ROADMAP
FOR ZOONOTIC
TUBERCULOSIS

World Health Organization

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Protecting animals, preserving our future

Food and Agriculture Organization of the United Nations

The Union International Union Against Tuberculosis and Lung Disease
Health solutions for the poor

ROADMAP
FOR ZOONOTIC
TUBERCULOSIS

Acknowledgements

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Abbreviations

FAO	Food and Agricultural Organization of the United Nations
GRAbTB	Global Research Alliance for bovine Tuberculosis
IHR	International Health Regulations
JEE	Joint External Evaluations
OIE	World Organisation for Animal Health
PVS	Performance of Veterinary Services
SDGs	Sustainable Development Goals
TB	tuberculosis
The Union	International Union Against Tuberculosis and Lung Disease
WHO	World Health Organization

Preface

Zoonotic tuberculosis (TB) is not a new disease, but has long been neglected. The time is right for a bold and concerted effort to finally address the impact of *Mycobacterium bovis* infection on the health and well-being of people and animals.

The United Nations Sustainable Development Goals (SDGs) have set the stage for inclusive, multidisciplinary approaches to improving health throughout the world by 2030. Goal 3 includes a target for ending the global TB epidemic. In 2014,the World Health Organization (WHO) defined the *End TB Strategy* – an ambitious framework for ending the epidemic by 2030. It calls for diagnosis and treatment of every person with TB. Patients with zoonotic TB must be included if the proposed targets are to be achieved. The fourth edition of the Stop TB Partnership's *Global Plan to End TB 2016–2020 – The Paradigm Shift* supports the tenets of the *End TB Strategy* and includes, for the first time, people at risk of zoonotic TB as a neglected population deserving greater attention. Additionally, the declaration made in July 2017 by leaders of the G20 forum, *G20 Leaders' Declaration: Shaping an interconnected world*, calls for a One Health approach to tackling the spread of antimicrobial resistance and highlights the need to foster research and development for TB.

Initial efforts to increase awareness began with the establishment of a working group by the zoonotic TB subsection of the International Union Against Tuberculosis and Lung Disease (The Union) in 2014. The first steps towards formally conceptualizing a roadmap for zoonotic TB began in April 2016 in Geneva at a meeting co-organized by WHO and The Union, with contributions from leading international organizations for human and animal health, academic institutions, and non-governmental organizations. The ten priorities proposed in this roadmap were endorsed by WHO's Strategic and Technical Advisory Group for TB in June 2016 in Geneva.

With this roadmap, we call for concerted action through broad engagement across political, financial and technical levels, including government agencies, donors, academia, non-governmental organizations and private stakeholders. Policy frameworks must prioritize quantifying and mitigating the risk of transmission of zoonotic TB from animals to people, strengthening laboratory capacity and surveillance, improving access to timely diagnosis and effective treatment and fostering intersectoral collaboration. Efforts to improve food safety, including scaling up the heat treatment of milk, will not only reduce the risk of transmission of zoonotic TB, but also bring substantial benefits for the control of other foodborne diseases. This must be underpinned by efforts to reduce the reservoir of *M. bovis* infection in animals, including livestock and wildlife. A healthier animal population leads to a healthier food supply, as well as bringing economic benefits and improvements in animal welfare.

We recognize the interdependence of the health of people and animals, and the importance of a One Health approach to zoonotic TB, which draw on expertise and collaborative relationships across different sectors and disciplines. Together, we can save lives and secure livelihoods.

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Key international organizations

World Health Organization

The *World Health Organization (WHO)* is a United Nations organization with the goal of building a better, healthier future for people across the world. The Global TB Programme provides global leadership for TB prevention, care and control by measuring progress, developing evidence-based policies and strategies, providing technical support to Member States and shaping the research agenda.

WORLD ORGANISATION FOR ANIMAL HEALTH — *Protecting animals, preserving our future*

The *World Organisation for Animal Health (OIE)* is the intergovernmental organization responsible for improving animal health and welfare worldwide. It is recognised by the World Trade Organization as the reference organization for setting international standards for animal health and zoonoses. The OIE is also responsible for collecting and sharing animal disease data and strengthening national animal health systems. The OIE lists bovine TB as a notifiable disease, recognizing its importance as an animal disease and zoonosis.

Food and Agriculture Organization of the United Nations

The *Food and Agricultural Organization of the United Nations (FAO)* has a global mandate to improve food security, nutrition and agricultural productivity and reduce rural poverty. FAO has prioritized bovine TB as an important infectious disease that should be controlled at the animal-human-ecosystem interface, in the interest of protecting the livestock production sector, livelihoods and public health. FAO assists member countries in the development and implementation of strategies and policies for sustainable bovine TB control programmes.

The Union — International Union Against Tuberculosis and Lung Disease — Health solutions for the poor

The *International Union Against Tuberculosis and Lung Disease (The Union)* is an international non-governmental organization comprised of a global network of technical experts and members. It aims to gather and disseminate knowledge on TB and lung disease and to support low- and middle-income countries to develop, implement and assess anti-TB, lung health and non-communicable disease programmes. Through the work of its zoonotic TB subsection, The Union strives to raise awareness of the disease and facilitate multi-institutional collaboration.

Executive Summary

Zoonotic tuberculosis (TB) is a form of TB in people predominantly caused by the bacterial species, *Mycobacterium bovis*, which belongs to the *M. tuberculosis* complex. The implications of zoonotic TB go beyond human health. The organism is host-adapted to cattle, where it is referred to as bovine TB, and it also causes TB in other animal species including wildlife. Bovine TB has an important economic impact and threatens livelihoods.

The time is right for a bold and concerted effort to collectively address zoonotic and bovine TB, framed within the multidisciplinary United Nations Sustainable Development Goals (SDGs) 2016–2030 and WHO's *End TB Strategy* which seek to end the global TB epidemic by 2030. The *Strategy* calls for diagnosis and treatment of every person with TB, and this must include zoonotic TB. This is supported by the Stop TB Partnership's *Global Plan to End TB 2016–2020 – The Paradigm Shift*, which identifies people at risk of zoonotic TB as a neglected population deserving greater attention.

The human burden of disease cannot be reduced without improving standards of food safety and controlling bovine TB in the animal reservoir. A One Health approach recognizes the interdependence of the health of people, animals and the environment, and the engagement of all relevant sectors and disciplines. The declaration made by the leaders of the G20 forum in July 2017, *G20 Leaders' Declaration: Shaping an interconnected world,* calls for a One Health approach to tackling the spread of antimicrobial resistance and highlights the need to foster research and development for TB.

The first steps towards formally conceptualizing this roadmap began in April 2016 in Geneva at a meeting co-organized by WHO and The International Union Against Tuberculosis and Lung Disease (The Union), with contributions from leading international organizations for human and animal health, academic institutions, and non-governmental organizations. With this roadmap, we call for concerted action through broad engagement across political, financial and technical levels, including government agencies, donors, academia, non-governmental organizations and private stakeholders. This roadmap lays down ten priorities grouped into three core themes. To end the global TB epidemic by 2030, action must begin today. Milestones are defined for the short-term, by 2020, and medium-term, by 2025.

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PRIORITIES FOR ADDRESSING ZOONOTIC TB

IMPROVE THE SCIENTIFIC EVIDENCE BASE

1. Collect and report more complete and accurate data
2. Improve diagnosis in people
3. Address research gaps

REDUCE TRANSMISSION AT THE ANIMAL-HUMAN INTERFACE

4. Ensure safer food
5. Improve animal health
6. Reduce the risk to people

STRENGTHEN INTERSECTORAL AND COLLABORATIVE APPROACHES

7. Increase awareness, engagement and collaboration
8. Develop policies and guidelines
9. Implement joint interventions
10. Advocate for investment

What is zoonotic tuberculosis?

Tuberculosis (TB) is a major cause of human deaths worldwide and the leading cause of death due to an infectious disease. Most cases of human TB are caused by the bacterial species, *Mycobacterium tuberculosis*. Zoonotic TB is a form of TB in people predominantly caused by a closely related species, *M. bovis*, which belongs to the *M. tuberculosis* complex. The organism is host-adapted to cattle, where it is referred to as bovine TB. It also causes TB in other animal species, including wildlife.

The main route of transmission of *M. bovis* to people is indirect. It is most commonly transmitted through the consumption of contaminated milk and other dairy products that have not been heat-treated. Less commonly, it can be transmitted through the consumption of raw or improperly cooked contaminated meat. Direct airborne transmission of *M. bovis* has also been reported from infected animals or animal products to people, as well as between people.

Throughout this document, "zoonotic TB" refers to disease caused by *M. bovis* infection in people and "bovine TB" refers to disease caused by *M. bovis* infection in animals.

The size of the problem

In 2016, WHO estimated that there were 147,000 new cases of zoonotic TB in people and 12,500 deaths due to the disease. However, estimates of the global burden of zoonotic TB are imprecise. This is due to the lack of routine surveillance data from human and animal populations from most countries – in particular, countries where bovine TB is endemic and where laboratory capacity is limited. Cases of zoonotic TB in people are uncommon in countries where bovine TB in cattle is controlled and where standards of food safety are high.

The implications of zoonotic TB extend beyond human health. During 2015 to 2016, 179 countries and territories reported their status with regards to bovine TB to OIE. Of these, more than half reported the presence of the disease in livestock and/or wildlife, demonstrating its wide geographical spread. Bovine TB threatens the well-being of communities that rely on livestock for their livelihoods. The disease has an important economic impact through reduced meat and milk production, as well as condemnation of carcasses or affected parts that are unfit for human consumption. Bovine TB also creates barriers to the international trade of animals and animal products. When it becomes endemic in wildlife populations, this threatens conservation efforts and can serve as a reservoir of infection for livestock and people.

Unique challenges

It is not possible to clinically differentiate between infections caused by *M. tuberculosis* and *M. bovis*. The most common form of TB in people, caused by *M. tuberculosis*, primarily affects the lungs, although up to one-third of cases may be extrapulmonary. Zoonotic TB in people can also involve the lungs, but it often affects extrapulmonary sites, including lymph nodes and other organs. The most frequently used laboratory procedures for diagnosing TB in people, such as sputum smear microscopy or the rapid molecular assay, Xpert MTB/RIF® (Cepheid, Sunnyvale, CA, USA), cannot differentiate *M. tuberculosis* from *M. bovis*. This means that zoonotic TB is under-diagnosed.

Zoonotic TB also poses challenges for effective patient treatment and recovery. *M. bovis* is naturally resistant to pyrazinamide, one of the four essential medications used in the current standard first-line anti-TB treatment regimen. As most healthcare providers initiate treatment without drug susceptibility testing results, patients with zoonotic TB may receive inadequate treatment. This may lead to poorer treatment outcomes and the development of further resistance to other anti-TB drugs. Resistance to additional drugs has also been detected in some *M. bovis* isolates, including rifampicin and isoniazid. Resistance to these two essential first-line medications is defined as multidrug-resistant TB (MDR-TB), which poses a major threat to human health globally.

As with other zoonotic diseases, zoonotic TB cannot be controlled by the human health sector alone. Animal health and food safety sectors must be engaged to address the role of animals in maintaining and transmitting *M. bovis*.

Unique opportunities

The time is right for a bold and concerted effort to address the impact of zoonotic TB on the health and well-being of people and their animals, framed within the multidisciplinary United Nations Sustainable Development Goals (SDGs) 2016–2030 and WHO's *End TB Strategy.* To end the global TB epidemic by 2030, diagnosis and treatment of every person with TB is essential, including those with zoonotic TB. The *Strategy* is supported by the most recent edition of the Stop TB Partnership's *Global Plan to End TB 2016–2020: The Paradigm Shift*. The *Global Plan* identifies, for the first time, people in contact with livestock as a key population at risk. Additionally, the declaration made by the leaders of the G20 forum in July 2017, *G20 Leaders' Declaration: Shaping an interconnected world*, calls for a One Health approach to tackling the spread of antimicrobial resistance and the need for research and development for addressing TB.

The animal-human bond and zoonotic diseases

Livestock play a major role in the lives of people throughout the world – from remote rural communities to large modern cities. They provide dietary protein through meat and milk, materials such as wool and leather, and draught power for agricultural activities. They are central to survival strategies of poor families, contributing to the livelihoods of around 70% of the world's 1.4 billion people living in poverty. They can serve as repository of a family's wealth, and may be sold as an emergency source of cash to pay bills and other expenses. In some settings, livestock ownership is linked to social status. Livestock may also hold ceremonial, cultural and religious significance.

A close relationship with livestock may involve certain public health risks. The most common routes of transmission of zoonotic diseases to people are through direct contact with an infected animal or consumption of unsafe food. The greatest burden of zoonotic diseases lies within poor, marginalised, rural communities that live in close proximity with livestock and may have reduced access to safe food and health care. As different zoonotic diseases often share common risk factors, well-designed control strategies can reduce risks posed by several diseases at once, increasing their overall cost- and resource-effectiveness.

WHO's End TB Strategy

The goal of WHO's *End TB Strategy* is to end the global TB epidemic by 2030. Endorsed by WHO Member States at the World Health Assembly in 2014, it outlines a unified response to ending suffering from TB. The *Strategy* fulfils the targets of Goal 3 of the United Nations SDGs for 2030. It calls for: (1) a 90% reduction in TB deaths and (2) an 80% reduction in the TB incidence rate by 2030 compared with levels in 2015; and (3) no TB-affected households facing catastrophic costs due to TB by 2030.

The *Strategy* is centred around three pillars: (i) integrated patient care and prevention, (ii) bold policies and supportive systems, (iii) intensified research and innovation. These pillars must by supported by the core principles of government stewardship, engagement of civil society, human rights and equity, and adaptation to the unique context of diverse epidemics and settings.

Stop TB Partnership's Global Plan to End TB 2016-2020: the Paradigm Shift

The fourth edition of the Stop TB Partnership's *Global Plan to End TB 2016–2020* is a concrete costed plan to support the efforts needed in the first five years of WHO's *End TB Strategy*. In particular, it provides countries with the methodology to address the TB-specific priorities of their local epidemic. It also details costs associated with developing new diagnostic tools, treatment regimens and an effective vaccine.

10 PRIORITIES FOR
ZOONOTIC TB

Ten priority areas have been identified for tackling zoonotic TB in people and bovine TB in animals. These fall under three core themes: improving the scientific evidence base, reducing transmission at the animal-human interface, and strengthening intersectoral and collaborative approaches.

IMPROVE THE SCIENTIFIC EVIDENCE BASE

1. Collect and report more complete and accurate data from human and animal populations

Systematically survey, collect, analyse and report better quality data on the incidence of zoonotic TB in people, and improve surveillance and reporting of bovine TB in livestock and wildlife

Estimates of the number of cases and deaths in humans due to zoonotic TB are imprecise. They are mainly based on subnational data from only a few countries, most of which are high-income with a low burden of disease in people and livestock. To better document the global burden and generate accurate, representative data that differentiate disease due to *M. bovis* from that due to *M. tuberculosis*, countries should strive to incorporate zoonotic TB into their routine surveillance activities. Better detection of cases requires greater awareness and expertise of healthcare providers, strengthened laboratory capacity, and improved access to accurate, rapid diagnostic tools. This must be coupled with development and implementation of reliable recording and reporting systems that are case-based and preferably electronic. Targeted surveys among potential high risk groups should also be considered.

Better quality surveillance data and enhanced reporting systems are also needed to accurately monitor the prevalence of bovine TB in animal populations, including domestic livestock and wildlife reservoirs. Coordination and communication between human health and animal health sectors must be strengthened. Timely sharing of information will allow the identification of geographical areas or patient groups with a high risk of exposure and facilitate a targeted response for prevention and control.

2. Improve diagnosis in people

Expand availability of appropriate diagnostic tools and capacity for testing to identify and characterize zoonotic TB in people

Without strengthened laboratory capacity and better access to appropriate diagnostic tools, efforts to improve surveillance and data quality will be unsuccessful. In many parts of the world, diagnosis of active TB in people is based on sputum smear microscopy or rapid assays such as Xpert MTB/RIF®. These commonly used tests are unable to differentiate the *M. tuberculosis* complex into the distinct species of *M. bovis* and *M. tuberculosis*, meaning that most cases of zoonotic TB are misclassified. *M. bovis* can be identified by polymerase chain reaction (PCR) and gene sequencing of culture isolates, but many countries lack the capacity to routinely conduct these analyses. As cases of zoonotic TB are often extrapulmonary, collecting samples suitable for testing can be difficult. Zoonotic TB is therefore also underdiagnosed. Given that *M. bovis* is naturally resistant to pyrazinamide, coverage of drug susceptibility testing should be expanded to ensure that patients receive adequate treatment.

3. Address research gaps

Identify and address research gaps in zoonotic and bovine TB, including epidemiology, diagnostic tools, vaccines, effective patient treatment regimens, health systems, and interventions coordinated with veterinary services

Mycobacterium bovis
4,345,492 bp
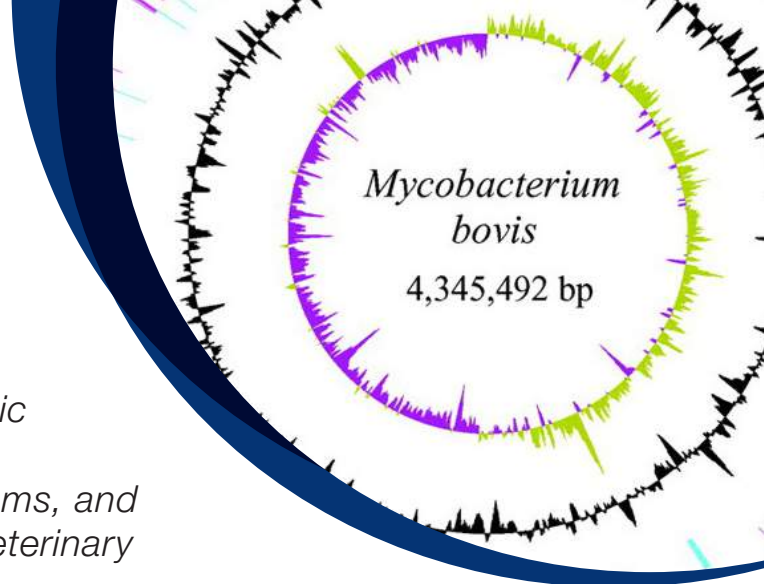
Pillar 3 of WHO's *End TB Strategy* and the Stop TB Partnership's *Global Plan to End TB: 2016–2020: The Paradigm Shift* call for intensified research and innovation to end the global TB epidemic. This must include the establishment of a sound evidence base for the burden and economic impact of zoonotic TB, the development and roll-out of new tools and initiatives, and the optimization of existing and new interventions across different settings.

A joint approach across sectors is critical for investigating disease epidemiology at the interface of humans, livestock and wildlife, including the relative importance of direct and indirect routes of transmission in different populations. Interpretation of multi-species data will require new methodologies for describing multi-species transmission, such as modelling approaches incorporating genetic data. Biological differences in the host-pathogen relationship of *M. tuberculosis* versus *M. bovis* in humans should be further investigated, as well as the consequences for clinical presentation, infectiousness, transmission and immunologic response which may be relevant for the development of a vaccine against all forms of TB.

Although new rapid point-of-care diagnostic tools for zoonotic TB in people could serve as the cornerstone to improved surveillance, they must be coupled with an understanding of how to overcome barriers to accessing health care. A better understanding of treatment outcomes will allow an assessment of the need for modified antimicrobial treatment regimens. The scale-up of heat treatment of milk requires technical capacity and a better understanding of the social, cultural and economic factors that may influence its implementation.

The feasibility of test-and-slaughter strategies, more often implemented in high-income countries for reducing the prevalence of bovine TB, could be guided by operational research into innovative agricultural insurance schemes for compensating affected farmers. The development of vaccines for livestock could offer a useful tool for disease prevention and control in the future, especially in countries where the prevalence of infection in cattle is high and test-and-slaughter strategies are not feasible for economic, logistic, social or cultural reasons. Major technical and scientific obstacles will need to be overcome, with validation of effectiveness under field conditions. This will require the development of affordable diagnostic tests in parallel to differentiate infected from vaccinated animals. The role of wildlife reservoirs, and potential approaches for control through targeted vaccination, could also be further investigated to find sustainable solutions for combatting the disease whilst safeguarding wildlife conservation.

Innovative research partnerships

The Global Research Alliance for bovine Tuberculosis (GRAbTB) was established in 2014. The vision for GRAbTB is a coordinated global research alliance enabling improved understanding and control of bovine TB. GRAbTB has several strategic goals, including to enhance collaboration, not only within the Alliance, but also with the broader human and animal TB research community, to serve as a communication and technology sharing gateway, and to develop novel and improved tools to control bovine TB.

REDUCE TRANSMISSION AT THE ANIMAL-HUMAN INTERFACE

4. Ensure safer food

Develop strategies to improve food safety

Food safety practices play a central role in the control of many zoonotic diseases, both at the household and the commercial level. Interventions targeting *M. bovis* will also reduce transmission of other important foodborne diseases; for example, illness caused by *Brucella, Campylobacter*, *Escherichia coli, Salmonella* and *Listeria* spp. Such interventions can be highly cost- and resource-effective.

Pasteurization, the decontamination of milk through exposure to high temperatures for a specified period of time, remains the most effective control measure to prevent the foodborne transmission of pathogens, including *M. bovis*, to people. In high-income countries, pasteurization is routinely implemented on an industrial scale using advanced technologies. In middle- and low-income settings, pasteurization is less widely implemented, although households may heat-treat milk by boiling. Sanitary inspection of carcasses at abattoirs is an important component of food safety that must be applied routinely, leading to removal of potentially contaminated animal products from the food chain and the traceback of animals to potentially infected herds of origin.

WHO's Five Keys to Safer Food are basic principles used by national and international institutions to teach safe practices to food handlers across all sectors. Correctly implementing these principles will reduce transmission of foodborne diseases, including zoonotic TB.

- Keep hands and equipment clean
- Separate raw and cooked food
- Cook food thoroughly
- Keep food at safe temperatures
- Use safe water and raw materials

5. Improve animal health

Develop capacity of the animal health sector to reduce the prevalence of TB in livestock

National veterinary services are the frontline for improved animal health and welfare, which results in economic benefits and reduced risk to human health from zoonotic diseases. A healthier animal population ultimately leads to a healthier food supply. Consequently, interventions targeting animal health must accompany efforts to improve food safety. Both public and private veterinary services must be well-organized and armed with appropriate tools and resources to detect diseases in animals and respond accordingly to reduce their prevalence.

The OIE *Terrestrial Animal Health Code* and *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* provide internationally agreed standards for diagnostic methods and surveillance of bovine TB in animals. However, potential barriers exist for implementing surveillance, control and elimination programs at the national and regional levels. These include limited capacity for diagnosis; weak frameworks for reporting, recording and analysing data; and a lack of financial and human resources to support animal health regulatory programs. In high-income countries, surveillance efforts include test-and-slaughter programmes with compensation for farmers; post-mortem examinations by trained meat inspectors in abattoirs; and trace-back programmes to allow identification of herds of origin and implementation of control strategies. Implementation of these approaches requires compliance of veterinary services with the OIE *Terrestrial Animal Health Code* and long-term financial commitment by governments. In resource-poor settings, a first step could be to target herds in a defined zone of a country to achieve disease-free status and gradually expand to other herds and zones, while ensuring control of livestock movements between endemic and disease-free areas. The presence of wildlife reservoirs in some settings can make the control of the disease in livestock more difficult, due to the risk of re-infection.

The role of wildlife

Domestic cattle are the principal hosts of M. *bovis.* However, other domestic livestock and wildlife are also susceptible to infection. Some wildlife species are considered "maintenance" hosts, acting as important sources of infection for livestock. This can be due to their inherent susceptibility to the pathogen or the habitat they occupy in relation to livestock. These include European badgers (*Meles meles*) in the United Kingdom and Ireland; brushtail possums (*Trichosurus vulpecula*) in New Zealand; wild boar (*Sus scrofa*) in the Iberian peninsula; African buffalo (*Syncerus caffer*) in South Africa; and elk (*Cervus canadensis*) and white-tailed deer (*Odocoileus virginianus*) in the United States. Other wildlife species can be considered "spillover" hosts, meaning that they can be infected but do not necessarily play a role in transmission to livestock. Multi-sectoral research efforts are needed to improve understanding of the role of wildlife in the dynamics of *M. bovis* infection in livestock and to develop sustainable control strategies.

The **OIE Performance of Veterinary Services (PVS) Pathway** is a voluntary tool for the evaluation and sustainable improvement of a country's veterinary services, and should be integrated into national efforts to improve animal health and tackle bovine TB. Following the PVS Pathway allows countries to proactively support the delivery of veterinary services by determining the current level of performance, identifying gaps and weaknesses in their ability to comply with OIE international standards, forming a shared vision with interested parties (including the private sector), establishing national priorities and securing the investments needed. The PVS Pathway includes, but is not limited to, a standardised OIE *Tool for the Evaluation of PVS* and *PVS Gap Analysis Tool.*

Social enterprise to improve animal health and productivity

Providing livestock owners with access to profitable markets is key to achieving a healthy and productive animal population. This requires innovative approaches and partnerships that take into account the local sociocultural context. In Senegal, for example, nearly four million people raise livestock, yet most of the milk consumed in the country is reconstituted from imported powdered milk. A local private company is responding to this gap by establishing a network of milk collection points for livestock owners, and subsequently manufacturing and marketing pasteurized dairy products. Investing in the local dairy industry ensures a safe supply of dairy products for the general population while providing livestock owners an opportunity to earn money to pay for household or medical bills as well as veterinary care for their animals.

6. Reduce the risk to people

Identify key populations and risk pathways for transmission of zoonotic TB

Preventing disease in people requires reducing the risk of exposure and transmission at the human-animal interface. While the principal routes of transmission are known, more information is needed about the underlying sociocultural and economic reasons for practices that facilitate transmission to people, and how to promote safer alternatives. Determinants of progression from exposure to infection, and from infection to disease, should be explored. The use of sequencing technologies and phylogenetic analyses may play a role in characterising transmission mechanisms, identifying sources of infection and investigating drug resistance. Groups at risk of disease need to be better defined but can include:

- communities living in close contact with livestock and where access to safe food, healthcare, veterinary services may be poor, including rural communities or semi-nomadic/nomadic pastoralist populations;
- people with an occupational exposure to livestock, including farmers, veterinarians and other animal health workers, abattoir workers, butchers and livestock traders;
- children and those more likely to consume unpasteurized milk and dairy products; and
- immunocompromised people, such as those living with HIV/AIDS.

Cultural practices can influence **food consumption behaviours.** In many parts of the world, dairy systems often lack specialized equipment for collecting, treating and processing milk, which may be influenced by cultural and/or economic factors. For example, groups such as the Fulani in West and Central Africa or the Maasai in East Africa rely on livestock for their livelihoods and commonly consume milk and other dairy products without heat treatment. This places these communities at risk of contracting foodborne diseases, including zoonotic TB. In some African countries, butchers may eat the parts of the cows' lungs with visible TB lesions in order to convince potential buyers that the meat is safe.

In high-income countries, zoonotic TB may still pose a risk to some groups. In the United States of America, Hispanic communities bear the majority of the burden of zoonotic TB. This is linked to the practice of consuming fresh cheese made from untreated milk (queso fresco), often sourced from areas in Latin America where bovine TB is endemic.

STRENGTHEN INTERSECTORAL AND COLLABORATIVE APPROACHES

7. Increase awareness, engagement and collaboration

Increase awareness of zoonotic TB, engage key public and private stakeholders and establish effective intersectoral collaboration

In many countries, government authorities from the human health and animal health sectors and at-risk communities may be unaware that zoonotic TB is a substantial public health threat. Strengthened diagnostic and treatment capacities rely upon well-informed healthcare and veterinary service providers in the public and private sector. Commitment from national TB programmes as well as from other policy-makers is essential. At the global level, international organizations, academic institutions and donors who shape the international response and research agenda must recognize that a reduction in the burden of zoonotic TB could have widespread health and economic benefits.

Collaboration and communication across different sectors and disciplines are key to effectively controlling any zoonotic disease. A One Health approach calls for an intersectoral and multidisciplinary approach extending from the ministerial level to the community level, with engagement of both public and private stakeholders. The most relevant sectors will include healthcare services, veterinary services, food safety authorities, wildlife authorities, farming organizations, consumer groups, trade organizations, educational bodies and financial institutions. Within these sectors, collaborative relationships must be fostered among different disciplines, including healthcare providers, veterinarians and other animal health workers, epidemiologists, sociologists, farmers, laboratory experts, wildlife conservationists, communication specialists and economist

8. Develop policies and guidelines

Develop and implement policies and guidelines for the prevention, surveillance, diagnosis, and treatment of zoonotic TB, in line with intergovernmental standards where relevant

The SDGs and WHO's *End TB Strategy* serve as the umbrella under which One Health approaches to zoonotic TB should be adapted to national, regional and community-level contexts. With the political will of the governments and in partnership with all relevant stakeholders, bold policy frameworks must prioritize assessing and reducing the risk of transmission of zoonotic TB, strengthening surveillance, and improving access to timely diagnosis and effective treatment. This must be underpinned by concerted efforts to implement appropriate interventions that reduce human risk and minimize the reservoir of infection in animals. Clearly, zoonotic TB cannot be adequately addressed by national TB programmes alone, as all of the required sectors and disciplines are not routinely engaged in TB prevention and control activities. Well-defined objectives and expectations for collaborative action across sectors and disciplines should be elaborated, as well as the channels and resources required for operationalization.

Internationally agreed standards for surveillance and diagnostic methods for bovine TB are detailed in the *OIE Terrestrial Animal Health Code* and *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*. When correctly applied, these standards help to ensure safe trade and minimize risks to human and animal health. Their implementation must be complemented by national frameworks for improving food safety.

The International Health Regulations (IHR) are an international legal instrument binding all Member States of WHO, with the aim of preventing and responding to acute public health risks with the potential to cross borders and threaten people worldwide. Within the context of IHR, countries have an obligation to establish and strengthen intersectoral collaboration in relation to public health threats. National core capacities and health systems that are put in place to meet obligations under the IHR, including establishment of collaborative mechanisms across human and animal health sectors, can also be used to reduce risks from other, non-emergency threats to human health, including for zoonotic TB.

The IHR Monitoring and Evaluation Framework of WHO assists countries in assessing their capacity to prevent, detect, and respond to public health threats, including zoonotic diseases. Within this Framework, Joint External Evaluations (JEE) are being conducted voluntarily within countries. These JEE are intersectoral in nature, not just for zoonotic diseases but also for evaluating capacities relating to food safety, antimicrobial resistance, and laboratories. Thus, information from the OIE PVS Pathway, and other animal health evaluations in the country, are integrated into JEE. National IHR – PVS bridging workshops are being jointly offered by WHO and OIE to support countries in implementing plans for national health security and aligning capacity and strategies across human and animal health sectors. In addition, operational guidance on intersectoral approaches for addressing zoonotic diseases are being jointly developed by WHO, OIE and FAO. Zoonotic TB can be used as an example for evaluating existing intersectoral collaborative mechanisms, identifying gaps, and strengthening capacity in countries.

'One Health' refers to the interdependence of the health of people, animals and the environment. In the case of zoonotic diseases, the burden of disease in people cannot be reduced without management of the animal reservoir. A One Health approach means that all relevant sectors and disciplines are identified and work together for developing policies and legislation, designing and implementing control strategies, investigating outbreaks and conducting research. This brings added benefits that could not be achieved by one sector alone, including a more comprehensive analysis of risks, interdisciplinary insights, better coverage of interventions, more efficient utilization of resources, reduced costs and, ultimately, improved health of human and animal populations. WHO, OIE and FAO have pioneered One Health approaches under a tripartite partnership. This partnership between the three organizations was formalized in 2010 to share responsibilities and jointly develop and implement integrated strategies for addressing health risks at the human-animal-ecosystem interface.

9. Implement joint interventions

Identify opportunities for community-tailored interventions that jointly address human and animal health

Interventions that jointly address human and animal health can increase health and economic benefits for communities. Sharing of human resources, equipment and transport across sectors can reduce operational costs. This increased cost-effectiveness is especially relevant given the public funding constraints that often exist in settings where people are most at risk of zoonotic TB. For example, outreach childhood immunization campaigns or other existing livestock vaccination or testing programmes conducted in rural communities could be used to concurrently deliver educational and behaviour change messages about food safety, to test livestock for bovine TB or, potentially in the future, to implement livestock vaccination campaigns against bovine TB. Interventions must be tailored to the cultural and socioeconomic characteristics of each setting. Community-driven participatory initiatives are key to achieving sustainability.

In order to promote behaviour change among key populations, risk reduction strategies must take into account cultural and socioeconomic factors that shape the relationship between

Behaviour change communication recognizes that effecting a positive influence on people's behaviours requires different messages and approaches that are tailored to reaching different groups. Behaviour change communication is central to reducing the transmission of zoonotic diseases, including zoonotic TB, from animal sources to people. Before designing a strategy, an analysis must first be undertaken to understand the nature of the problem and barriers to change. For example, the uptake of heat treatment practices for milk may be influenced by cultural traditions or costs of fuel, water and labour. Designing the communication strategy requires careful consideration of the objectives, target audience and available resources for each setting. The strategy should be pretested and modified as needed before dissemination. Finally, the impact of the communication strategy must be measured so that these findings can be used to improve future project design.

people, animals and practices. These could include the consumption of untreated milk or raw or improperly cooked meat. Local non-governmental organizations as well as human health and animal health workers have a role to play in reaching these communities.

10. Advocate for investment

Develop an investment case to advocate for political commitment and funding to address zoonotic TB across sectors at the global, regional and national levels

Reducing the burden of zoonotic diseases, including zoonotic TB, saves lives and secures livelihoods. Ultimately, political commitment and buy-in from governments, donors, public and private stakeholders and communities rely on sound evidence of the value to be gained by investing in the disease. Costs are associated with scaling up diagnosis in people, providing effective treatment for people, improving food safety, and controlling the disease in livestock. These must be quantified and compared against the economic losses arising from illness, disability and death in people, reduced milk and meat production in livestock, condemnation of livestock carcasses, international trade barriers, and the negative impact on wildlife conservation. Furthermore, due to shared risk factors between zoonotic TB and other zoonotic or foodborne diseases, substantial additional benefits for the control of other diseases must also be highlighted.

TIMELINE FOR ACTION

To end the global TB epidemic by 2030, action must begin today. Key milestones to be achieved in the short-term, by 2020, and in the medium-term, by 2025, are indicated under the three core themes. Ongoing monitoring of progress is essential, to evaluate achievements and shortcomings, identify gaps, and refine the timeline as appropriate.

Improve the scientific evidence base

By 2020

- Joint guidance developed for surveillance and management of zoonotic and bovine TB, at global and national levels

- Improved detection, recording and reporting of zoonotic and bovine TB within countries to allow more accurate estimations of disease burden

- Capacity of national healthcare and laboratory services strengthened for diagnosing and treating zoonotic TB

By 2025

- New, rapid diagnostic tools available for diagnosing zoonotic TB and rolled-out to high risk groups

- Appropriate drug regimens defined for effective treatment of zoonotic TB

- Anti-TB vaccine available for people and rolled-out

Reduce transmission at the animal-human interface

By 2020

- Capacity of national veterinary services strengthened for improving animal health, including detecting and controlling bovine TB in livestock and wildlife

- Efforts scaled-up to improve national food safety standards

- Community education campaigns implemented nationally to raise awareness of foodborne diseases and promote behavioural change

- Targeted surveys conducted to identify high-risk populations

By 2025

- New diagnostics assays available for livestock

- Effective bovine TB vaccines available for livestock and rolled-out in endemic settings

- Multi-species transmission pathways and sources of infection better characterized and used to inform the design of appropriate interventions

Strengthen intersectoral and collaborative approaches

By 2020

- Zoonotic and bovine TB properly addressed by government authorities and other stakeholders, in light of available evidence

- Intersectoral and multidisciplinary collaborations established to build mechanisms and policies for One Health coordination and communication, within and between countries

- Global case for investment and business plan developed, providing rationale for investing in zoonotic and bovine TB and detailing the activities and resources needed

- Global advocacy strengthened to promote a research agenda that addresses knowledge gaps

By 2025

- Mainstreaming of One Health approaches into efforts to improve human and animal health at global, national and community levels

Resources

Guidelines and reports

Communication for Behaviour Impact (COMBI). A toolkit for behavioural and social communication in outbreak response. Geneva: World Health Organization; 2012 (WHO/HSE/GCR/2012.23; http://www.who.int/ihr/publications/combi_toolkit_outbreaks/en/)

Electronic recording and reporting for tuberculosis care and control. Geneva: World Health Organization; 2012 (WHO/HTM/TB/2011.22; http://www.who.int/tb/publications/electronic_recording_reporting/en/)

Global Plan to End TB 2016 – 2020: The Paradigm Shift. Geneva: Stop TB Partnership; 2016 (http://www.stoptb.org/global/plan/plan2/).

Global Tuberculosis Report 2017. Geneva: World Health Organization; 2017 (http://www.who.int/tb/publications/global_report/en/)

G20 Leaders' Declaration: Shaping an interconnected world. Hamburg: G20; 2017 (https://www.g20.org/Content/EN/_Anlagen/G20/G20-leaders-declaration.pdf?__blob=publicationFile&v=1)

Implementing the End TB Strategy: The Essentials. Geneva: World Health Organization; 2015 (WHO/HTM/TB/2015.31; http://www.who.int/tb/publications/2015/The_Essentials_to_End_TB/en/)

Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2017. Paris: World Organisation for Animal Health; 2017 (http://www.oie.int/international-standard-setting/terrestrial-manual/access-online/)

OIE Tool for the Evaluation of Performance of Veterinary Services. Paris: World Organisation for Animal Health; 2013 (http://www.oie.int/fileadmin/Home/eng/Support_to_OIE_Members/pdf/PVS_A_Tool_Final_Edition_2013.pdf)

Terrestrial Animal Health Code. Paris: World Organisation for Animal Health; 2017 (http://www.oie.int/international-standard-setting/terrestrial-code/access-online/)

Websites

FAO – Animal Production and Health: http://www.fao.org/ag/againfo/home/en/index.htm

OIE: http://www.oie.int/

One Health Initiative: http://www.onehealthinitiative.com/

The Union – Zoonotic TB subsection: http://www.theunion.org/news-centre/features/member-highlight-the-zoonotic-tb-sub-section

United Nations – Sustainable Development Goals: http://www.un.org/sustainabledevelopment/sustainable-development-goals/

WHO – The End TB Strategy: http://www.who.int/tb/strategy/en/

WHO – The Five Keys to Safer Food Programme: http://www.who.int/foodsafety/areas_work/food-hygiene/5keys/en/

End TB