DALYs
African	19 919	695 114	1071573	1 246 819
Americas	182	122 701	835 656	11 951
Eastern Mediterranean	4027	385 724	694 498	254 101
European	137	262 049	906 159	8 539
South-East Asia	27 710	5 553 718	10 062 934	1 754 753
Western Pacific	7 016	8 674 192	15 596 355	438 163
Total	58 991	15 693 498	29 167 175	3 714 333

Source: reference 9

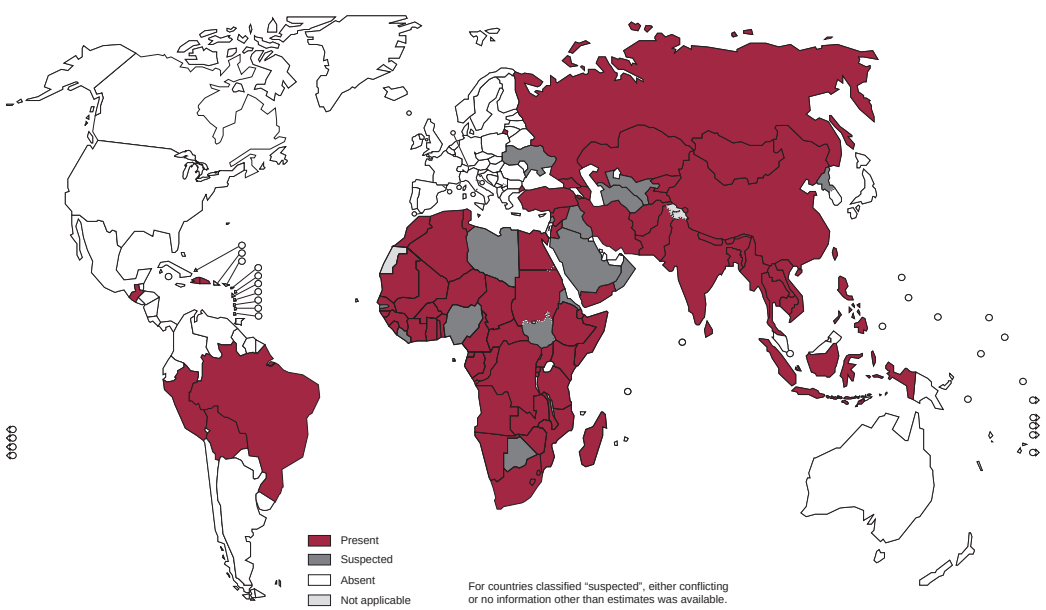
Progress towards Roadmap targets

The Roadmap sets targets for reductions in human cases of rabies transmitted by dogs and human deaths from rabies in Latin America and the South-East Asia and Western Pacific regions.

The specific Roadmap target for Latin America is, by 2015, to have eliminated human rabies transmitted by dogs and to have interrupted dog-to-dog transmission in all Latin American countries. Since the launch in 1983 of the Regional Program for Rabies Elimination, coordinated by PAHO, countries in the Region of the Americas have reduced the incidence of human rabies by more than 95% and the incidence of canine rabies by more than 98%. This has been achieved through the implementation of effective policies, mostly dog vaccine campaigns, increased public awareness and widespread availability of PEP (*10*). In 2015, 17 human deaths were reported for the region, partly mediated by animal species other than dogs. (Table 5.14).

According to country statistics, more than 45 million dogs are vaccinated, around 1 million dog attacks on humans occur, and between 1.7 and 2 million PEP doses are applied across the region every year in related programmes. However, because canine rabies is no longer perceived as a threat in many countries, it does not receive the attention and funding needed to achieve elimination in the region (*11*). Transmission of human rabies mediated by vampire bats is a public health issue of increasing importance in Latin America, particularly in the remote Amazonian regions of Brazil, Colombia and Peru, where access to appropriate medical treatment is limited.

Fig. 5.31. Distribution of dog-transmitted human rabies based on most recent data points from different sources, 2010–2015 Presence of dog-transmitted human rabies based on most recent data points from different sources, 2010–2015



The Roadmap sets a regional elimination goal for 2020 for the South-East Asia and Western Pacific regions. Rabies has been eliminated for decades in Japan and Malaysia, while many other countries in the regions have embarked on elimination campaigns. The Association of Southeast Asian Nations (ASEAN) demonstrated its continued support to accelerating progress towards the goal of a "Rabies-free ASEAN by 2020" through the endorsement of the ASEAN Rabies Elimination Strategy; Viet Nam led its development. The South Asian Association for Regional Cooperation (SAARC) has also identified rabies as a regional priority and adopted a resolution for prevention and control with an elimination target of 2020 (*12*). In August 2015, Sri Lanka hosted a meeting on rabies leading the SAARC countries to reinforce the target of zero human rabies deaths by 2020 as a next step of the *Strategic framework for elimination of human rabies transmitted by dogs in the South-East Asia Region* (*13, 14*).

Notable success stories in the region include Bhutan, where the National Centre for Animal Health has taken a strong lead in implementing a successful Catch–Neuter–Vaccinate–Release programme, significantly reducing the numbers of rabies cases in animals and humans, while building a buffer zone along the highly porous and rabies endemic national border of India. In Bangladesh, the Ministry of Health has shown strong leadership, by introducing intradermal PEP in 65 districts, and supporting an intensive dog vaccination campaign. This has led to a 50% decrease in the numbers of human rabies deaths in the period 2010–2013. Thailand has pioneered intradermal

Table 5.14. Numbers of human rabies cases reported to WHO, Latin America, 2013–2015

Disease	2013			2014			2015		
	Dog-mediated	Other species-mediated	Total	Dog-mediated	Other species-mediated	Total	Dog-mediated	Other species-mediated	Total
Bolivia (Plurinational State of)	2	0	2	4	0	4	4	0	4
Brazil	3	2	5	0	0	0	1	1	2
Chile	0	1	1	0	0	0	0	0	0
Colombia	0	0	0	0	0	0	0	1	1
Costa Rica	0	0	0	0	1	1	0	0	0
Dominican Republic	2	0	2	0	0	0	2	0	2
Guatemala	1	0	1	2	0	2	0	0	0
Haiti	3	0	3	4	0	4	3	0	3
Mexico	0	0	0	0	0	0	0	1	1
Nicaragua	0	0	0	0	1	1	0	0	0
Peru	1	5	6	0	0	0	1	3	4
Venezuela (Bolivarian Republic of)	0	0	0	0	0	0	1	0	1
Total	**12**	**8**	**20**	**10**	**2**	**12**	**12**	**6**	**18**

Source: reference *6*

techniques for rabies vaccination, while, in 2014, India included rabies (for the first time) in its 12th national programme of work.[1]

Progress has also been reported in the Philippines, where a project supported by the Bill & Melinda Gates Foundation and led by WHO resulted in two of the nine islands in the Visayas being declared rabies-free in 2013 (*15*). The number of human deaths from rabies in the Visayas decreased from 51 in 2008 to 4 in 2013. In Sri Lanka, rabies has been a notifiable disease since 1973 under the programme led by the Ministry of Health, Nutrition & Indigenous Medicine, which has made rabies elimination a national health priority, and makes PEP available to victims of animal bites free of charge at government hospitals throughout Sri Lanka (*16*). The 2020 target is now within reach in the country, with only 5 cases of rabies recorded in the first half of 2016 compared with 24 cases in 2015.

There has been an increased perception that in conflict areas there is an increased risk of infectious diseases including rabies (*17*). However, Morocco, a lead country progressing towards rabies elimination, still registers about 20 fatalities ever year.

Notwithstanding these encouraging developments, the populations of these regions continue to bear the greatest burden of rabies, although suboptimal monitoring makes it difficult to estimate its exact size or how much progress is being made in reducing it. Latin America has shown tremendous successes in eliminating the disease. However, for the South-East Asian and Western Pacific regions, much remains to be done to reach the 2020 target, and control rather than elimination may be a more realistic option in some countries. Overall, it is clear that momentum for rabies control needs to be maintained and/or accelerated in order to achieve the 2020 Roadmap targets.

Beyond 2020

All the tools required to end human deaths from rabies exist, and the arguments supporting increased investment in those tools – notably, rabies vaccine – are very clear. What is now needed is greater collaboration between countries and stakeholders, better coordination between the animal and human health sectors, improved community awareness and engagement, and greater resources and political commitment. WHO and partners are creating the impetus to raise the profile of rabies, strengthen the evidence base, develop a business plan to reach the 2030 goal, prepare up-to-date technical guidance to reduce costs, and create a vaccine stockpile that, with potential investment from GAVI (the Vaccine Alliance), will catalyse progress towards the 2020 goals and beyond, and aspire towards the goal of zero deaths by 2030.

Specific areas of concern are detailed below.

Political commitment. There are no biological or technical challenges to rabies elimination, but institutional challenges impede effective implementation and expansion of rabies control interventions in many countries. Meeting these challenges will require greater political commitment at the country level as well as increased collaboration between the members of the tripartite (FAO, OIE, WHO) and countries to ensure that

1. http://117.239.178.13/national-rabies-control-programme

responses to rabies are prioritized. Setting clear goals and establishing clear strategies for achieving them is essential. Recent progress made in this area includes the preparation of a strategic framework with a global target of zero rabies deaths by 2030 (*5*), which was launched at the end of 2015 by WHO, OIE, FAO and GARC.

Improved guidance. One area that requires particular attention is the disconnect between the treatment recommended in WHO's position paper on rabies vaccines and immunoglobulins (*18*), which states that vaccine must in many cases be given in conjunction with rabies immunoglobulins, and the practical realities faced in low-resource countries. The relative complexity of the recommended vaccine regimen may also act as a barrier for donor support. In recognition of these issues, WHO's Strategic Advisory Group of Experts on Immunization has initiated a Working Group to review WHO's position, and plans to complete its work in October 2017. The group will also assess the evidence for new vaccines and for vaccines in the process of obtaining WHO prequalification or national market authorization.

Improved procurement. Human rabies vaccine is not included in the routine immunization that is part of WHO's Expanded Programme on Immunization. In many countries, this leads to insufficient forecasting and weak understanding of vaccine demand, which in turn leads to delays in procurement and vaccine shortages. Countries are thus often forced to turn to manufacturers whose products are not prequalified by WHO, and who may supply the vaccine at greatly inflated prices without the quality assurance that prequalification brings. WHO is working with partners to forecast vaccine needs and assess their impact on burden, and to create a procurement system and vaccine stockpile to be operational by the end of 2017. Countries in need of an emergency supply will be able to rapidly obtain quality-assured vaccine. This initiative is also likely to generate a demand and supply cycle (stabilizing demand for manufacturers and supply and forecasting for countries), and generate much-needed data on morbidity and mortality for rabies.

Increased collaboration. Meeting the 2020 target and sustaining the progress made beyond 2020 will depend on strengthened networks, increased collaboration and enhanced coordination. In some cases networks are already developing. For example, without being explicitly assigned Roadmap targets, some regions have formed regional networks to facilitate collaboration in the fight against rabies. These have helped to identify national rabies focal points and champions who have been instrumental in increasing public awareness and political commitment. Notable examples include the Pan-African Rabies Control Network (PARACON), which gathered representatives from medical and veterinary Sectors of 33 African countries for the first time in 2015, and the Middle East and Eastern Europe Rabies Expert Bureau (MEEREB), an informal group of rabies experts who exchange information and lessons learnt in their respective countries, consider specific problems encountered in their clinical practice and devise practical solutions.

Improved surveillance. Rabies surveillance is virtually non-existent in many settings. It is therefore crucial that countries and development partners invest in monitoring capacity to capture human exposure to rabies and ensure immediate reporting of suspected and

confirmed cases from the local level (by diagnosing physician and laboratory) to the intermediate and central levels. Rapid exchange of information with services in charge of animal rabies surveillance and control is vital. Epidemiological investigation of rabies outbreaks should include investigation of all rabies foci to identify sources of infection as well as humans and animals exposed or possibly exposed.

To support countries' efforts to improve surveillance and reporting, WHO in collaboration with Panaftosa, WHO Rabies Information System of the WHO Collaboration Centre for Rabies Surveillance and Research PARACON and MEEREB, is finalizing a web-based, open source information system based on the DHIS2 software. This system is increasingly used by countries as a national health information system.

Finance and financial planning. Ensuring adequate finance and financial planning is another major challenge. The WHO is coordinating the development of a global human rabies elimination business plan to quantify the resources needed to invest in rabies strategies and interventions to guide stakeholders, Member States and donors.

Research. Innovative tools and technologies offer promise to further improve and support faster, broader implementation of rabies control programmes. However, they are not a precondition to stepping up the fight against rabies.

Diagnostic tests to confirm animal rabies cases allow better PEP decision-making and monitoring of the progress of control efforts. The reference fluorescent antibody test is not practicable in many endemic settings due to costs and enhanced laboratory requirements. Thus, alternative tools using less specialized equipment – such as DRIT (*19*) and lateral flow devices (*20*) – could be important in providing further validation and quality approval.

While poor accessibility to and affordability of PEP remain a major issue in most countries endemic for rabies (*21*) there is hope that the new technologies under evaluation by WHO (namely, thermostable rabies vaccines, vaccines administered via micorscopic needles on a patch, and monoclonal antibodies as an alternative to human and equine rabies immunoglobulins) will facilitate cost–effective delivery of PEP as well as dog vaccine to where it is needed. Also, innovative ways to deliver vaccines through civilian drones could change the way that supplies are transported to remote, difficult-to-access areas and regions.

References

1. WHO Expert Consultation on Rabies: second report. Geneva: World Health Organization; 2013 (WHO Technical Report Series, No. 982; http://apps.who.int/iris/bitstream/10665/85346/1/9789240690943_eng.pdf).
2. Rabies: rationale for investing in the global elimination of dog-mediated human rabies. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/NZD/2015.2; http://apps.who.int/iris/bitstream/10665/185195/1/9789241509558_eng.pdf).
3. Lembo T, Attlan M, Bourhy H, Cleaveland S, Costa P, de Balogh K et al. Renewed global partnerships and redesigned roadmaps for rabies prevention and control. Vet Med Int. 2011;2011:923149. doi:10.4061/2011/923149.
4. FAO, OIE and WHO unite to eliminate human rabies and control the disease in animals. Geneva: World Health Organization; 2013 (http://www.who.int/rabies/WRD_2013_Statement_Eng.pdf).

5. Global elimination of dog-mediated human rabies: report of the rabies global conference. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/NZD/2016.02; http://apps.who.int/iris/bitstream/10665/204621/1/WHO_HTM_NTD_NZD_2016.02_eng.pdf).
6. Human rabies transmitted by dogs: current status of global data, 2015. Wkly Epidemiol Rec. 2016;91:13–20 (http://www.who.int/wer/2016/wer9102.pdf).
7. Taylor LH, Hampson K, Fahrion A, Abela-Ridder B, Nel LH. Difficulties in estimating the human burden of canine rabies. Acta Trop. 2017;165:133–40. doi:10.1016/j.actatropica.2015.12.007.
8. Shwiff S, Hampson K, Anderson A. Potential economic benefits of eliminating canine rabies. Antiviral Res. 2013;98:352–6. doi:10.1016/j.antiviral.2013.03.004.
9. Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M et al. Estimating the global burden of endemic canine rabies. PLoS Negl Trop Dis. 2015;9:e0003709. doi:10.1371/journal.pntd.0003709.
10. Vigilato MA, Cosivi O, Knöbl T, Clavijo A, Silva HM. Rabies update for Latin America and the Caribbean. Emerg Infect Dis. 2013;19:678–9. doi:10.3201/eid1904.121482.
11. OPS, 2015. Seminario PRE-REDIPRA. Experiencia de países y herramientas para la declaración de áreas libres de rabia canina variantes 1 y 2. [The experience of countries and tools for the declaration of canine rabies Variants 1 and 2 free areas] Brasilia, Brasil. PAHO 2015. REDIPRA (Rabies Program Directors of the Americas) International Pre-Seminar. Brasilia, Brazil (in Portuguese).
12. Report on informal consultation to finalize regional strategic framework for elimination of human rabies transmitted by dogs in the South-East Asia Region. New Delhi: WHO Regional Office for South-East Asia; 2012 (http://apps.searo.who.int/pds_docs/B4883.pdf).
13. Prevention and control of rabies in SAARC countries. New Delhi; WHO Regional Office for South-East Asia; 2016 (SEA-CD-316; http://www.searo.who.int/entity/emerging_diseases/documents/sea_cd_316.pdf).
14. Strategic framework for elimination of human rabies transmitted by dogs in the South-East Asia Region. New Delhi; WHO Regional Office for South-East Asia; 2012 (http://www.searo.who.int/entity/emerging_diseases/links/Zoonoses_SFEHRTD-SEAR.pdf).
15. Report of the fifth meeting of the International Coordinating Group of the World Health Organization and the Bill & Melinda Gates Foundation project on eliminating human and dog rabies. Geneva: World Health Organization; 2014 (WHO/HTM/NTD/NZD/2014.2; http://apps.who.int/iris/bitstream/10665/102317/1/WHO_HTM_NTD_NZD_2014.2_eng.pdf).
16. Kularatne SAM, Ralapanawa DMPUK, Weerakoon K, Bokalamulla UK, Abagaspitiya N. Pattern of animal bites and post exposure prophylaxis in rabies: a five year study in a tertiary care unit in Sri Lanka. BMC Infect Dis. 2016; 16:62. doi:10.1186/s12879-016-1394-5.
17. Petersen E, Baekeland S, Memish ZA, Leblebicioglu H. Infectious disease risk from the Syrian conflict. Int J Infect Dis. 2013;17:e666–7. doi:10.1016/j.ijid.2013.06.001.
18. Rabies vaccines: WHO position paper. Wkly Epidemiol Rec. 2010;85:309–20 (http://www.who.int/wer/2010/wer8532.pdf).
19. Dürr S, Naïssengar S, Mindekem R, Diguimbye C, Niezgoda M, Kuzmin I et al. Rabies diagnosis for developing countries. PLoS Negl Trop Dis. 2008;2:e206. doi:10.1371/journal.pntd.0000206.
20. Léchenne M, Naïssengar K, Lepelletier A, Alfaroukh IO, Bourhy H, Zinsstag J et al. Validation of a rapid rabies diagnostic tool for field surveillance in developing countries. PLoS Negl Trop Dis. 2016;10:e0005010. http://dx.doi.org/10.1371/journal.pntd.0005010.
21. Hampson K, Cleaveland S, Briggs D. Evaluation of cost-effective strategies for rabies post-exposure vaccination in low-income countries. PLoS Negl Trop Dis. 2011;5:e982. http://dx.doi.org/10.1371/journal.pntd.0000982.

5.15 Schistosomiasis

Schistosomiasis (also known as bilharzia or "snail fever") is a parasitic disease that results from infection with blood flukes (trematode worms) of the genus *Schistosoma*. Transmission of *Schistosoma* spp. relies on freshwater snails as intermediate hosts (*1*). Five main species of blood flukes parasitize humans and cause the two major forms of the disease (intestinal and urogenital schistosomiasis); *S. haematobium* and *S. mansoni* are the main causative parasites (Table 5.15).

Intestinal schistosomiasis can result in abdominal pain, diarrhoea and bloody stools. Liver enlargement is common in advanced cases, and is frequently associated with an accumulation of fluid in the peritoneal cavity and hypertension of the abdominal blood vessels; enlargement of the spleen may also occur. Urogenital schistosomiasis results in fibrosis of the bladder and ureter; kidney damage is sometimes diagnosed in advanced cases. Female urogenital schistosomiasis may present with genital lesions, vaginal bleeding, pain during sexual intercourse and nodules in the vulva. Male urogenital schistosomiasis can induce pathology of the seminal vesicles, prostate and other organs. The disease may also provoke other long-term irreversible consequences, including infertility.

The transmission cycle begins when human excreta containing parasite eggs enters fresh water habitats and hatched larvae infect susceptible snail hosts. The parasites multiply asexually in snails and release another larval stage into water that is infective to humans. Infection is transmitted via domestic, occupational and recreational contact with water. Inside the body the larvae evolve into male and female worms that coexist in the blood

Table 5.15. Parasite species causing schistosomiasis and their geographical distribution

	Species	Geographical distribution
Intestinal schistosomiasis	*Schistosoma mansoni*	Africa, the Middle East, the Caribbean, Brazil, Venezuela (Bolivarian Republic of) and Suriname
	Schistosoma japonicum	China, Indonesia and the Philippines
	Schistosoma mekongi	Several districts of Cambodia and the Lao People's Democratic Republic
	Schistosoma guineensis and realted *S. intercalatum*	Rain forest areas of central Africa
Urogenital schistosomiasis	*Schistosoma haematobium*	Africa, the Middle East, Corsica (France)

vessels for years. Female worms release thousands of eggs that are evacuated in urine and faeces. If people urinate or defecate in freshwater sources, the eggs migrate to snails where they eventually hatch and perpetrate the transmission cycle.

Preventive chemotherapy, the main strategy for controlling morbidity, involves the periodic distribution of the anthelminthic medicine praziquantel. Complementary interventions such as provision of safe water, sanitation and hygiene, health education for behavioural change, environmental management and snail control are recommended in order to sustain control and advance towards elimination.

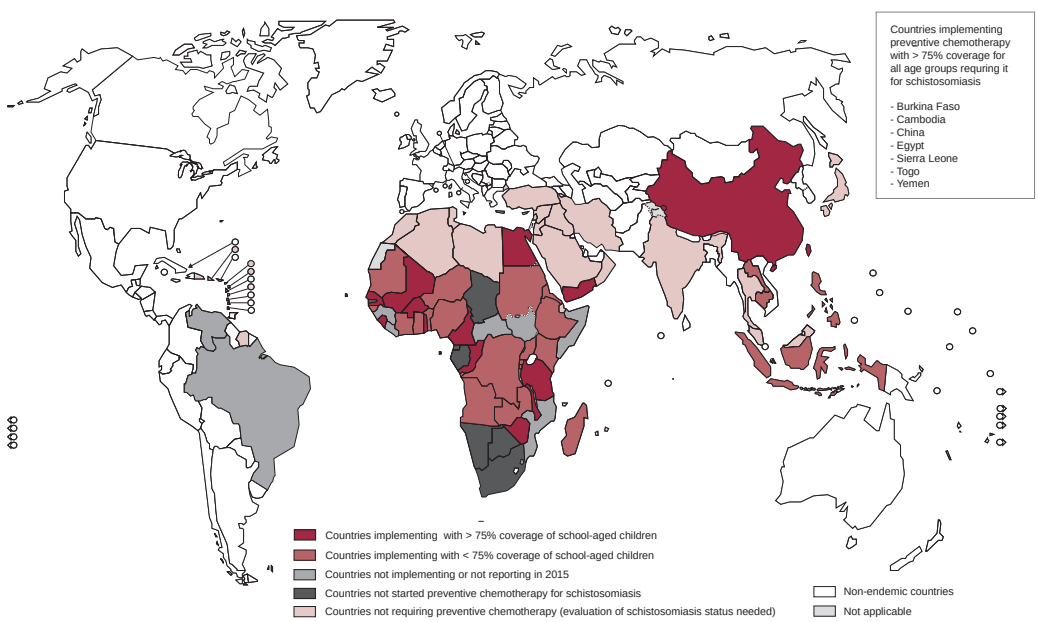
Burden and distribution

The distribution of schistosomiasis is highly focal because transmission relies on specific intermediary snail hosts and activities that expose humans to infection. The level of endemicity changes with the environment, water development schemes, migration, control interventions and snail host distribution.

A total of 78 countries are endemic for schistosome infections, of which populations in 52 countries require preventive chemotherapy. In 2015, an estimated 218.2 million people required treatment, of which school-aged children represented more than half (54.4%) of that total (Fig. 5.32). The global burden of the disease is estimated at 3 514 145 DALYs (2).

Africa, the most affected region, houses 92% of people requiring preventive treatment (2). Currently, treatment is targeted at school-aged children and adults at risk. Preschool-aged

Fig. 5.32. Countries requiring and implementing preventive chemotherapy for schistosomiasis, worldwide, 2015



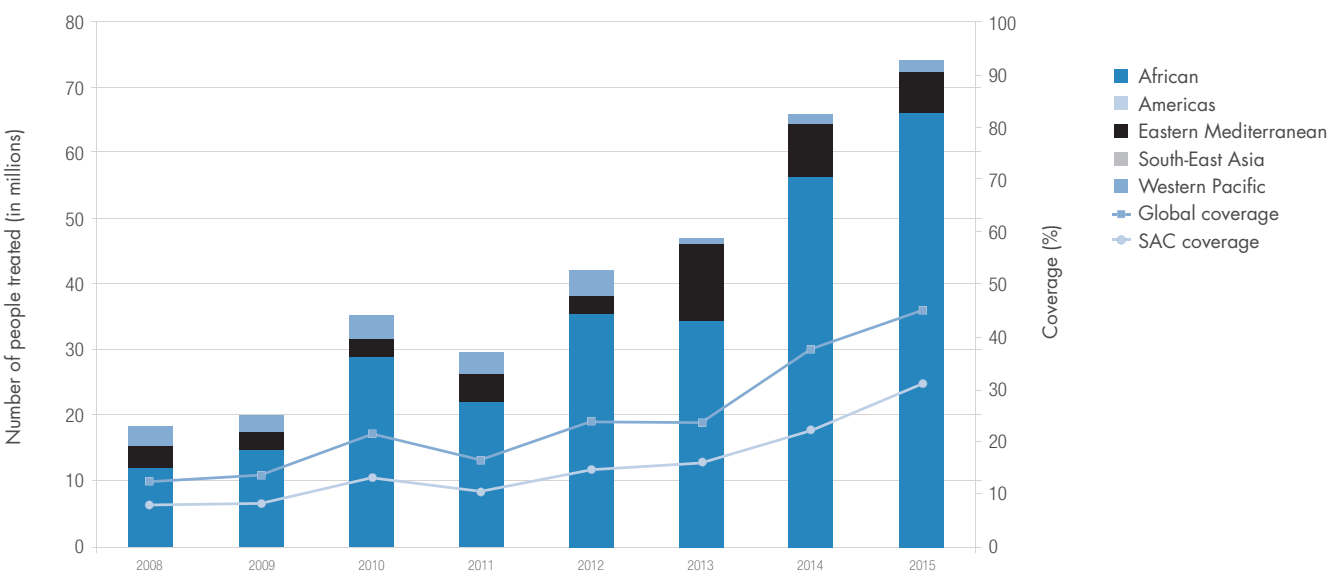
children are also at risk of infection (*3*), but the lack of a suitable paediatric formulation of praziquantel currently precludes them from treatment. Pregnant and lactating women are also at risk in endemic areas and should be included in treatment; praziquantel is safe for their use (*4,5*).

Human schistosomiasis affects the genitourinary or intestinal organs, depending on the infecting species. However, the manifestations of genitourinary schistosomiasis seem to be less well known than those of intestinal schistosomiasis, and they are less well managed or sufficiently considered in control strategies. A recent review highlighted morbidity from schistosomiasis in genital organs and emphasized the need for more research and action (*6*). In 2015, WHO published a pocket atlas designed to increase awareness among health professionals about proper case management and prevention of female genital schistosomiasis (*7*). New evidence suggests that the risk of HIV infection increases in women who are suffering from schistosomiasis (*8*). Preventive chemotherapy should therefore be expanded to include areas in which HIV and schistosomiasis are co-endemic, and treatment of schistosomiasis should be included in interventions to prevent HIV.

Progress towards Roadmap targets

The Roadmap targets are to control morbidity and achieve treatment coverage of at least 75% of all school-aged children by 2020. Other targets and milestones have been set for regional elimination in the Eastern Mediterranean Region, the Caribbean, Indonesia and the Mekong River Basin (2015) and in the Region of the Americas, the Western

Fig. 5.33. Number of people treated globally for schistosome infections and treatment coverage globally and in school-aged children (SAC), by WHO region, 2008–2015



Pacific Region and in selected countries of the African Region (2020). The ambitious targets set for regional elimination (that is, interruption of transmission) are unlikely to be achieved.

Globally in 2015, a total of 74.3 million people received preventive chemotherapy for schistosomiasis, based on reports to WHO from 35 countries, representing coverage of 31% (**Fig. 5.32**). Treatment coverage for all age groups was 49.6% (Eastern Mediterranean Region), 47.7% (Western Pacific Region) and 29.8% (African Region).

Treatment coverage for school-aged children increased significantly in 2015 (44.9%) compared with 2008 (14%), representing more than two-thirds of the 2020 target of 75% (**Fig. 5.33**). This clearly suggests that with improved supplies of praziquantel, treatment for schistosomiasis can be expanded. Of the 35 countries that reported on treatment levels attained in 2015, only 13 (37.1%) achieved 75% coverage of all school-aged children. However, 58,6% of the implementation units that conducted preventive chemotherapy in 2015 achieved the 75% coverage target.

African Region. Although treatment coverage is increasing globally, the speed of implementation differs from country to country. Among the 41 countries in the African Region requiring preventive chemotherapy for schistosomiasis, 28 (68.3%) were implementing it in 2015, but only 15 had extended coverage to all endemic areas. Efforts therefore need to be sustained, and preventive treatment expanded in all geographical areas. Endemic countries that have not started preventive chemotherapy need also to begin implementation. Expansion of treatment is of particular concern in the highest burden African countries (Angola, the Democratic Republic of the Congo, Ethiopia, Madagascar and Nigeria), where it is unlikely that the Roadmap targets will be reached unless efforts are made to expand interventions.

Mapping of schistosomiasis has improved. In 2015, 87% of countries were entirely mapped; only Angola, Central African Republic, Ethiopia, South Africa and South Sudan had areas that remained to be surveyed. In order to reach 100% geographical coverage and to increase population coverage, preventive chemotherapy must be expanded in areas that have been mapped but where populations have not been treated.

A number of African countries are reporting decreases in the prevalence and intensity of infection as a result of nationwide mass drug distribution. For example, in Burkina Faso, six of nine regions have seen such reductions in prevalence that schistosomiasis can be considered eliminated as a public health problem (9). Ghana and Rwanda have witnessed similar decreases. Elimination projects in Burundi and the United Republic of Tanzania (Zanzibar) are using integrated approaches that combine health education, improved sanitation and water supply, and snail control. In Zanzibar, the prevalence of infection has been reduced to below 10%; however, some hot spots persist.

The mapping project in the region has begun survey preparations to update the situation in Algeria and Mauritius.

Region of the Americas. Socioeconomic progress and declining rural populations have led to a significant reduction in the prevalence of schistosomiasis. About 1.6 million people are estimated to require preventive chemotherapy in Brazil and the Bolivarian Republic of Venezuela. In Brazil, an integrated NTD treatment campaign targeting trachoma, soil-transmitted helminthiases, schistosomiasis and leprosy was initiated in 2013, but activities need to be extended to all areas at high risk of transmission. Saint Lucia and Suriname may have residual transmission. Schistosomiasis has been eliminated from Puerto Rico and transmission has been interrupted (subject to verification) in Antigua and Barbuda, the Dominican Republic, Guadeloupe, Martinique and Montserrat in the Caribbean (*10*).

South-East Asia Region. In the South-East Asia Region, only Indonesia has populations that require preventive chemotherapy, which are located in Central Sulawesi province. Elimination plans need to be devised and implemented, then integrated with public health measures to interrupt transmission of schistosomiasis, such as snail control, and provision of potable water, sanitation and hygiene education.

European Region. An outbreak of schistosomiasis in Corsica (France) in 2013 recorded a total of 120 cases in the local population and among tourists (*11*). Hybrids of *S. haematobium* and *S. bovis* were implicated in transmission. The re-introduction of transmission highlights the need for vigilance and sensitive tools to detect and prevent its establishment in new areas where snail intermediate hosts are present. A robust post-elimination surveillance system is required in areas where transmission has been interrupted.

Eastern Mediterranean Region. Egypt, Sudan and Yemen are implementing preventive preventive chemotherapy, but the 2015 regional elimination target is unlikely to have been achieved as transmission continues at high levels in endemic areas of Somalia, Sudan and Yemen. The World-Bank-supported project in Yemen ended in 2016, and means to maintain its momentum are being explored. Egypt is reassessing the situation of schistosomiasis before moving towards elimination. Surveys are required to verify whether transmission has been interrupted in Iraq, Oman and the Syrian Arab Republic. Ongoing conflict in Iraq and the Syrian Arab Republic makes this possibility unlikely. Somalia began mapping the disease in 2016 in order to begin preventive chemotherapy.

Western Pacific Region. Cambodia, China, the Lao People's Democratic Republic and the Philippines have populations requiring preventive chemotherapy. Progress is mixed. For example, *S. japonicum* infection has been successfully controlled in China but remains prevalent in the Philippines. Morbidity associated with *S. mekongi* has been controlled in Cambodia, but endemic foci persist in the Lao People's Democratic Republic, where elimination efforts have been boosted by intensifying integration of water, sanitation and hygiene interventions. The Philippines is also investing in such interventions, as well as focusing on interrupting transmission by animal reservoir hosts.

In addition to the shortage of funding for implementation, one of the main obstacles to expanding preventive chemotherapy is the so-called praziquantel gap. Of the 597 million tablets needed globally for preventive chemotherapy in 2015, only 198 million (33%) were available. Some 285 million tablets were available in 2016; for 2017 the number is likely to be 263 million, or less than 50% of the amount needed to treat all the

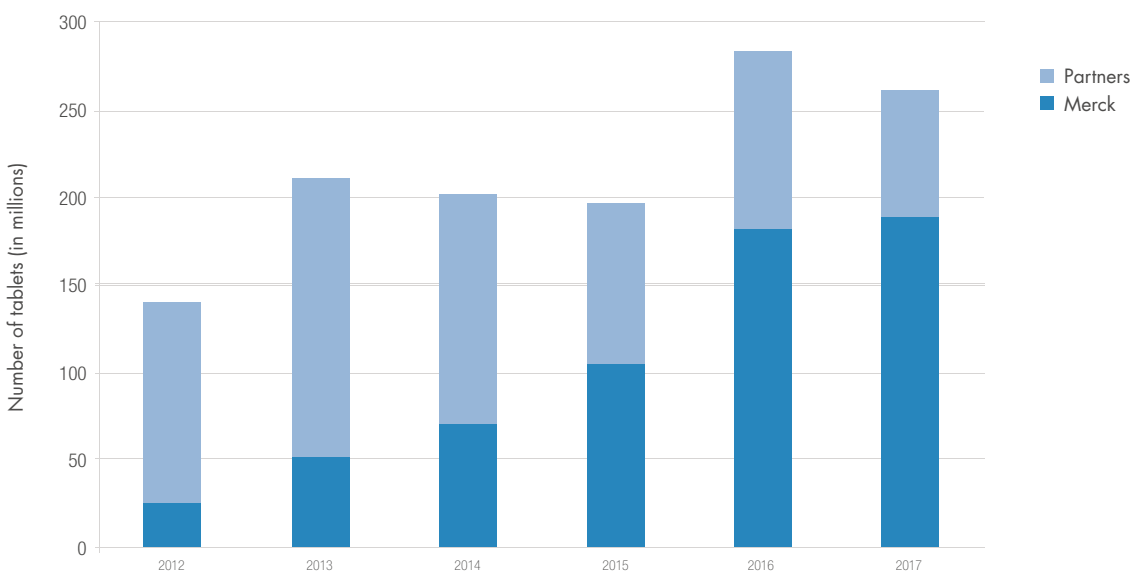
people requiring preventive chemotherapy for schistosomiasis worldwide. The maximum level of 250 million tablets of praziquantel per year that has been pledged could be reached in 2017. Of particular concern is that the increase in donated praziquantel has coincided with a decrease in donated medicine from other sources (Fig. 5.34). This scenario, and the lack of funds for implementing preventive chemotherapy in many countries, could jeopardize the achievement of the Roadmap's targets. Advocacy must therefore be intensified to maintain and increase the availability of praziquantel and to secure funds for its implementation in order to meet the targets.

In 2012, the Sixty-fifth World Health Assembly resolved to eliminate schistosomiasis (WHA65.21), calling on WHO to prepare guidance for Member States on when to initiate elimination campaigns and on procedures for verifying the interruption of transmission. Guidance documents are in preparation.

Beyond 2020

The progress achieved demonstrates that schistosomiasis can be controlled and eliminated (*12*). However, it is essential that national commitment and ownership of programmes as well as continuous support from partners are maintained. Domestic financing of programmes is crucial, and it is hoped that integrating NTDs in the context of the SDGs will increase the leverage of countries and stakeholders to mobilize more resources.

Fig. 5.34. Amount of praziquantel donated to WHO or pledged by partners, 2012–2017



In order to sustain the achievements made in controlling morbidity from schistosomiasis, and in striving towards elimination, it is essential that 100% geographical coverage with preventive chemotherapy is achieved and maintained, and that all age groups requiring it are treated. The treatment of preschool-aged children will be greatly enhanced when the introduction of paediatric formulations of praziquantel, which are currently under clinical development, and in the future will allow inclusion of pre-school-aged children in preventive chemotherapy programmes.

Particular attention should be given to the high transmission zones (hot spots) where new strategies need to be implemented to improve the impact of interventions.

More surveillance surveys are needed to update the situation and evaluate the impact of interventions. Surveillance is required also to demonstrate the impact of control and to facilitate the adjustment of strategies, such as reducing the frequency of preventive chemotherapy where possible and targeting hot spots and populations at risk. It is key also to optimizing the use of the limited resources that are available.

Revision and simplification of preventive chemotherapy strategies to include all age groups (adults and preschool-aged children) in need of treatment is critical to achieving maximum impact, and to moving from control to elimination.

The "ending" of schistosomiasis will also require the implementation and reinforcement of safe water, sanitation and hygiene, health education, snail control and integration of the programme within the health system. WHO has prepared a guideline for laboratory and field evaluation of molluscicides and an operational manual for field application of molluscicides to assist countries in using the strategy. Countries should be encouraged to combine agricultural development and sanitation facility projects. Capacity must be built in national programmes.

Finally, the development of new diagnostic tools, particularly more sensitive and specific tests for use in test-and-treat strategies (selected chemotherapy) in areas of low endemicity, is essential. Such tools will permit a re-assessment of the situation after several rounds of preventive chemotherapy, to verify the interruption of transmission of schistosomiasis and to implement surveillance after elimination in order to avoid reintroduction (*13*).

References

1. Colley DG, Bustinduy AL, Secor WE, King CH. Human schistosomiasis. Lancet. 2014;383:2253–64. doi:10.1016/S0140-6736(13)61949-2.
2. Global Health Estimates. In: World Health Organization, Health Statistics and Information systems [website]. Geneva: World Health Organization; 2017 (www.who.int/evidence/bod, accessed 21 March 2017).
3. Report of a meeting to review the results of studies on the treatment of schistosomiasis in preschool-age children. Geneva: World Health Organization; 2011 (WHO/HTM/NTD/PCT/2011.7; http://apps.who.int/iris/bitstream/10665/44639/1/9789241501880_eng.pdf).
4. Schistosomiasis: progress report 2001–2011 and strategic plan 2012–2020. Geneva: World Health Organization; 2013 (WHO/HTM/NTD/PCT/2013.2; http://www.who.int/neglected_diseases/resources/9789241503174/en/, accessed 6 March 2017).
5. Olveda RM, Acosta LP, Tallo V, Baltazar PI, Lesiguez JL, Estanislao GG et al. Efficacy and safety of praziquantel for the treatment of human schistosomiasis during pregnancy: a phase 2, randomised, double-blind, placebo-controlled trial. Lancet Infect Dis. 2016;16:199–208. doi:10.1016/S1473-3099(15)00345-X.
6. Christinet V, Lazdins-Helds JK, Stothard JR, Reinhard-Rupp J. Female genital schistosomiasis (FGS): from case reports to a call for concerted action against this neglected gynaecological disease. Int J Parasitol. 2016;46:395–404. doi:10.1016/j.ijpara.2016.02.006.
7. Female genital schistosomiasis: a pocket atlas for clinical health-care professionals. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/2015.4; http://apps.who.int/iris/bitstream/10665/180863/1/9789241509299_eng.pdf).
8. Brodish PH, Singh K. Association between *Schistosoma haematobium* exposure and human immunodeficiency virus infection among females in Mozambique. Am J Trop Med Hyg. 2016;94:1040–4. doi:10.4269/ajtmh.15-0652.
9. Ouedraogo H, Drabo F, Zongo D, Bagayan M, Bamba I, Pima T et al. Schistosomiasis in school-age children in Burkina Faso after a decade of preventive chemotherapy. Bull World Health Organ. 2016;94:37–45. doi:10.2471/BLT.15.161885.
10. Zoni AC, Catalá L, Ault SK. Schistosomiasis prevalence and intensity of infection in Latin America and the Caribbean countries, 1942–2014: a systematic review in the context of a regional elimination goal. PLoS Negl Trop Dis. 2016;10:e0004493. doi:10.1371/journal.pntd.0004493.
11. Boissier J, Grech-Angelini S, Webster BL, Allienne JF, Huyse T, Mas-Coma S et al. Outbreak of urogenital schistosomiasis in Corsica (France): an epidemiological case study. Lancet Infect Dis. 2016;16:971–9. doi:10.1016/S1473-3099(16)00175-4.
12. Savioli L, Fenwick A, Rollinson D, Albonico M, Ame SM. An achievable goal: control and elimination of schistosomiasis. Lancet. 2015;386:739. doi:10.1016/S0140-6736(15)61536–7. (Comment on Lancet. 2015;385:2220–1. doi:10.1016/S0140-6736(14)61417-3.)
13. Utzinger J, Becker SL, van Lieshout L, van Dam GJ, Knopp S. New diagnostic tools in schistosomiasis. Clin Microbiol Infect. 2015;21:529–42. doi:10.1016/j.cmi.2015.03.014.

5.16 Soil-transmitted helminthiases

Soil-transmitted helminths are intestinal parasitic nematode worms that infect humans and are transmitted through soil contaminated with human faeces containing parasite eggs. These infections, which are among the most common worldwide, affect the poorest and most deprived communities. Those of major concern to humans are *Ascaris lumbricoides* (round worm), *Trichuris trichiura* (whip worm), and *Necator americanus* and *Ancylostoma duodenale* (two hookworm species).

Adult worms colonize the intestine where they produce thousands of eggs each day. In areas of inadequate sanitation or where practices such as open defecation persist, the eggs contaminate the soil and parasitize humans when they are ingested with food or through contaminated hands. Additionally, hookworm eggs hatch in the soil and release larvae that mature into a form that can penetrate the skin. People can therefore also acquire hookworm infections by walking barefoot on contaminated soil. However, infection cannot be transmitted from person to person through fresh faeces because the eggs evacuated in faeces need about 3 weeks to mature in the soil before becoming infective. Since these worms do not multiply in the human host, re-infection occurs only as a result of contact with infective stages in the environment.

The resultant morbidity depends on the quantity of worms a person carries. Light infections are usually asymptomatic, but heavier infections can cause a range of symptoms including diarrhoea and abdominal pain, general malaise and weakness as well as impaired cognitive and physical development. Hookworms cause chronic intestinal blood loss that can result in anaemia. Soil-transmitted helminths also impact the nutritional status of those who are infected in several ways: by feeding on host tissues, including blood, which leads to a loss of iron and protein; and by increasing malabsorption of nutrients causing loss of appetite and therefore a reduction of nutritional intake and physical fitness. In particular, *T. trichiura* can cause diarrhoea and dysentery (*1*).

The main response to infection is control of morbidity through periodic treatment of all populations at risk living in endemic areas. WHO recommends anthelminthic treatment without previous individual diagnosis (*2*). Treatment should be given once a year (when the prevalence of infections in the community exceeds 20%) or twice a year (when the prevalence of infections in the community exceeds 50%). This intervention reduces morbidity by reducing the worm burden. In addition, education on health and hygiene reduces the risk of transmission and reinfection by encouraging healthy behaviours, and provision of adequate sanitation reduces the risk of exposure.

Burden and distribution

The latest estimates for 2014 indicate that approximately 1.5 billion people are infected with soil-transmitted helminths worldwide. Infections are widely distributed in tropical and subtropical areas; most occur in sub-Saharan Africa, the Americas, China and South-East Asia (*1*). About 269 million preschool-aged children (**Fig. 5.35a**) and 572 million school-aged children (**Fig. 5.35b**) live in areas where the causative parasites are intensively transmitted and where treatment and preventive interventions are required. Soil-transmitted infections cause the loss of an estimated 3.39 DALYs; Asia account for about 70% (*3*).

Progress towards Roadmap targets

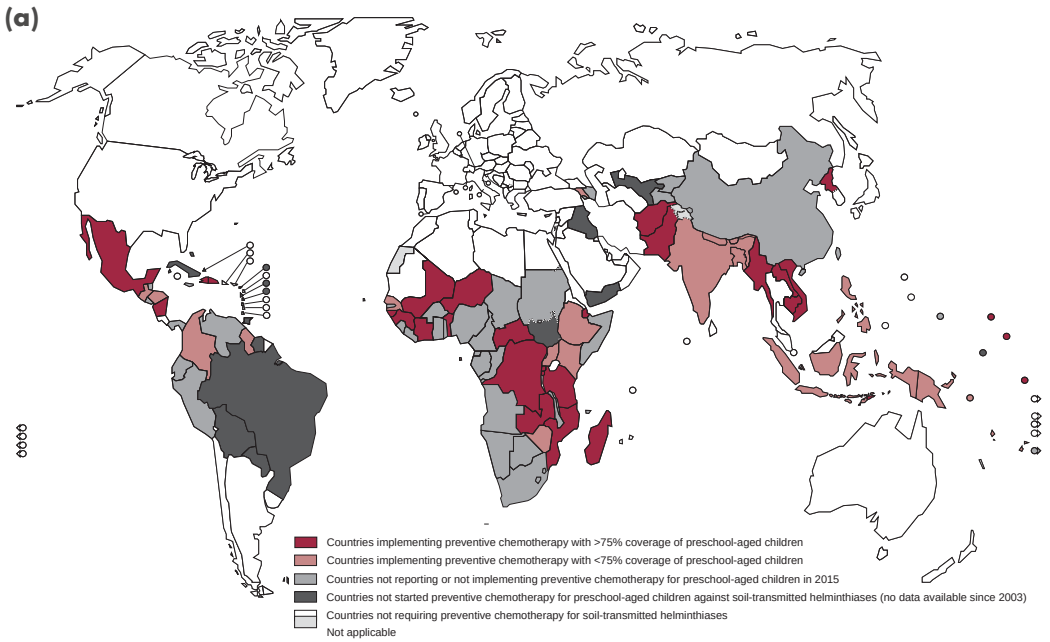
The only definitive control intervention is to improve sanitation so that human excreta no longer contaminates the soil. Despite efforts to achieve this aim during the past 15 years, ensuring access to improved water and sanitation is a challenge in many settings (*4*). Pending improvements in the provision of water, sanitation and hygiene, the most cost–effective way to control morbidity is to provide periodic anthelminthic treatment to populations at risk. The goal of control is to reduce the prevalence of infections to a level low enough for them no longer to be considered a public health problem.

The population groups at risk of morbidity are those who need micronutrients most. These groups include preschool-aged children (estimated number requiring preventive chemotherapy, 266.9 million); school-aged children (estimated number requiring preventive chemotherapy, 567.8 million); and women of reproductive age (estimated number requiring preventive chemotherapy, 250 million). A coverage goal of 75% of the 834.7 million children estimated to require preventive treatment by 2020 has been set for preschool-aged and school-aged children; no specific target for 2020 has been set for women of reproductive age.

More than 75% of children requiring preventive chemotherapy live in countries of WHO's South-East Asia (42%) and African (35%) regions, and approximately 25% live in the Western Pacific Region (9%), the Eastern Mediterranean Region (9%) and the Region of the Americas (5%). Some 2 million children live in countries of the European Region.

Rates of coverage of preventive chemotherapy for preschool-aged children (**Fig. 5.36a**) and school-aged children (**Fig. 5.36b**) have steadily increased from 10% in 2003 to 59.5% in 2015, when 496.8 million children in need of treatment received albendazole or mebendazole.

Fig. 5.35. Countries requiring and implementing preventive chemotherapy for soil-transmitted helminthiases in preschool (a) and school-aged (b) children, worldwide, 2015



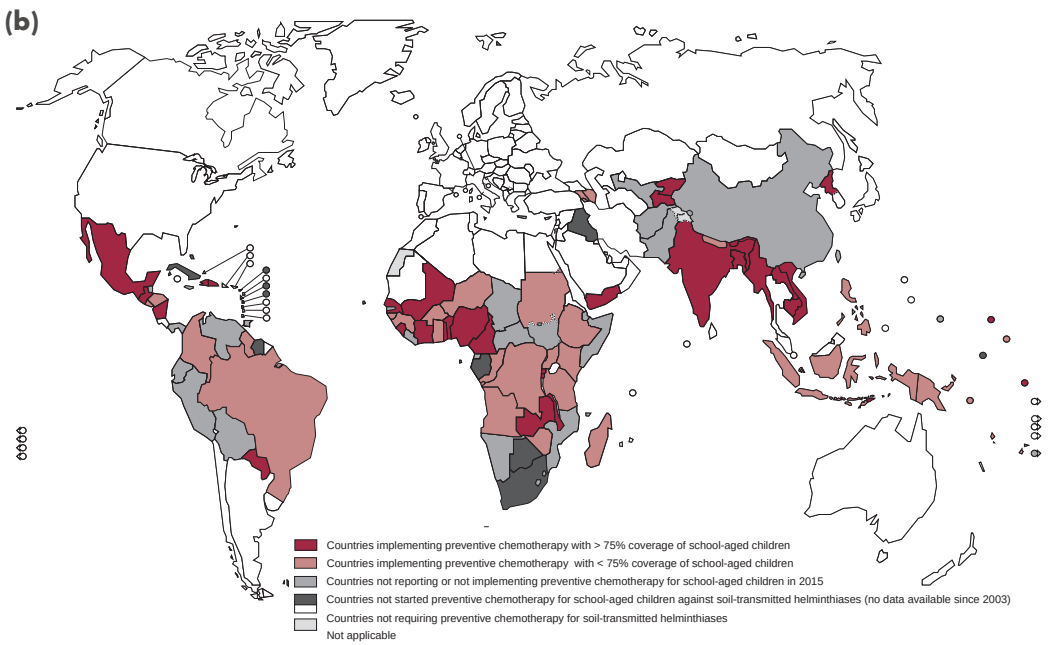
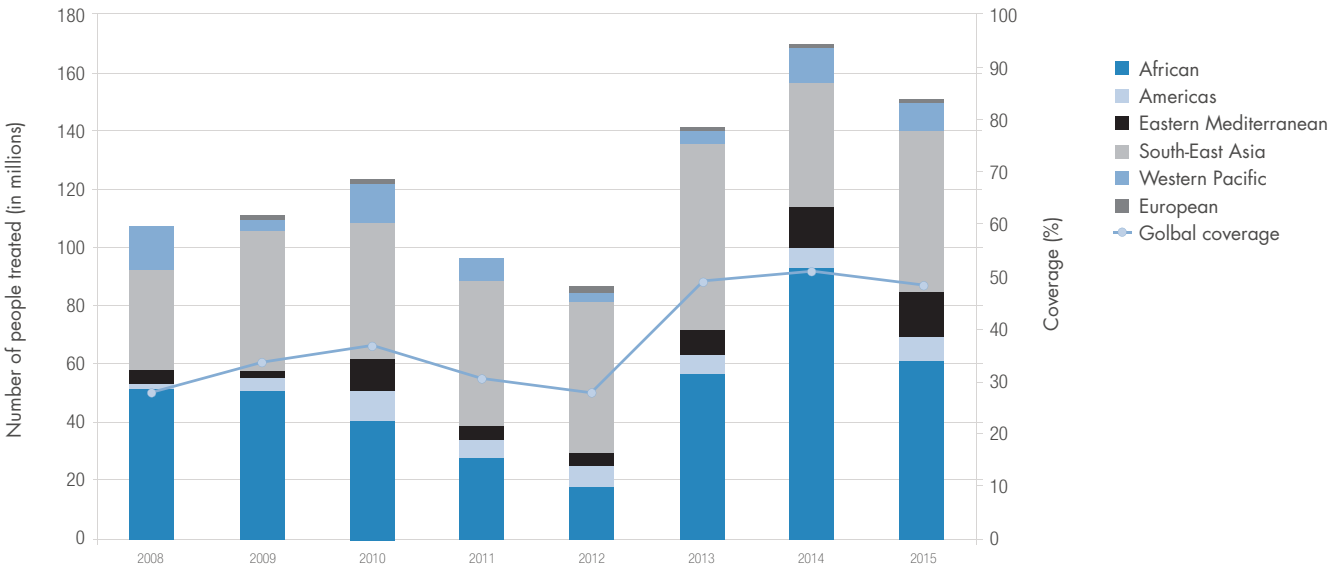
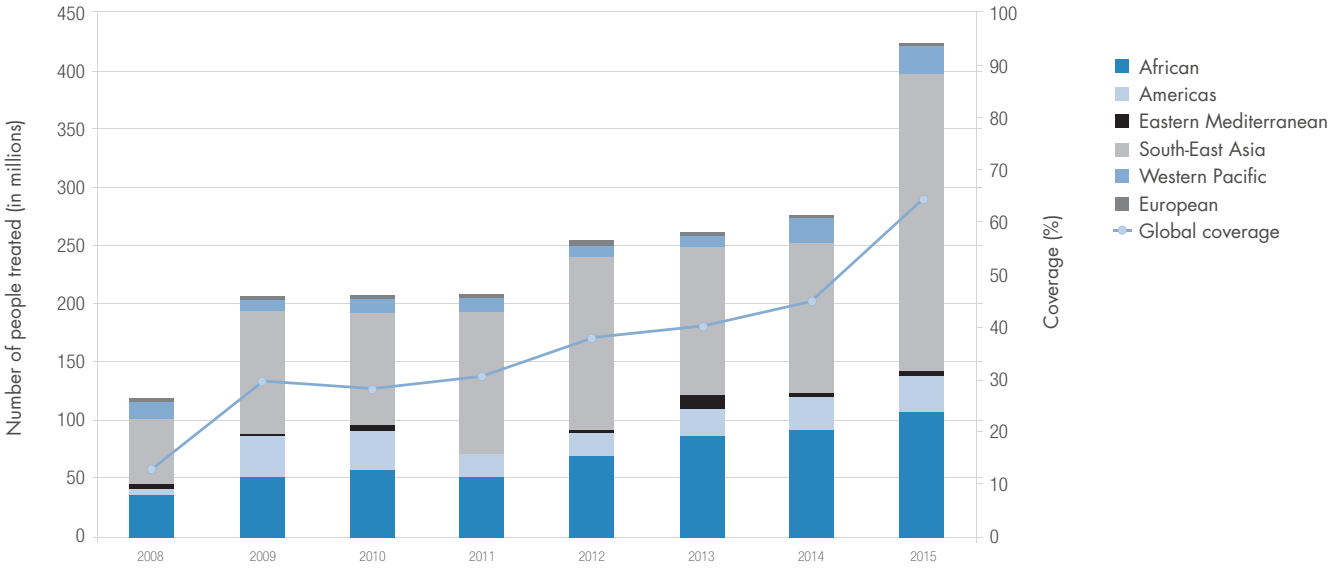


Fig. 5.36. Coverage of preventive chemotherapy for soil-transmitted helminthiases in preschool-aged children (a) and school-aged children (b), by WHO region, 2008–2015

(a)



(b)



Regional updates

African Region. The African Region has the second highest number of children infected with soil-transmitted helminths of all WHO's regions; 286.6 million children require preventive chemotherapy. The four countries where need is highest are the Democratic Republic of the Congo, Ethiopia, Nigeria and the United Republic of Tanzania. Of the 42 countries where preventive chemotherapy is required, 29 have, since 2011, achieved coverage in preschool-aged children exceeding 75% and 19 countries have achieved the same level of coverage for school-aged children. Seven additional countries have demonstrated their ability to reach this high coverage rate in preschool-aged children, and 36 countries have treated more than 75% at least once since 2003. The region has already reached the 2015 milestone and seems well placed to achieve the 2020 target.

Region of the Americas. In most countries of the Region of the Americas the intensity of soil-transmitted helminth infections is low or moderate; 44.7 million children require preventive chemotherapy. Of the 25 countries in which the intervention is required, 10 have, since 2011, achieved coverage exceeding 75% in school-aged children and seven countries have sustained this level of coverage for preschool-aged children. Four additional countries have demonstrated their ability to reach this high coverage level in school-aged children, and 14 countries have treated more than 75% at least once since 2003. The region has also reached the 2015 milestone and is poised to attain the 2020 target.

South-East Asia Region. The burden of soil-transmitted helminthiases is high in most countries in the region. Preventive chemotherapy is required in all countries except the Maldives, Sri Lanka and Thailand; nearly 355 million children require treatment. The South-East Asia Region has the highest number of infected children of all of WHO's regions; most of them are living in Bangladesh, India and Indonesia. However, the region has already reached the 2015 milestone and seems well placed to achieve the 2020 target.

European Region. The European Region has a limited burden of disease linked to soil-transmitted helminth infections; most countries are classified as having no burden and zero countries report a high burden. However, more than 2.4 million children require preventive chemotherapy, especially among marginalized population groups and nomadic populations. Although the region did not meet the 2015 milestone, it seems to have the personnel and the financial resources available to reach the population in need.

Eastern Mediterranean Region. Six of the seven countries in the Eastern Mediterranean Region are endemic for soil-transmitted helminthiases and are classified as having a moderate or high intensity of infection; nearly 75 million children require preventive chemotherapy. The milestone for 2015 was not reached mainly because of problems associated with political instability and ongoing conflict.

Western Pacific Region. The Western Pacific Region is home to more than 71 million children requiring preventive chemotherapy. It has the third highest number of infected children among all WHO regions and two of the largest countries in terms of the numbers of children in need of treatment (China and the Philippines). Although the 2015 milestone was not met, the region seems well placed to achieve the 2020 target (5).

Beyond 2020

Going forward, a number of challenges will have to be faced, including continuing to address environmental concerns – for example, in terms of ensuring access to safe water. A key challenge is how to maintain the benefits of control interventions at a cost that is sustainable for low-income countries. One promising strategy, once morbidity is under control, is to reduce the frequency of administering anthelminthic medicines and to integrate their delivery into national health systems as part of the transition to UHC; the concurrent improvement of sanitation conditions in many countries is expected to further reduce the need for pharmacological intervention.

Another key consideration is how to wind down interventions. Because the degree of integration among programmes varies, the process of discontinuing operations will not be limited to programmes for soil-transmitted helminthiases. For example, a few years after 2020, the programmes for lymphatic filariasis and poliomyelitis will have probably reached their targets, and the large campaigns conducted every year that provide part of the infrastructure for reaching children in order to administer treatment with albendazole and mebendazole will be phased out. The Global Programme to Eliminate Lymphatic Filariasis provides an important platform for distributing albendazole, accounting for 40% of the albendazole treatment administered to school-aged children. The gradual discontinuation of MDA for lymphatic filariasis in India will have only a marginal impact on the coverage of school-aged children because a national school deworming programme has been established. Coordination between the national programmes on lymphatic filariasis and soil-transmitted helminthiases should involve a review of the plans for implementing TAS and the appropriate measures needed to maintain the deworming coverage in all targeted populations.

The progressive winding down of the Global Polio Eradication Initiative that is expected may also impact the coverage of preventive chemotherapy for soil-transmitted helminth infections. The Initiative also provides an important platform for distributing albendazole (around 60% of the albendazole treatment to preschool-aged children). Those areas in which financial support to child health days or immunization days will be discontinued when the eradication objective is achieved should be carefully evaluated and appropriate measures taken to maintain the present deworming activities.

The winding down of programmatic activities will need to be integrated into broader health systems as part of the transition to UHC. A key objective of the control programme, once the control targets have been reached, will be progressively to reduce preventive chemotherapy and transfer responsibility for distributing anthelminthic medicines to countries where the diseases are endemic. In this context, efforts to control soil-transmitted helminthiases should focus on reducing the cost of distributing albendazole and mebendazole.

The main costs of a preventive chemotherapy programme are training of personnel, procurement of medicines, and distribution and monitoring activities. It is expected that training costs will reduce dramatically as programmes reach maturity. In order to minimize costs in other areas it will be necessary to:

- maintain donations of anthelminthic medicines to enable the programme to focus on local costs;
- use TAS surveys organized in the context of the Global Programme to Eliminate Lymphatic Filariasis as an opportunity to collect data on soil-transmitted helminthiases (a manual to facilitate the collection of epidemiological data during the final phases of the Global Programme to Eliminate Lymphatic Filariasis is available (*6*));
- reduce the frequency of preventive chemotherapy once low levels of prevalence and intensity are reached by using the decision tree that WHO has published for this purpose (*7*);
- institutionalize preventive chemotherapy (for example by routinely providing it to all children entering the first year of school and during the last year of primary school); and
- support efforts by countries to improve sanitation by sharing epidemiological data with partners in the water, sanitation and hygiene sectors and focusing interventions on areas in need of improvement.

The following issues have been identified and may affect progress beyond 2020.

Antimicrobial resistance. Every year, preventive chemotherapy programmes administer more than 1 billion tablets of albendazole and mebendazole. Distribution on this scale increases the likelihood of antimicrobial resistance. Veterinary research has demonstrated that helminths can acquire resistance to benzimidazoles. It is therefore essential to monitor periodically the efficacy of medicines and to develop and test alternative deworming agents. One simple option would be to test combinations of anthelminthic medicines used in the past; those found effective could then be brought to market in a relatively short time.

Water, sanitation and hygiene. Lack of adequate sanitation amplifies transmission of soil-transmitted helminths and is expected to remain a problem after 2020 in many countries where these diseases are endemic. For this reason, in areas where levels of sanitation are insufficient to impede environmental contamination, it is likely that the prevalence of soil-transmitted helminth infections will return to levels recorded before preventive chemotherapy a few years after control programmes have been discontinued. Therefore, programmes should be discontinued only when levels of water, sanitation and hygiene services are sufficient to impede environmental contamination with human faeces.

It is to be hoped that the SDG goal for clean water and sanitation, particularly target 6.2 ("by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation"), will serve to direct efforts. If environmental contamination with human excreta is substantially reduced, then it should be possible to progressively reduce and, in many places, stop preventive chemotherapy altogether.

It is essential therefore that all partners working to control soil-transmitted helminthiases reinforce the message on sanitation, begin dialogue with institutions working to improve sanitation standards in endemic countries, and share epidemiological data with them. The data on transmission of these infections are one of the more meaningful indicators of a lack of sanitation infrastructure. These data can be used to identify those communities in need of improved sanitation as well as preventive chemotherapy interventions.

References

1. Soil-transmitted helminth infections. In: World Health Organization; Media Centre [website]. Geneva: World Health Organization; 2017 (http://www.who.int/mediacentre/factsheets/fs366/en/, accessed 6 March 2017).
2. Preventive chemotherapy in human helminthiasis. Coordinated use of anthelminthic drugs in control interventions: a manual for health professionals and programme managers. Geneva: World Health Organization; 2006 (http://apps.who.int/iris/bitstream/10665/43545/1/9241547103_eng.pdf).
3. Global Health Estimates. In: World Health Organization, Health Statistics and Information systems [website]. Geneva: World Health Organization; 2017 (www.who.int/evidence/bod, accessed 17 March 2017).
4. Bain R, Cronk R, Wright J, Yang H, Slaymaker T, Bartram J. Fecal contamination of drinking water in low- and middle-income countries: a systematic review and meta-analysis. PLoS Med. 2014;11:e1001644. doi:10.1371/journal.pmed.1001644.
5. Control of soil-transmitted helminth infections: progress report 2010 to 2015 and strategy to reach the 2020 targets. Geneva: World Health Organization; 2017 [in press].
6. Helminth control in school-age children: a guide for managers of control programmes. 2nd ed. Geneva: World Health Organization; 2011 (http://apps.who.int/iris/bitstream/10665/44671/1/9789241548267_eng.pdf).
7. Assessing the epidemiology of soil-transmitted helminths during a transmission assessment survey (TAS) in the Global Programme for the Elimination of Lymphatic Filariasis. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/PCT/2015.2; http://apps.who.int/iris/bitstream/10665/153240/1/9789241508384_eng.pdf).

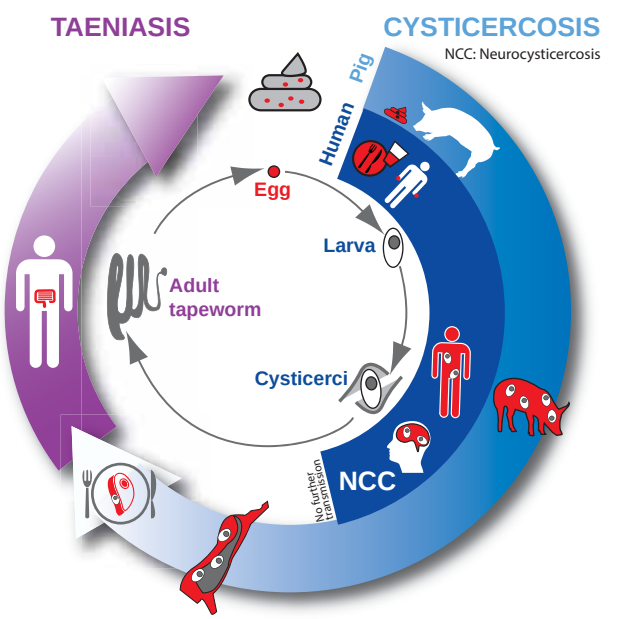
5.17 *Taenia solium* taeniasis and neurocysticercosis

Taeniasis is a parasitic infection of humans and animals caused by the pork tapeworm *Taenia solium*. Humans become infected by eating raw or undercooked pork containing the larval cysts (cysticerci) of the tapeworm; the larvae develop into a tapeworm in the intestine and excrete eggs (invisible to the naked eye) into the environment through infective human stools. Pigs become infected by eating human stool containing eggs or by ingesting eggs from the environment, which develop into small cysts throughout the pig's body, especially in the muscle tissue (porcine cysticercosis) (Fig. 5.37).

Humans can also acquire *T. solium* eggs by ingesting contaminated food or water (human cysticercosis) or as a result of poor hygiene. Tapeworm larvae develop in the muscles, eyes, under the skin, and in the central nervous system where they cause neurocysticercosis, symptoms of which may include epilepsy, severe headache and blindness. The disease can be fatal (*1*). Neurocysticercosis is the leading preventable cause of epilepsy worldwide (*2,3*).

Because taeniasis and cysticercosis are transmitted from humans to animals and vice versa, they are linked to water and sanitation as well as sociocultural factors such as defecation habits, food preparation and personal hygiene. Their control therefore calls for integrated approaches that span the public health, veterinary and environmental sectors.

Fig. 5.37. Transmission cycle of *Taenia solium* taeniasis and cysticercosis



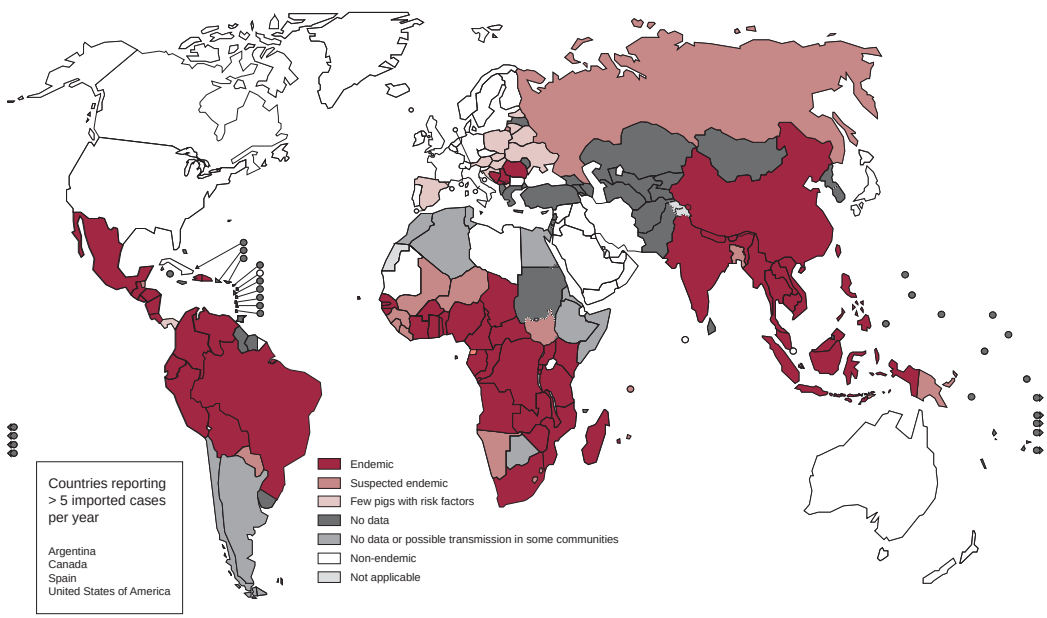
Burden and distribution

Lack of systematic surveillance means that data on taeniasis are unreliable. However, there are indications that the prevalence of cysticercosis may be increasing in different parts of the world as production and consumption of pork increase (Fig. 5.38). *T. solium* cysticercosis prevails in areas where humans live close to pigs, sanitation is inadequate and porcine management is poorly understood. Cysticercosis has been a serious public health problem in Latin America for decades (*4*). The disease is endemic in South and South-East Asia (*5*) and evidence is accumulating for its presence in large areas of sub-Saharan Africa (*6,7*). Cases of neurocysticercosis have been reported in the developed world, including in Europe (*8,9*) and the United States of America (*10*).

Estimates from the WHO Foodborne disease burden Epidemiology Reference Group in 2015 identified *T. solium* as a leading cause of death from foodborne diseases, accounting for an estimated 28 000 deaths per year and 2.8 million DALYs globally (*12*). The contribution of *T. solium* to the number of DALYs was especially high for many African, South American and some South-East Asian subregions (Fig. 5.39). These data underscore the global importance of the *T. solium* disease complex (*13*).

The total number of people with neurocysticercosis, including symptomatic and asymptomatic cases, is estimated at between 2.56 million and 8.30 million (*1*), based on the range of prevalence data available for epilepsy. Neurocysticercosis is estimated to be the cause of around 30% of all epilepsy cases in endemic countries (*3*), and

Fig. 5.38. Endemicity of *Taenia solium*, worldwide (In the absence of conclusive data, classification of the disease is based on a combination of indicators on the biological cycle of *T. solium*, including human and porcine cysticercosis cases, water and sanitation, pig production, population data and geographical conditions)



Source: reference *11*

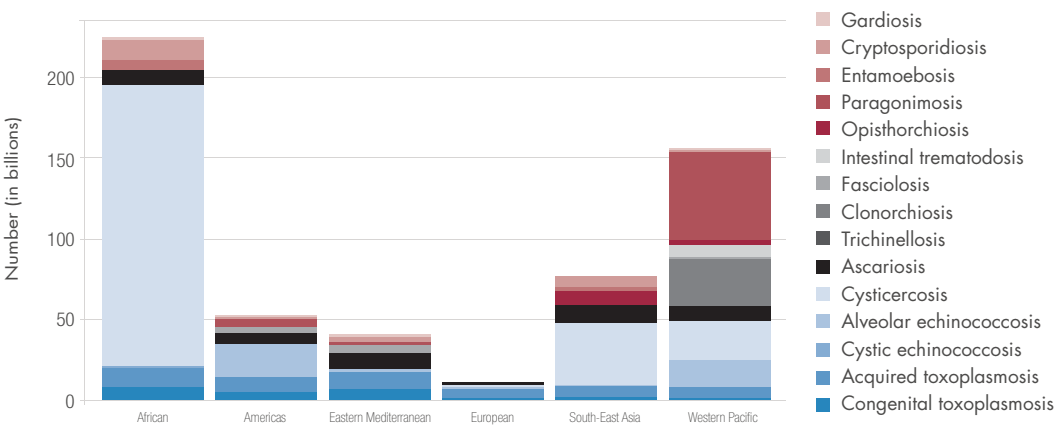
is also reported as a cause of death. The annual proportion of deaths caused by epilepsy associated with neurocysticercosis has been estimated at 6.9% incident cases in Cameroon (*14*) and 0.5% in Mexico (*15*). Neurocysticercosis burdens health systems, economies, societies and individuals because of the impact of epilepsy on wages and health costs and the stigmatization of those with the disease (*16*). Where access to health services is limited, mortality from neurocysticercosis is about 3–6 times higher than in the general population (*2*).

Progress towards Roadmap targets

The Roadmap sets two targets for control of *T. solium* taeniasis and neurocysticercosis: by 2015, to have available a validated strategy for control and elimination of *T. solium* taeniasis and cysticercosis, and, by 2020, to have expanded interventions for control and elimination of *T. solium* taeniasis and cysticercosis.

The 2015 target was not met. A WHO landscape analysis published in 2015 (*17*) of current evidence for *T. solium* control confirmed the importance of cross-sectoral approaches, including community-level pig and human public health interventions, deworming and vaccination of pigs, and improving diagnostic capacities and sanitation. However, few conclusive studies exist indicating the optimal combination of existing tools and interventions to break the transmission cycle and control the disease (*18*). Following an informal consultation (Geneva, 2014) on assembling a framework to intensify control of taeniasis and cysticercosis (*19*), several countries including Brazil, China, Côte

Fig. 5.39. Contribution of causative pathogen to foodborne disability-adjusted life-years (DALYs), by WHO region, 2010



Source: reference *12*

d'Ivoire, Madagascar and Viet Nam have initiated or strengthened national projects or programmes (*16*). At a follow-up meeting (Paris, June 2016) countries reiterated the need for clear guidance on a step-wise approach to develop control programmes, as well as targeted advocacy from FAO, OIE and WHO to encourage political commitment in their governments. WHO, together with partners from FAO and OIE, as well as the research community, remains committed to working towards the preparation of such operational guidelines.

In the Region of the Americas, endemic countries were invited to complete a survey to establish a baseline of their capacity to advance prevention and control of *T. solium* taeniasis and cysticercosis. At the first regional meeting (Colombia, October 2015) attended by 12 endemic countries, the proposed protocol of intervention was refined. The meeting highlighted the need for an operational manual to support planning and interventions in countries as well as management of cases of neurocysticercosis, and the need to create a regional network to share experiences and best practices. A meeting of experts (Mexico, July 2016) elaborated operational guidelines for identifying endemic risk areas and the implementation of the protocol.

The Western Pacific Region will provide support to Cambodia and the Lao People's Democratic Republic in mapping taeniasis and foodborne trematodes in some communities. Integrated control of other NTDs, for example by combining rabies vaccination and deworming with praziquantel in dogs, is being considered.

Beyond 2020

The inclusion of a target to control morbidity from *T. solium* taeniasis and cysticercosis in the Roadmap and the prioritization of interventions in recognition of their burden suggest that more ambitious targets beyond 2020 could be reached. In large parts of Europe and the United States of America, cases of *T. solium* and cysticercosis were reduced almost to zero during the 20th century. In Peru, a project has shown the feasibility of eliminating *T. solium* from a rural region with a population of 81 170 people and 55 638 pigs (*20*). The success of the project indicates that elimination is feasible, and provides valuable information on strategies that could be adapted to interrupt transmission of *T. solium* and improve case detection and management of neurocysticercosis. Madagascar started a pilot study using public awareness-raising and MDA against *T. solium* as primary interventions. In 2015 and 2016, about 65 000 people aged over 5 years were treated each year with anthelminthics in a pilot study in a district of previously high endemicity for *T. solium* infection. The success of this study in lowering the burden will be evaluated by comparing the prevalences of human taeniasis and porcine cysticercosis at baseline and after a 3-year annual treatment protocol. WHO and its partners will continue to compile experiences and guidance for countries with a view to preparing a manual on intervention options for the control and eventual elimination of cysticercosis.

Specific interventions to be considered include:

- **Preventive chemotherapy** of human populations at risk. The efficacy and safety of this type of intervention is being investigated on a broader scale, for example in the Madagascar project.

- **Vaccination and chemoprophylaxis in pigs**. Prevention and control of porcine cysticercosis are important to break the transmission cycle. Vaccination and chemoprophylaxis in pigs have been widely used as a control strategy, with demonstrated high efficacy in protecting pigs from cysticercosis (*21,20*); a pig vaccine is now commercially available and produced in India. The vaccine is a good example of how a single veterinary public health intervention can reap several advantages simultaneously. Vaccination has the potential to improve pig health, and increase market prices for pigs and the value of pork meat in the food value chain, while contributing to breaking the transmission cycle and thereby preventing epilepsy through neurocysticercosis in humans.
- **Improved sanitation**. Ensuring that sanitation facilities are adequate, available and advantageous yields benefits for public health beyond control of *T. solium*.
- **Better pig farming practices**. Encouraging farmers to adopt better pig farming practices, specifically by confining their pigs to prevent them from accessing human faecal material.
- **Meat inspection and processing**. Inspecting meat and its processing in order to break the life-cycle of *T. solium*, which is considered to be the most important foodborne parasitic infection.
- **Health education**. Health education campaigns can target the general population, health workers, pig farmers and meat workers, and focus on the biology of the disease, improvements in meat preparation and personal hygiene, and the need for adequate sanitation and improved pig husbandry.

Generally, these interventions call for a broad intersectoral perspective based on a One Health approach. As other zoonotic diseases, *T. solium* taeniasis and cysticercosis are closely interlinked with other sectors and their control extends beyond the health SDG 3. As an example, interventions such providing clean water and sanitation targeted in SDG 6 will be effective in controlling this parasite, with targets to improve water quality, halve wastewater and end open defecation. Control of taeniasis and cysticercosis needs to be integrated with other NTD programmes requiring similar interventions (*22,23*), other WHO departments involved in mental health, research and development, food safety, water and sanitation as well as partner agencies such as FAO and OIE to meet the needs for interdisciplinary collaboration to control *T. solium*. The final goal is to prevent human suffering from neurocysticercosis.

In May 2015, the Sixty-eighth World Health Assembly adopted resolution WHA68.20 on the global burden of epilepsy and the need for coordinated action at the country level to address its health, social and public knowledge implications. The resolution urged Member States to promote actions to prevent the causes of epilepsy, using evidence-based interventions, within the health sector and in other sectors outside health. WHO is leading the development of evidence-based standard guidelines for diagnosis and treatment of neurocysticercosis (to be published in 2017).

Diagnosis of taeniasis and neurocysticercosis requires laboratory tools and neuroimaging techniques. WHO in collaboration with TDR initialized a process in December 2015 that should address the lack of a suitable diagnostic toolbox for taeniasis, cysticercosis

and neurocysticercosis for care of patients and surveillance purposes in low-resource settings (*24*). Laboratory and country programme delegates have compiled priorities for newly developed diagnostic methods in target product profiles, which are currently being further defined in broad consultation and will lead to guidance for better targeted tools.

References

1. Landscape analysis: management of neurocysticercosis with an emphasis on low- and middle-income countries. Geneva: World Health Organization; 2015 (WHO/HTM/NTD/NZD/2015.05; http://apps.who.int/iris/bitstream/10665/152896/1/WHO_HTM_NTD_NZD_2015.05_eng.pdf).
2. Torgerson PR, Macpherson CN. The socioeconomic burden of parasitic zoonoses: global trends. Vet Parasitol. 2011;182:79–95. doi:10.1016/j.vetpar.2011.07.017.
3. Ndimubanzi PC, Carabin H, Budke CM, Qian YJ, Rainwater E, Dickey M et al. A systematic review of the frequency of neurocysticercosis with a focus on people with epilepsy. PLoS Negl Trop Dis. 2010;4:e870. doi:10.1371/journal.pntd.0000870.
4. Bruno E, Bartoloni A, Zammarchi L, Strohmeyer M, Bartalesi F, Bustos JA et al. Epilepsy and neurocysticercosis in Latin America: a systematic review and meta-analysis. PLoS Negl Trop Dis. 2013;7:11. doi:10.1371/journal.pntd.0002480.
5. Ito A, Wandra T, Li T, Dekumyoy P, Nkouawa A, Okamoto M, Budke CM. The present situation of human taeniasis and cysticercosis in Asia. Recent Patents on Anti-Infective Drug Discovery. 2014:9:173–185.
6. Braae UC, Saarnak CFL, Mukaratirwa S, Devleesschauwer PM, Johansen MV. *Taenia solium* taeniosis/cysticercosis and the co-distribution with schistosomiasis in Africa. Parasit Vectors. 2015;8:323. doi:10.1186/s13071-015-0938-7.
7. Gabriël S, Dorny P, Mwape KE, Trevisan C, Braae UC, Magnussen P et al. Control of *Taenia solium* taeniasis/cysticercosis: the best way forward for sub-Saharan Africa? Acta Trop. 2017;165:252–60. doi:10.1016/j.actatropica.2016.04.010.
8. Fabiani S, Bruschi F. Neurocysticercosis in Europe: still a public health concern not only for imported cases. Acta Trop. 2013;128:18–26. doi:10.1016/j.actatropica.2013.06.020.
9. Devleesschauwer B, Allepuz A, Dermauw V, Johansen MV, Laranjo-González M, Smit GS et al. *Taenia solium* in Europe: still endemic? Acta Trop. 2017;165:96–9. doi:10.1016/j.actatropica.2015.08.006.
10. Serpa JA, White AC. Neurocysticercosis in the United States. Pathog Glob Health. 2012;106:256–60.doi:10.1179/2047773212Y.0000000028.
11. *Taenia solium*: WHO endemicity map. In: Donadeu M, Lightowlers MW, Fahrion AS, Kessels J, Abela-Ridder B. Wkly Epidemiol Rec. 2016;49/50:595 (http://apps.who.int/iris/bitstream/10665/251913/1/WER9149_50_595-599.pdf, accessed 10 March 2017).
12. Torgerson P, Devleesschauwer B, Praet N, Speybroeck N, Willingham AL, Kasuga F et al. World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: a data synthesis. PLoS Med. 2015;12:e1001920. doi:10.1371/journal.pmed.1001920.
13. WHO estimates of the global burden of foodborne diseases: foodborne disease burden epidemiology reference group 2007–2015. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/199350/1/9789241565165_eng.pdf).

14. Praet N, Speybroeck N, Manzanedo R, Berkvens D, Nsame Nforninwe D, Zoli A et al. The disease burden of *Taenia solium* cysticercosis in Cameroon. PLoS Negl Trop Dis. 2009,3:e406. doi:10.1371/journal.pntd.0000406.
15. Bhattarai R, Budke CM, Carabin H, Proano JV, Flores-Rivera J, Corona T et al. Estimating the non-monetary burden of neurocysticercosis in Mexico. PLoS Negl Trop Dis. 2012;6:e1521. doi:10.1371/journal.pntd.0001521.
16. Preventable epilepsy: *Taenia solium* infection burdens economies, societies and individuals. A rationale for investment and action. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/NZD/2016.1; http://apps.who.int/iris/bitstream/10665/204716/1/9789241549486_eng.pdf).
17. Thomas LF. Landscape analysis: control of *Taenia solium*. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/164359/1/9789241508643_eng.pdf).
18. Carabin H, Traoré AA. *Taenia solium* taeniasis and cysticercosis control and elimination through community-based interventions. Curr Trop Med Rep. 2014;1:181–93. doi:10.1007/s40475-014-0029-4.
19. Assembling a framework for intensified control of taeniasis and neurocysticercosis caused by *Taenia solium*: report of an informal consultation. Geneva; World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/153237/1/9789241508452_eng.pdf).
20. Garcia HH, Gonzalez AE, Tsang VC, O'Neal SE, Llanos-Zavalaga F, Gonzalvez G et al. Elimination of *Taenia solium* transmission in northern Peru. N Engl J Med. 2016;374:2335–44. doi:10.1056/NEJMoa1515520.
21. Assana E, Kyngdon CT, Geerts S, Dorny P, De Deken R, Anderson GA et al. Elimination of *Taenia solium* transmission to pigs in a field trial of the TSOL18 vaccine in Cameroon. Int J Parasitol. 2010;40:515–9. doi:10.1016/j.ijpara.2010.01.006.
22. Braae UC, Saarnak CFL, Mukaratirwa S, Devleesschauwer B, Magnussen P, Vang Johansen M. *Taenia solium* taeniasis/cysticercosis and the co-distribution with schistosomiasis in Africa. Parasit Vectors. 2015;8:323. doi:10.1186/s13071-015-0938-7.
23. Braae UC et al. Effect of National Schistosomiasis Control Programme on *Taenia solium* taeniosis and porcine cysticercosis in rural communities of Tanzania. Parasite Epidemiol Control. 2016;1:245–51. http://dx.doi.org/10.1016/j.parepi.2016.08.004.
24. *Taenia solium* taeniasis/cysticercosis diagnostic tools: report of a stakeholder meeting. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/NZD/2016.4; http://apps.who.int/iris/bitstream/10665/206543/1/9789241510516_eng.pdf).

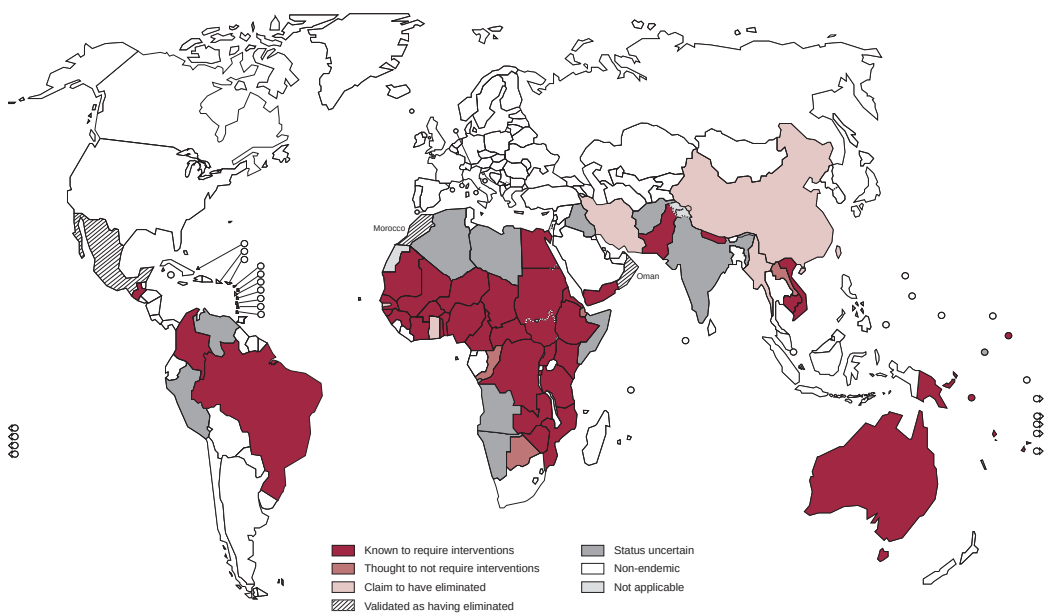
5.18 Trachoma

Trachoma is a bacterial disease of the eye that results from infection with *Chlamydia trachomatis*. The disease accounts for about 1.4% of all cases of blindness worldwide (*1*). The bacterium is transmitted through contact with infected discharge from the eyes and nose; it is also spread by flies. Repeated episodes of inflammation and resolution precipitated by ocular *C. trachomatis* infection and occurring over years to decades generate conjunctival scarring. In some individuals, this causes the eyelashes to turn inward (trichiasis) and rub the surface of the eye, causing pain every time a person blinks and damaging the cornea. Corneal damage leads to corneal scarring and also provides a portal of entry for infection with other bacteria and fungi. Left untreated, trichiasis leads to the formation of irreversible opacities, with resulting visual impairment or blindness. The age at which these conditions manifest depends on several factors including the intensity of local transmission. In very highly endemic communities, blindness can occur in childhood, although the onset of visual impairment more typically occurs between the ages of 30–40 years.

Burden and distribution

An estimated 3.2 million people require surgery for trichiasis and 450 000 are irreversibly blind (*1,2*). About 192 million people live in areas endemic for trachoma where they are at risk of trachomatous blindness. Trachoma is a public health problem in many of the poorest and most remote areas of 42 countries in Africa, Asia, Central and South America, Australia and the Middle East (**Fig. 5.40**) (*2*).

Fig. 5.40. Burden of trachoma, worldwide, 2015



Africa, the continent worst affected, has an estimated 1.9 million cases of trichiasis (61% of all cases globally) distributed across 29 of the 47 countries in WHO's African Region. Ethiopia has 22% of the total estimated burden of trichiasis (*2*); Ethiopia and South Sudan have the highest prevalences of active trachoma. In some parts of these countries, active disease is present in more than 50% of children aged 1–9 years. The risk of blindness from trachoma is considerably greater in women than in men.

Progress towards Roadmap targets

In 1998 the Fifty-first World Health Assembly resolved to eliminate trachoma as a public health problem (WHA51.11). The Roadmap sets a target date of 2020 to achieve the elimination objective. Elimination is defined as a reduction in the prevalence of trachomatous trichiasis "unknown to the health system" to less than 1 case per 1000 total population (where "known" cases are those in which trichiasis has recurred after surgery, those who refuse surgery, or those yet to undergo surgery whose surgical date is set); and a reduction in the prevalence of the active trachoma sign "TF" (a measure of trachomatous inflammation) in children aged 1–9 years to less than 5% (*3*).

Elimination of trachoma is technically feasible through implementation of the SAFE strategy. The strategy comprises Surgery for individuals with trichiasis, Antibiotics to reduce the reservoir of ocular chlamydial infection, and Facial cleanliness and Environmental improvement to reduce transmission. The strategy has been endorsed by WHO since 1993. An international partnership – the WHO Alliance for the Global Elimination of Trachoma by 2020, or GET2020 – comprises Member States where the disease is endemic, nongovernmental organizations, academic institutions, donors and other interested parties. The Alliance was established in 1996 with the aim of fostering planning, advocacy, research and programme coordination towards the trachoma elimination goal (*4*). The Alliance held its 20th meeting in April 2016.

Significant progress has been made in generating data for programme planning and elimination validation purposes, thanks to strong partnerships among health ministries, nongovernmental organizations and research institutions within the Global Trachoma Mapping Project (*5*). This enormous project, funded by the United Kingdom's Department for International Development and the United States Agency for International Development, completed population-based prevalence surveys in 1542 districts in which trachoma was suspected but for which prevalence data had not previously been available. The data generated by the project permit planning of interventions against trachoma where needed, and removal from the list of suspected endemic districts of those areas in which trachoma was not found at levels sufficient to constitute a public health problem. The project also led directly to the establishment of Tropical Data, launched in July 2016 to support national programmes to conduct prevalence surveys for trachoma, wherever required.

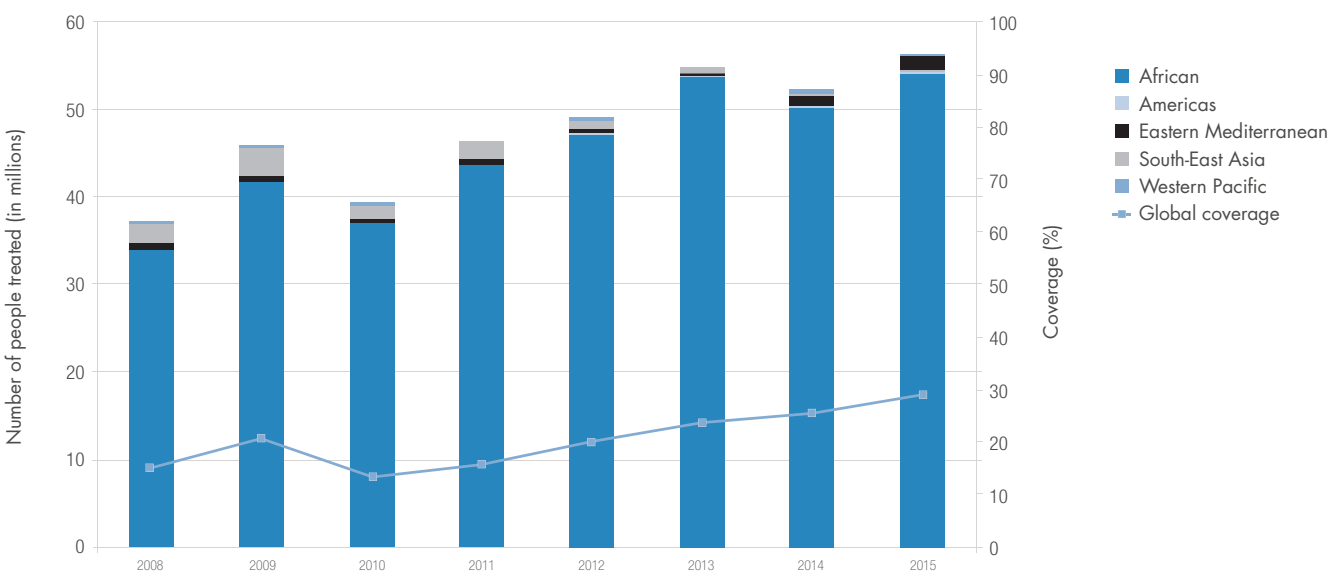
Most countries endemic for trachoma have now set elimination target dates, and have agreed with partners to accelerate implementation of the SAFE strategy. The task of setting aggressive but realistic national and subnational targets and determining the steps required to make them possible is greatly assisted by the existence of a formal planning process, known as "trachoma action planning" (*6*). National programmes are

further supported in this process by the availability of various manuals and preferred practice documents that provide guidance on implementing the components of the SAFE strategy. Delivering high-quality interventions is a continuing focus, as exemplified by the introduction in 2014 of a mannequin-based (*7*) training system for trichiasis surgery.

In 2015, more than 185 000 patients had surgery for trichiasis worldwide (**Fig. 5.41**) and more than 56 million people received antibiotics for trachoma. Thanks to strengthening support from donors, greatly increased global coverage is anticipated in 2016. Links with water, sanitation and hygiene (WASH)-related efforts that underpin the effective delivery of the F and E components of the SAFE strategy are also strengthening in line with WHO's joint NTD–WASH global strategy 2015–2020 (*8*). Priority areas have become more clearly defined with the publication in 2016 of *Eliminating trachoma: accelerating towards 2020* (*2*); so too have remaining gaps in programme funding.

By the end of January 2017, WHO had validated three countries (Mexico, Morocco and Oman) as having eliminated trachoma as a public health problem. A further six countries (China, the Gambia, Ghana, the Islamic Republic of Iran, Lao People's Democratic Republic and Myanmar) have also reported achieving the elimination targets, and steps are being taken to evaluate their claims in line with WHO's standard operating procedures for validation (*3*). In other settings, political instability, insecurity and public health emergencies have slowed and, in some cases, reversed previous gains. It is currently unclear to what extent such forces will impact progress towards the GET2020 goal.

Fig. 5.41. Number of people receiving antibiotics for trachoma worldwide, by WHO region, 2008–2015



While much progress has been made, challenges remain. Research can play an important role in meeting them, and is urgently needed in a number of areas:

- to determine the place of alternative diagnostic strategies (to supplement or replace clinical diagnosis) within impact surveys and during the surveillance phase;
- to test decision algorithms for discontinuing mass antibiotic treatment;
- to investigate the efficacy and safety of co-administering azithromycin with other preventive chemotherapy agents;
- to design strategies for accurately estimating antibiotic coverage;
- to optimize methods for detecting trichiasis cases and encouraging them to seek surgery;
- to determine how best to manage lower lid and recurrent trichiasis; and
- to establish how to most effectively and cost–effectively implement the facial cleanliness and environmental improvement components of the SAFE strategy.

A nascent network of WHO Collaborating Centres for Trachoma is working with national programmes to address these and other questions relevant to trachoma elimination.

Beyond 2020

Targets for trachoma after 2020 will depend primarily on the extent to which the GET2020 goal is achieved. As of 1 March 2016, there were 144 districts (*2*) worldwide, representing a population of 16.3 million people, in which the baseline prevalence of TF mandates at least three annual rounds of azithromycin MDA (together with appropriate implementation of the F and E components of SAFE) before re-survey, and in which MDA had not yet commenced. As a result, there will undoubtedly be countries which, by December 2020, will not have completed 2 years of surveillance after cessation of interventions in each formerly endemic district. Of these 144 districts, 36 had baseline prevalences of active trachoma mandating at least five annual rounds of azithromycin MDA before re-survey; for such districts in which distribution was not possible in 2016, the first phase of programme implementation will not have finished by December 2020.

Additionally, as of 1 March 2016, there were an estimated 3.2 million people with trichiasis worldwide, while delivery of trichiasis surgery worldwide has only once resulted in the treatment of more than 200 000 people in a calendar year. Many programmes report difficulties in finding numbers of cases commensurate with predicted local backlogs. Whether such numbers are actually over-estimates based on prevalence calculations before the inception of the Global Trachoma Mapping Project, or significant acceleration in delivery is still needed across many countries, or both, is not presently known. Achieving agreed public health endpoints, including implementation of appropriate surveillance, must be the first priority for the global programme.

After elimination is validated, it is inevitable that some individuals living in communities that are currently or have previously been endemic for trachoma will continue to develop incident trichiasis (*9*). Those individuals need surgery to prevent trachoma-related blindness. In order for elimination of trachoma as a public health problem to be validated, there is a requirement for the health system to be able to identify and manage incident trichiasis cases, using defined strategies, with evidence of appropriate financial resources to implement them (*3*). It should be noted that in many areas, surgery for trichiasis is one of the few surgical services to which the population has ready access, making it a beachhead for efforts to improve the delivery of safe, affordable, basic surgery for all as a part of the movement towards UHC.

References

1. Bourne RR, Stevens GA, White RA, Smith JL, Flaxman SR, Price H et al. Causes of vision loss worldwide, 1990–2010: a systematic analysis. Lancet Glob Health. 2013;1:e339–49. doi:10.1016/S2214-109X(13)70113-X.
2. Eliminating trachoma: accelerating towards 2020. London: International Coalition for Trachoma Control; 2016 (http://www.trachomacoalition.org/sites/all/themes/report-2016/PDF/GET2020_2016_EN.pdf).
3. Validation of elimination of trachoma as a public health problem. Geneva: World Health Organization; 2016 (WHO/HTM/NTD/2016.8; http://apps.who.int/iris/bitstream/10665/208901/1/WHO-HTM-NTD-2016.8-eng.pdf).
4. Planning for the global elimination of trachoma (GET): report of a WHO consultation. Geneva: World Health Organization; 1997 (WHO/PBL/97.60; http://apps.who.int/iris/bitstream/10665/66169/1/WHO_PBL_97.60.pdf).
5. Solomon AW, Pavluck AL, Courtright P, Aboe A, Adamu L, Alemayehu W et al. The Global Trachoma Mapping Project: methodology of a 34-country population-based study. Ophthalmic Epidemiol. 2015;22:214–25. doi:10.3109/09286586.2015.1037401.
6. Trachoma action planning: a planning guide for the national elimination of blinding trachoma. London: International Coalition for Trachoma Control; 2015 (http://www.trachomacoalition.org/sites/default/files/content/resources/files/ICTC%20TAP%20planning%20guide%20eng.pdf).
7. Gower EW, Kello AB, Kollmann KHM. Training trichiasis surgeons: ensuring quality. Community Eye Health 2014;27:58. PMCID: PMC4322749.
8. Water, sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases: a global strategy 2015–2020. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/10665/182735/1/WHO_FWC_WSH_15.12_eng.pdf).
9. Gambhir M, Grassly NC, Burton MJ, Solomon AW, Taylor HR, Mabey DC et al. Estimating the future impact of a multi-pronged intervention strategy on ocular disease sequelae caused by trachoma: a modelling study. Ophthalmic Epidemiol. 2015;22:394–402. doi:10.3109/09286586.2015.1081249.

Integrating neglected tropical diseases into global health and development: fourth WHO report on neglected tropical diseases evaluates the changing global public health landscape; assesses progress towards the 2020 targets; and considers the possible core elements of a strategic vision to integrating neglected tropical diseases into the 2030 Agenda of the Sustainable Development Goals.

Advances have been made through expanded interventions delivered through five public health approaches: innovative and intensified disease management; preventive chemotherapy; vector ecology and management; veterinary public health services; and the provision of safe water, sanitation and hygiene. In 2015 alone nearly one billion people were treated for at least one disease and significant gains were achieved in relieving the symptoms and consequences of diseases for which effective tools are scarce; important reductions were achieved in the number of new cases of sleeping sickness, of visceral leishmaniasis in South-East Asia and also of Buruli ulcer.

The report also considers vector control strategies and discusses the importance of the draft WHO Global Vector Control Response 2017–2030. It argues that veterinary public health requires a multifaceted approach across the human–animal interface as well as a multisectoral programme of work to protect and improve the physical, mental and social well-being of humans, including veterinary, water, sanitation and hygiene.

Integration of activities and interventions into broader health systems is crucial, and despite challenges, has the potential to accelerate progress towards universal health coverage while advancing the 2030 Agenda.

In short, this report drives the message home that "no one must be left behind".

DEPARTMENT OF
CONTROL OF NEGLECTED TROPICAL DISEASES

World Health Organization

20, Avenue Appia
CH–1211 Geneva 27
Tel: +41 22 791 2111
Fax: +41 22 791 3111
Visit WHO at www.who.int

http://www.who.int/neglected_diseases/en

ISBN 978-92-4-156544-8