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Azadi Ka Amrit Mahotsav

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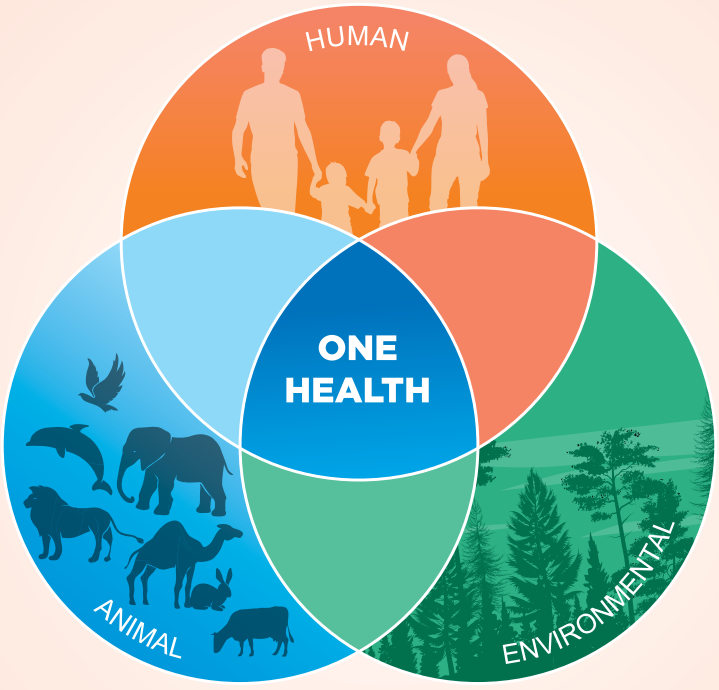
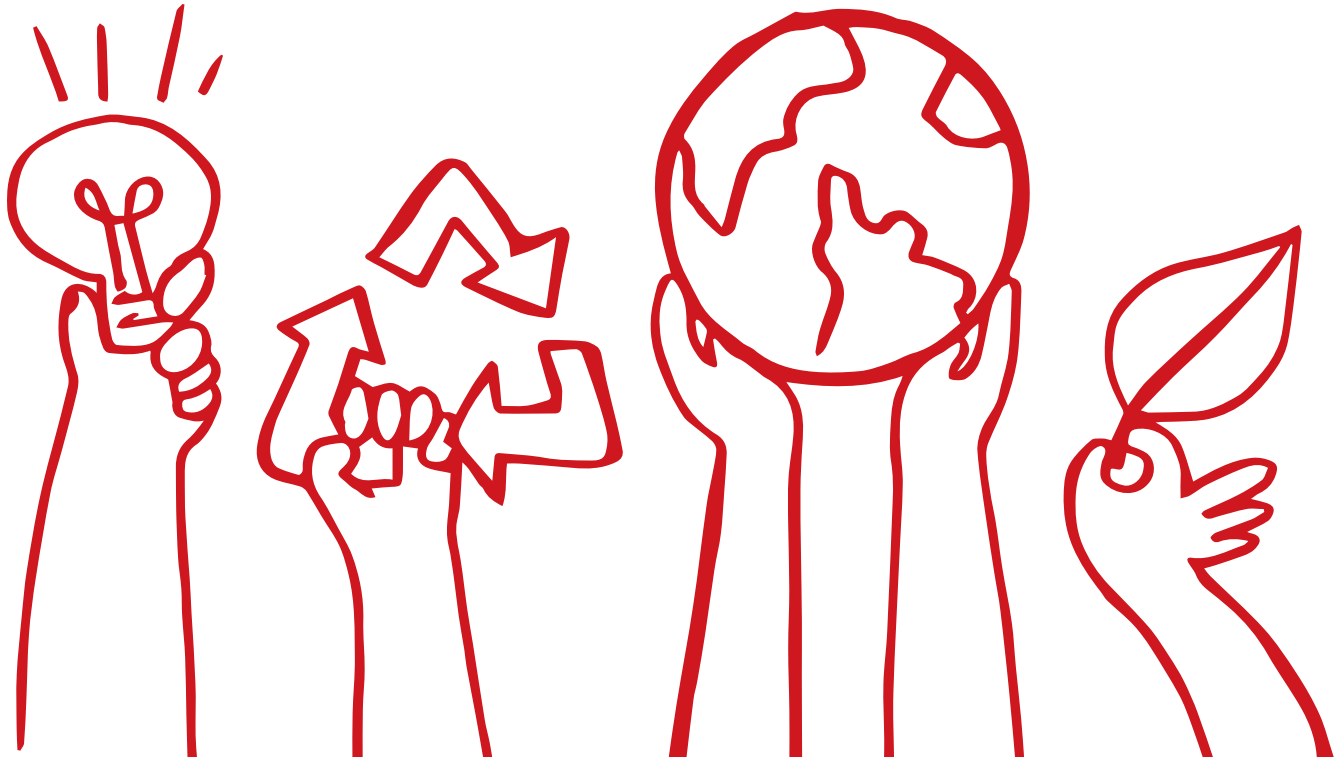
GLOBAL LEARNINGS ON ONE HEALTH



ONE HEALTH
HEALTHY ANIMALS, HEALTHY PEOPLE, HEALTHY NATIONS

Compilation by One Health Support Unit
Department of Animal Husbandry, Government of India

Content



ACRONYMS

AFENET	African Field Epidemiology Network
AFROHUN	Africa One Health University Network
AIDS	Acquired Immuno Deficiency Syndrome
BMGF	Bill and Melinda Gates Foundation
BSL4ZNet	Biological Safety Level 4 Zoonotic Disease Laboratory Network
CAS	Community-based Active Surveillance
CFIA	Canadian Food Inspection Agency
CL4	Canada's Containment Level 4
CSCHAH	Canadian Science Centre for Human and Animal Health
CSR	Corporate Social Responsibility
CTPH	Conservation Through Public Health
DHIS	District Health Information Systems
DPS	District-based Passive Surveillance
DRC	Democratic Republic of Congo
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EID	Emerging Infectious Diseases
EPT	Emerging Pandemic Threats
ESC	Epidemiological Surveillance Centres
FAO	Food & Agricultural Organization
FETP	Field Epidemiology Training Program
FETPV	Field Epidemiology Training Program for Veterinarians
GPP	Good Production Practices
HACCP	Hazard Analysis Critical Control Point
HEV	Hepatitis E Virus
HEVnet	Hepatitis E virus network
iSOP	interdependent Series of Projects
LACER	Latin America Coalition for Escherichia coli Research
MCM	Multisectoral Coordination Mechanism
NBC	National Blood Centre
NCFAD	National Centre for Foreign Animal Diseases

NFELTP	Nigeria Field Epidemiology and Laboratory Training Program
NSTOP	National Stop Transmission of Polio
NTC	National Transplant Centre
OH	One Health
OHP	One Health Partnership
OIE	World Organization for Animal Health
PAHO	Pan American Health Organization
PEP	Post-Exposure Prophylaxis
PPP	Public Private Partnership
PREDICT	Pandemic Preparedness for Global Health Security
PREEMPT	Preventing Viral Spillover Potential
PREZODE	Preventing Zoonotic Disease Emergence
REDISSE	Regional Disease Surveillance Systems Enhancement
RIG	Rabies Immunoglobulins
SACIDS	Southern African Centre for Infectious Disease Surveillance
SARE	Stepwise Approach towards Rabies Elimination
SEAOHUN	South East Asian One Health University Network
SOS	Stamp Out Sleeping Sickness
SPS	Sanitary and phytosanitary standards
UN	United Nations
USAID	US Agency for International Development
UYF	Urban Yellow Fever
VHCT	Village Health and Conservation Teams
VSLA	Village Saving and Loan Associations
VOHUN	Vietnam One Health University Network
WAHO	West African Health Organization
WebGIS	web-based geographic information system
WHO	World Health Organization
WNV	West Nile Virus
YF	Yellow Fever
YFV	Yellow Fever Virus
ZDU	Zoonotic Disease Unit

1. Introduction to One Health

One Health is not a new concept. It can be demonstrated that its origins and development literally run the gamut from A to Z from Aristotle to Zoobiquity. Indeed, the consequences of the interaction that occurs between ecosystems, animals and people have shaped and continue to shape the course of human events and history. The One Health ideas of the 21st Century constitute a re-conceptualisation of health management in response to the accelerating environmental changes of the past 100 years, changes that are associated with the parallel exponential growth and concentration of the global human population accompanied by increase in animal number through intensive animal production. Consequently, the concept of One Health must recognise the constantly evolving relationship between animals and humans and the planet they share.

Defining One Health

Today's risk environment is one of complexity, interconnectedness, and convergence, resulting from, among other factors, epidemiological globalisation, pathogen adaptation, food insecurity, changing human demographics, evolving animal production systems and climate change. There is an increased awareness of the opportunity and the critical need to address health issues and to achieve health objectives by re-focusing more of health management on the interface between ecosystem health, animal health and human health. This change in thought towards the concept has been fuelled by several high-profile international infectious disease events over the past several decades. These include the emergence of zoonotic diseases such as Lassa fever, acquired immunodeficiency syndrome (AIDS) and Lyme disease, and viruses such as the highly pathogenic H1N1, H5N1 and H7N9 influenza viruses, Nipah and Hendra viruses, West Nile virus, Ebola and other filoviruses, and severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome (MERS) coronaviruses (MERS-CoV), Crimean Congo Haemorrhagic virus (CCHF), Nipah Disease, Zika fever, and SARS-CoV-2. There are also continued threats from other diseases such as rabies, Chagas disease, malaria, leptospirosis, as well as human and bovine tuberculosis. The animal diseases of economic significance such as Lumpy Skin Disease, African Swine Fever, and foot and mouth disease adversely impact the animal food systems which, in turn, jeopardized human health. There has also been a massive decline in wild animal populations as a result of diseases such as chytrid fungus in amphibians and white-nose syndrome in bats. An important factor that is often overlooked is that zoonoses are in fact a two-way street where diseases are shared between human and animals.

Different people with different perspectives define health differently. These same differences are brought to the definition of One Health and thus, there has been no universally accepted definition of One Health till OHHLEP gave one definition in 2021. The significant social, economic, and political impacts of the events referred to above have understandably resulted in many choosing to define One Health in a very limited way, with the objective being solely the achievement of human health. For others, animal health and/or resilient, sustainable ecosystems are objectives of equal importance. The essence of the One Health concept is that these three objectives are interdependent and, in fact, constitute a single objective, because to achieve all three at once is the only means of achieving any one of them.

Consequently, to understand and effectively address the cause and effect that is inherent to many of the health issues that continue to emerge and re-emerge, a true One Health construct must incorporate both the human activities and the naturally occurring events that have an impact on water quality, biodiversity, genetic diversity, and ecosystem health.

Therefore, One Health is concerned with more than just some critically important infectious and zoonotic diseases. One Health is a paradigm in which health is determined by a broad, inclusive, and interdependent continuum of cause and effect across ecosystems and human and animal populations that fully embraces food security, biodiversity, economic prosperity, and emotional and mental well-being.

The One Health concept is undoubtedly a challenge to current collective human and institutional behaviours. It shines a spotlight on policies and decisions in human affairs that may often be made without due consideration or recognition of their negative impacts on health outcomes. It advocates new ways of incorporating health risk assessment into decisions made in a far wider array of private and public sectors than is the current general practice. The One Health concept insists that the responsibility for ecosystem health, animal health and human health must be accepted and shared across many different disciplines and sectors of human affairs.

Some very commonly used definitions of one health are as under:

FAO definition

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems (FAO).

CDC Definition

One Health is a collaborative, multisectoral, and transdisciplinary approach — working at the local, regional, national, and global levels — with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment (CDC, USA).

CDC and OHC definition

One Health is a collaborative, multisectoral, and trans-disciplinary approach - working at local, regional, national, and global levels - to achieve optimal health (and well-being) outcomes recognizing the interconnections between people, animals, plants and their shared environment.

Previous OHC definition

One Health is the collaborative effort of multiple health science professions, together with their related disciplines and institutions – working locally, nationally, and globally – to attain optimal health for people, domestic animals, wildlife, plants, and our environment.

WHO 2017 definition

'One Health' is an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes (WHO, 2017).

OHHLEP Definition

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems (OHHLEP, Joint Tripartite (FAO, OIE, WHO) and UNEP Statement, 08-12-2021).

OHHLEP's definition of One Health

The term "One Health" is rather popular these days and is used by various players worldwide. However, the exact definition of the term often remains vague, which makes it difficult to design and implement concrete measures.

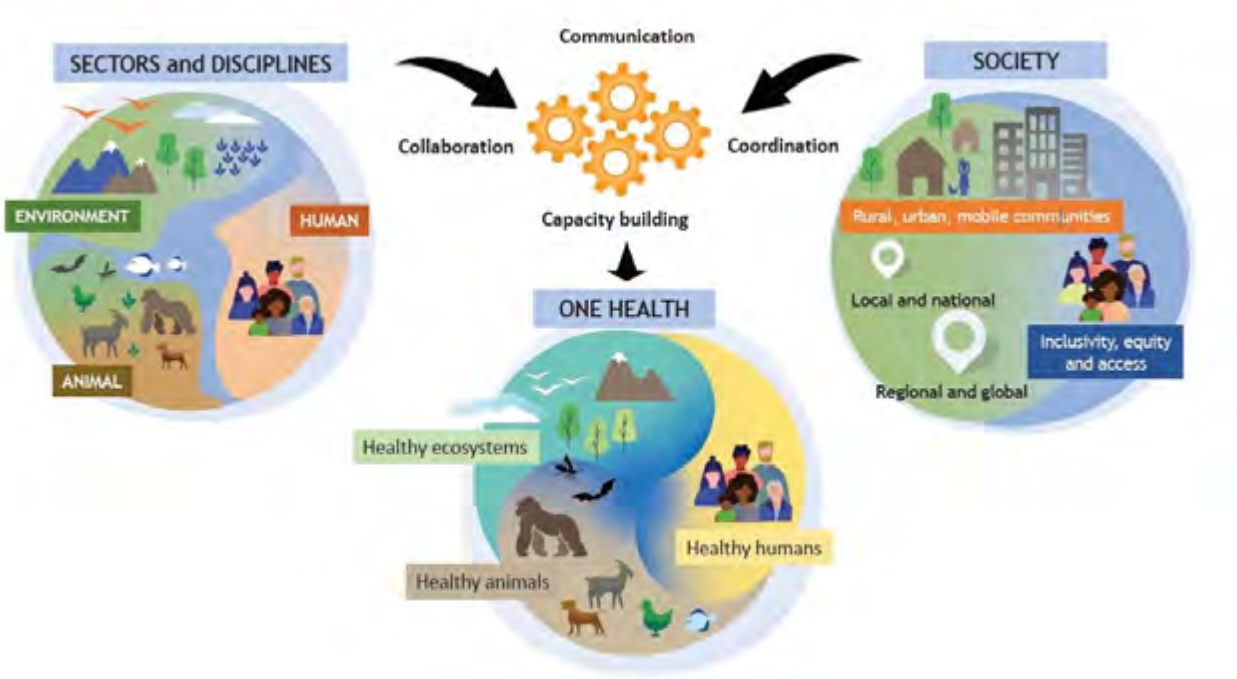
Earlier this year, the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) established an advisory body, the One Health High Level Expert Panel (OHHLEP). This has now produced an operational definition of One Health to develop a common language and understanding of One Health [Please see the box below] [source: https://www.zoonosen.net/en/ohhleps-definition-one-health].

OHHLEP One Health-Definition

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems.

It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent.

The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.



OHHLEP One Health Definition, source: WHO, FAO, OIE, UNEP [https://www.zoonosen.net/en/ohhleps-definition-one-health]

The new comprehensive OHHLEP-One Health definition aims to promote clear understanding and translation across sectors and specialties. It aims to help establish holistic approaches to solutions globally and demonstrate their benefits. The definition is supported by OIE, FAO, WHO and UNEP.

History of the One Health concept

The notion of One Health has no single origin in human thought. It is, rather, a basic condition of life on earth, repeatedly re-discovered and further explored throughout human history. From time immemorial, the health and well-being of humans has been intimately linked to animals and the planet they share. The interdependence of humans, animals and respect for land and water, which are the foundation of One Health, are an intrinsic part of the culture and spiritual beliefs of many ancient civilisations and modern aboriginal peoples.

Since it is fundamentally a social, medical and ecological concept, it can also be glimpsed in various formulations in the historical record of Western thought. A notion of One Health can be found in the writings of the physician Hippocrates (460 BCE– 367 BCE). In 'On Airs, Waters and Places', he identified the interdependence of public health and a clean environment. He is also credited with formulating the edict of 'Primum Non Nocere' – 'above all, do no harm', which all health practitioners agree to adhere to.

Shortly thereafter, Aristotle (384 BCE–322 BCE) introduced the concept of comparative medicine through his study of common characteristics among different species, including people and other mammals, which is reflected in his writings on the diseases of animals in the various books of his series 'Historia Animalium'. Almost 2,000 years later, the Italian physician Giovanni Maria Lancisi (1654–1720), a pioneering epidemiologist, physician, and veterinarian, wrote of the important role the environment plays in the spread of diseases to humans and animals. He is viewed as a pioneer in the management of rinderpest in cattle through his advocating of animal depopulation and quarantine strategies and it is suggested that he may have been the first to recommend the draining of swamps and the use of protection against biting flies in the prevention and management of human malaria.

The founding of the first veterinary faculty in Lyons, France, by Claude Bourgelat (1712–1779) established in Europe formal education in animal health and in its interactions with human health. The subsequent work of Louis-René Villermé (1782–1863) and Alexandre Parent-Duchatelet (1790–1835), also in France, led to the development of the veterinary specialty field of public hygiene.

The German physician and pathologist Rudolf Virchow (1821–1902) coined the term 'zoonosis' and is quoted as saying: 'Between animal and human medicines there are no dividing lines – nor should there be. The object is different, but the experience obtained constitutes the basis of all medicine'. He insisted that health and disease in humans and animals differed only in detail and not in kind. He recognised that environmental factors were key determinants of health outcomes; for example, his prescription for ending a persistent epidemic of typhus, which he himself had investigated, was to provide the affected region with freedom, improved roads and good schools.

The Canadian Sir William Osler (1849–1919), who studied under Virchow, further promoted the concepts of comparative medicine and comparative biology and the integration of human and animal health through his concurrent faculty appointments at both the Montreal veterinary college and the faculty of medicine at McGill University. He is often referred to as the father of modern medicine.

More recently, James Steele (1913-2013) and Calvin Schwabe (1927–2006) of the United States (USA) have been recognised for their visionary leadership in promoting the ecological nature of animal and human health. In 1947, Steele established the veterinary public health unit in what has become the Centres for Disease Control and Prevention in the USA and helped establish graduate education in public health as a new veterinary specialty. His warnings about the socio-economic consequences of zoonotic diseases led to the establishment of a veterinary public health unit by the WHO. Schwabe established a pioneering programme in veterinary preventive medicine at the School of Veterinary Medicine at the University of California, Davis. Moreover, in 1964, he published the textbook Veterinary Medicine and Human Health, which called for integration among animal, human and environmental health in the management of veterinary and public health issues. In his book he referred to the importance of 'one medicine' and said that 'the critical needs of man include the combating of diseases, ensuring enough food, adequate environmental quality and a society in which human values prevail'. The most novel, and thus a defining, feature of the One Health concept of the 21st Century is its focus on ecological processes and environmental factors as key determinants of human and animal health. Thus, the concept rests as much on the intellectual history of the philosophy and science of ecology as on that of veterinary and human medicine. Like the notion of One Health itself, the interactions among the living and non-living elements of the earth's surface and human dependence and interference with these have been at the forefront of human thought and experience since the beginning of history. In the history of Western thought, they are already a central theme of the legends of Gilgamesh from about 2500 BCE and of the many renditions of the story of the Garden of Eden. While all schools and movements in philosophy contemplated these fundamental relationships across the subsequent 4,500 years, ecology, as a science, emerged only in the early 20th Century. This was a time that saw the end of the great fragmentation of science into separate and disconnected fields in the 17th, 18th and 19th Centuries. Instead, science took a new turn toward convergence, stimulated primarily by the concept of species evolution articulated by Charles Darwin and the notion of selection forces shaping all living things, including people. The term 'ecology' was coined in 1866 by the multidimensional Ernst Haeckel (1834–1919), a German philosopher, physician, biologist, artist and professor.

Because ecology is a convergent science, it has many historic roots, far too many to recount here. Nonetheless, some of the more influential people along the path leading to the ecology of health and disease, and thus to the current concept of One Health, include Charles Elton (1900–1991) from England, who wrote a seminal textbook on animal ecology; Alfred Lotka (1880–1949) of the USA and Vito Volterra (1860–1940) of Italy, who laid the foundation for mathematical analysis and models of ecological processes;

Aldo Leopold (1887–1948) of the USA, who wrote compellingly about the possibility, dimensions and consequences of human alterations of ecosystems; and Robert MacArthur (1932–1972), also of the USA, who pioneered concepts in community and landscape ecology. The successful application of the concepts of ecology to health and disease was further established in two seminal papers by Robert May and Roy Anderson in 1979. These papers proposed the new concept of the basic reproductive number (R0) of an infectious disease and stimulated a flourishing new field of disease ecology which has established an environmental and ecological framework supporting the current concept of One Health.

One Health in the 21st Century

The One Health ideas of today constitute a reconceptualization of health management in response to the exponentially accelerating environmental changes of the past 100 years associated with the parallel exponential growth of the global human population. The number of people on earth, the intensity of our activities and the pace and extent of environmental change have never been as great as they are today. It took between 100,000 and 200,000 years for the human population to reach one billion people, in about 1800. By 1925, the population was two billion. Now, 90 years later, the population is seven billion and headed for nine or ten billion. Global populations of domestic animals and the use of all-natural resources have risen in parallel with human numbers, at unprecedented rates and scales. All the risk factors for the health of people, animals and our shared environment are the direct or indirect result of environmental changes that now so vastly exceed the biological pace of adaptation by people and animals.

One Health is a hopeful, adaptive approach to achieving health in a perturbed biosphere. It proposes to achieve human or animal or environmental health by achieving all three together in a form of integrated mutualism and recognises that health in all three sectors must be achieved simultaneously and together, or not at all. In 2004, the Wildlife Conservation Society hosted a conference of international experts in multiple disciplines to discuss and respond to the reported and potential movements of diseases among human, domestic animal and wildlife populations. The symposium resulted in the publication of the ‘Manhattan Principles on One World – One Health’ whose title led to the coining of the term ‘One Health’ in its current context. This was followed by two additional international developments.

In 2008, WHO, the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization (FAO) of the United Nations, with the support of the United Nations Children’s Fund and the United Nations System Influenza Coordination, developed an unprecedented tripartite agreement to work more closely together to address the animal, human and ecosystem interface. Then, in June 2012, the World Bank published an assessment of the economic benefits of One Health. Over the past decade, multiple international meetings, symposia, publications, university programmes, health management measures and research projects have served to create an ever-expanding community of practice and an increasing number of networks advancing the use of the term and the tenets and principles captured by One Health. Perhaps One Health has truly come of age. (https://doc.oie.int/dyn/portal/index.xhtml).

2. Global Perspective on One Health

Today, approximately 75% of newly emerging infectious diseases (EIDs) are zoonoses that result from various anthropogenic, genetic, ecologic, socioeconomic, and climatic factors. These interrelated driving forces make it difficult to predict and to prevent zoonotic EIDs. Although significant improvements in environmental and medical surveillance, clinical diagnostic methods, and medical practices have been achieved in the recent years, zoonotic EIDs remain a major global concern, and such threats are expanding, especially in less developed regions. The current epidemic and pandemics like Ebola in West Africa, Monkeypox in 52 countries (5783 confirmed cases as on 01-07-2022), still ongoing episodes of COVID-19 are extremely stark reminder of the role animal reservoirs play in public health and reinforces the urgent need for globally operationalizing a One Health approach. The complex nature of zoonotic diseases and the limited resources in developing countries reiterates that the need for implementation of Global One Health in low-resource settings is crucial.

Most of the parasitic diseases worldwide are also zoonotic, transmitted either directly between animal and human hosts or indirectly via consumption of raw food containing flesh from domestic or feral animals, consumption of food and water contaminated by animal or human faeces, or via arthropod vectors, which can be impacted by ecological or climatic changes. Vector-borne parasitic diseases do remain a major concern that requires the One Health approach for effective mitigation, control, and prevention. However, some of the vector-borne diseases such as tick-borne zoonoses are overshadowed by other major arthropod-borne diseases.

Capacity-Building Needs in Low-Resource Developing Countries

One of the most important aspects related to the control of pathogens at the human, animal, and environment interface is the development of adequate science-based risk management policies that respect transboundary regulations. An adequate surveillance system, including a strong laboratory network, is a key component of any meaningful prevention and control strategy for zoonotic diseases.

The development of an effective One Health implementation plan for strengthening capacity at national, regional, or global levels entails re-examination of how existing systems are structured, resourced, and managed. Such analyses will enable the development and sustainability of synergies among the human health, animal health, and ecosystem sectors.

Translating theory of One Health into practice through outreach and engagement at the community level and tapping into the technological innovation in mobile technology for animal disease surveillance through empowerment of local people to report real-time events in their communities, thus giving ownership of the solutions to their common concerns regarding health and disease, livelihoods and welfare, and learning and teaching.

Training of various stakeholders with complimentary roles, including policy makers and inspectors, was critical for the development of hazard analysis critical control point (HACCP)-based good production practices (GPPs). The application of GPPs not only improves the quality of life and health of people but also can help to increase economic incentives to producers and processors that further improve the quality of life. Capacity building is necessary for the establishment of an enhanced laboratory network to improve the efficacy of these practices in both domestic and export market aspects. The development of laboratory networks linked with central reference laboratories associated with active and passive environmental and medical surveillance are essential. Surveillance is dependent on the availability of high-quality analytical and clinical laboratory diagnostic facilities. Of late, genomic surveillance has become very critical as it helps in delineating the newly emerging strains and understanding the evolution of the circulating viruses helps in early diagnosis and strategizing the control programmes in real-time.

Education and training in risk analysis and all aspects related to the application of sanitary and phytosanitary standards (SPS)–related risk assessment capacities are highly needed. Overall, the need for risk-based policy development is crucial before making any attempt to operationalize One Health.

The needs and benefits of an integrated surveillance system - to better understand the emergence and epidemiology of zoonotic diseases - has been established. Better reporting systems from medical care facilities and a comprehensive national database that includes reports from environmental monitoring and human and animal health diagnostic systems are key components of an integrated surveillance system. This is deemed essential for One Health implementation. Collaborative regional networks that promote standardized curriculum for graduate studies within the framework of the One Health approach are currently emerging.

On-time and real-time communication and awareness creation to reach target audiences at the grassroots level and upward activities plays crucial roles in operationalizing One Health in low-resource settings.

Recognizing the serious consequences of EIDs dictates the need for development of thoughtful strategies to prevent and control diseases. Strategies must consider the economic, cultural, technological, and logistical issues encountered in developing countries. The development of capable diagnostic facilities is paramount for dealing with infectious diseases. There is a need for continued investment and political commitment to meet the enormous persisting challenge to public health worldwide in the 21st century. We need more science to advance our knowledge in the complex interplay between the microbe, the host, and the ecosystem in pathogenesis of microbes including resistant microbial strains.

In addition to strong scientific reports that necessitate One Health implementation, the four-key capacity-building needs mainly directed at low-resource settings that have emerged are (1) development of adequate science-based risk management policies, (2) skilled-personnel capacity building, (3) accredited veterinary and public health diagnostic laboratories with a shared database, and (4) improved use of existing natural resources and implementation. (https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0003257)

3. Global Learnings

The One Health practical implementation in different countries and for different diseases have been studied and summarized below. Many countries are working on multiple subjects, but the nest of their activities have been divided into following categories, namely institutionalization and operationalization.

The institutionalization broadly highlights the need for structure of government organization to implement One Health activities. The operationalization has further been divided into Surveillance, human resource training, laboratory capacity building, response & control and risk communication.

The major One Health activities studied are highlighted through this world map.

A Institutionalization

Thailand's National Strategic plan for EID

After the outbreak of H5N1 in 2004 and Influenza (H1N1) in 2009, Thailand developed National Strategic Plan for Emerging Infectious Diseases (EID). This plan enables multi-sectoral coordination for nationwide implementation of the action plans to reduce the risks of infection, illness, prevent the outbreak, quickly control, and mitigate the negative consequences to economic, social and environmental aspects. This goal is achieved through six strategies, namely –

a. Public Health Emergency Preparedness – in alignment with National Disaster Prevention and Mitigation Plan of Thailand.

b. EIDs Surveillance, Prevention and Control with One Health policy – focus on integrated surveillance system, healthy livestock and animal husbandry system, infection control through biological security.

c. Enhance public information, risk communication and education on EIDs – focus on risk communication and developing public relations system.

d. International, Regional and Global Collaboration - support technical collaboration, research, knowledge, and information sharing.

e. Multi-sectoral, private sectors, provincial and community participations - wider participation with communities, networks & private sectors.

f. Research, Development and Knowledge Management - Integrated and sustainable knowledge management.

Establishing a One Health office in Kenya

Kenya established an OH office, referred to as the Zoonotic Disease Unit (ZDU) in 2011. The objective of ZDU was to establish and maintain active collaboration at the animal, human, and ecosystem interfaces towards better prevention and control of zoonotic diseases. The ZDU bridges the animal and human

health sectors with a senior epidemiologist deployed from each ministry; and with the goal of maintaining collaboration at the animal and human health interface towards better prevention and control of zoonoses. The country is adding an ecologist to the ZDU to ensure that environmental risks are adequately addressed in emerging disease control.

The curriculum of the medical, veterinary, and public health institutions will be revised to include OH approaches. The ZDU will create OH structures at the county and sub-county levels, involving identifying and training OH officers from the animal or human health sectors within each of Kenya's 47 counties.

It will strengthen surveillance, detection, prevention, and control of zoonoses in both humans and animals. Kenya plans to strengthen systematic surveillance of zoonotic diseases in animal and human in order to understand the burden of disease and identify hot spots within the country. Subsequently, the country will develop or adopt prevention and control guidelines for each disease, including the support of testing and licensing of approved and commercially available animal and human vaccines for the prevention of zoonotic diseases.

It will also stimulate and conduct research and training at the human-animal-ecosystem interfaces. Apart from identifying and promoting priority research on zoonoses, the ZDU is providing field training and mentorship to veterinary, medical, and public health trainees using existing surveillance and training platforms.

In its three years of existence, the ZDU has had several successes. A list of priority zoonotic diseases was developed in 2013. The country has developed a risk map for Rift Valley fever disease and revised the contingency plan for the disease to ensure an OH approach to coordination and response. Most recently, the ZDU has coordinated the development of a strategic plan for the elimination of rabies in the country, which was launched on the World Rabies Day in September 2014 and the implementation planned from early 2015. Administratively, the ZDU is now fully integrated as a functioning unit by both ministries (MOH and MALF) with budget lines allocated for its activities.

Strategic framework for One Health in Bangladesh

In Bangladesh, there are three main line ministries for the One Health approach: the Ministry of Health & Family Welfare, the Ministry of Fisheries & Livestock, and the Ministry of Environment & Forests. Under these ministries, there are agencies responsible for implementing One Health activities. These three ministries supported the development of the Strategic Framework for One Health approach to infectious diseases in Bangladesh through organizing and facilitating participation of their officials in two key One Health workshops which forms the basis of Strategic Framework of One Health in Bangladesh. The United Nations (UN) agencies (FAO, WHO and UNICEF) provided support to develop a strategic framework for the application of the One Health approach in Bangladesh.

Considerable challenges exist in implementation of One Health approach in Bangladesh such as institutional arrangements for coordination and collaboration between the line agencies and operational departments. Recognizing these challenges, Ministries involved have demonstrated full political commitment to the process and have pledged to continue to do so. The Framework has been validated by the officials of line ministries and agencies and includes the necessary components, outputs, and activities to reach the goal of conceptualizing and implementing One Health programs in the country.

It is important to enhance the capacity of relevant departments to foster meaningful partnerships without surrendering individual authority. An incremental approach that includes existing initiatives will facilitate the trust-building process and the evolution of the One Health model. With the implementation of projects and activities, the governance structure proposed in the Strategic Framework will be institutionalized.

This is supported by the experience at global level where there is recognition of the value in leveraging the inception of the One Health approach using existing activities.

One of the useful strategies for One Health is to leverage existing programs to institutionalize the One Health approach. At present there are structures at the national and local levels that have been developed and activated to promote matters related to Avian and Human Pandemic Influenza preparedness. These structures can be used as models for other disease programs under the One Health approach.

The One Health approach must be introduced gradually through initiatives that take advantage of existing resources. It will take time for the various line agencies to develop the necessary collaboration with and trust in each other. This makes it essential that ownership of the One Health strategy is established at high levels of government. In addition, project development and implementation should be scheduled to enable all the participating sectors to contribute adequately at the appropriate level. Most components of a One Health project require stakeholder analysis to identify capacity gaps and ways of filling them. To avoid delays, efforts should be made to carry out and monitor appropriate capacity-building activities while other project/programme activities are being implemented.

Key Learnings –

1) Multi-sectoral coordination at the animal, human, and ecosystem interfaces is necessary for nationwide implementation of the One Health action plans.

2) One Health structures should be developed at state and district levels for better implementation of One Health Platform.

3) List of priority disease should be developed which is of importance for all three sectors, viz., animal, human and wildlife.

4) It is important to enhance the capacity of relevant departments to foster meaningful partnerships without surrendering individual authority.

5) One of the useful strategies for One Health is to leverage existing programs to institutionalize the One Health approach. These structures can be used as models for other disease programs under the One Health approach.

B Operationalization

A. SURVEILLANCE

Integrated surveillance in Serbia, Tunisia, and Georgia

One Health integrated surveillance consists of the systematic collection, validation, analysis, interpretation of data and of the dissemination of the acquired information on humans, animals, and the environment to inform decisions for more effective, evidence- and system-based health interventions.

The components of integrated surveillance mechanism, highlighted in the study were –

a. Policy level –

- Existence of a National policy addressing integrated surveillance.

b. Institutional level –

- Existence of agreements among the institutions involved in human/animal/ environment surveillance
- Existence of a coordination mechanisms among the institutions involved
- Existence of identified focal points for each of human/animal/ environment surveillance

c. Interoperability mechanisms at data collection level –

- Existence of integrated data collection tools
- Existence of activation mechanisms of human surveillance based on signals from animal/ entomological surveillance

d. Interoperability mechanisms at data analysis level –

- Presence of DB exchange/merging/other mechanisms to facilitate joint analysis among sectors
- Performance of joint/integrated data analysis among the different surveillance sectors.

e. Dissemination level –

- Existence of joint result dissemination mechanisms (e.g., bulletins, reports, papers, media reports, websites)

The results from these three countries showed that One Health integrated surveillance may lead to faster disease detection, more efficient disease control and tangible financial savings when formally compared against separated surveillance.

The operationalization of One Health in terms of inter-sectoral data collection and analysis that are strategic for early warning and risk assessments was shown to be particularly challenging. These are the areas in which multisectoral integration needs to be further developed. This will promote data sharing and analysis across sectors and increase awareness on inter-sectoral priorities, including cross-border ones.

Southern African Centre for Infectious Disease Surveillance (SACIDS) approach

As per the SACIDS approach, the surveillance strategy consists of two complementing systems, viz., Community-based Active Surveillance (CAS) system and District-based Passive Surveillance (DPS) system.

Community-based Active Surveillance (CAS) system was designed to actively capture disease events in animal and human populations using simple case definitions of symptoms and syndromes occurring in communities. It was also agreed that the CAS system would use community-based health reporters who would actively screen for the occurrence of disease events in human, wildlife, and domestic animal populations. Data on these events would be recorded and transmitted through Android mobile phones using the Epicollect data capture application in near- to real-time.

District-based Passive Surveillance (DPS) system uses existing surveillance strategies in animal and human (IDSR) health sectors with enhanced performance through application of mobile technologies in transmission of near- to real-time data in the two health sectors.

The two systems (CAS and DPS) are linked together at the data analysis point. Data collected through CAS and DPS systems are stored centrally on a server located at Southern African Centre for Infectious Disease Surveillance (SACIDS) headquarters which acts as a custodian and stores data on behalf of the Ministry of Livestock and Fisheries Development and the Ministry of Health and Social Welfare who own the data.

The approach designed by SACIDS on OH surveillance is considered suitable for detecting and containing infectious diseases in animal and human populations in countries with limited resources such as those in southern Africa. Adoption of mobile telephone technologies and appropriate surveillance approaches will improve timely and complete capture of events that would otherwise have been missed using routine surveillance systems in the animal and human health sectors. It is concluded that the OH surveillance strategy is timely and relevant to sub-Saharan Africa.

USAID Emerging Pandemic Threats Program PREDICT project

In 2009, the US Agency for International Development (USAID) launched the Emerging Pandemic Threats (EPT) Program's PREDICT Project. PREDICT utilizes a One Health approach focused on early detection and response to potentially zoonotic viral threats at their source ideally before they emerge in people. PREDICT's efforts have focused on strengthening zoonotic virus surveillance and laboratory capacity in "hotspots" for EIDs. The project provided a platform for breaking down barriers through development of cross-sectoral surveillance and laboratory networks with open sharing of data, coordination on disease outbreak response, and contributions to extant or new national One Health platforms.

Over the past decade, PREDICT partnered with foreign governments, universities, and other organizations to advance One Health initiatives. In collaboration with local partners, the PREDICT project strengthened capacity for viral surveillance at high-risk animal-human interfaces. Also, when requested by host country government partners, PREDICT provided support during disease outbreaks by incorporating animal sampling into investigations, expanding laboratory analyses to look for novel viruses, and promoting the growth of a trained One Health workforce.

During the widespread Ebola virus disease (EVD) outbreak in West Africa in 2014, the ***Democratic Republic of Congo (DRC)*** requested PREDICT to support laboratory testing. Suspect cases were sampled, specimens were shipped to the PREDICT laboratory at l'Institut National de Recherche Biomédicale (INRB) for analyses, and Ebola virus was detected within 1 day of receiving the specimens. Following the prompt testing and pathogen identification, the DRC government was able to access the affected area and respond rapidly with contact tracing, dispatching a mobile laboratory, and quarantining suspected cases, leading to swift containment with only 66 cases reported over the two-month duration of this outbreak.

PREDICT activities in Bolivia demonstrated that monitoring for zoonotic viruses in wild animals can be a valuable early detection tool for preventing disease outbreaks, particularly in landscapes undergoing substantial alteration, such as deforestation, where breakdown of natural barriers leads to increased contact between wildlife and people.

In 2012, staff at a wildlife sanctuary in Bolivia, who had received training in wildlife disease surveillance through PREDICT, discovered six dead howler monkeys near the park. In collaboration with the sanctuary, PREDICT investigated the mortality event. Post-mortem examinations and diagnostic testing performed at the PREDICT's partner laboratory in Bolivia, indicated infection by a flavivirus, the family of viruses to which Yellow Fever Virus (YFV) belongs. PREDICT partners reported the results to the Ministry of Health, while conducting further laboratory analyses to confirm that infection was caused by YFV. The Ministry of Health, Pan-American Health Organization (PAHO), and PREDICT conducted a joint risk assessment followed by a prompt cross-sectoral, coordinated response in the affected area. The response included preventive YF human vaccination, public education and outreach, and mosquito control to reduce risk of infection.

Although Yellow Fever outbreaks had never been documented in Bolivian primates, authorities were able to implement preventive measures in the surrounding area within 1 week of detection of the mortality event. No human cases of YF were subsequently reported, suggesting the value of early warning systems for increased zoonotic disease risk, local pathogen detection capacity, effective collaboration channels across sectors, and prompt implementation of public health measures for preventing pathogen spill over from animals into people.

In Rwanda, PREDICT-trained personnel served on the Government of Rwanda's One Health Steering Committee. As part of the committee, PREDICT team members aided in the development of a One Health Strategic Plan in 2016. The plan references commitments to enhance cross-sectoral collaboration and increase One Health workforce capacity in Rwanda. It outlines an implementation strategy covering organizational structure and pooling and mobilizing resources. The Steering Committee oversees the plan, including prioritization of resource allocations, and coordinates the technical aspects of the strategy, which are integrated into the annual action plans of the implementing partners. If successfully operationalized, Rwanda's One Health Strategic Plan will lead to more efficient and timely responses to disease threats.

West Nile virus - integrated surveillance system in Italy

In Italy, a national Plan for the surveillance of imported and autochthonous human vector-borne diseases [chikungunya, dengue, Zika virus disease and West Nile virus (WNV) disease] that integrates human and

veterinary (animals and vectors) surveillance, is issued and revised annually according with the observed epidemiological changes. A real-time data exchange protocol is in place between the surveillance systems to rapidly identify occurrence of human and animal cases and to define and update the map of affected areas, i.e., provinces during the vector activity period from June to October.

In 2008 and 2011, the national WNV veterinary surveillance plan and the West Nile Neuro-invasive disease (WNND) human surveillance recommendations were revised, respectively. New activities were added including the potential integration between veterinary (animals and vectors) and human surveillance. Pillars of the national integrated surveillance system are: (i) the entomological monitoring based on mosquito collections in selected sites; (ii) the animal surveillance targeting migratory and resident birds as well as horses and poultry; (iii) the human surveillance system requesting clinicians to report all possible, probable, and confirmed WNV cases, irrespective of age, using a modified European case definition which includes neurological symptoms in the clinical criteria.

For veterinary surveillance purposes, the Italian territory was subdivided in two distinct epidemiological territories: endemic and non-endemic. In the endemic territories, an early warning system is in place, which enables the reinforcement of the activities aiming at detecting WNV in vectors and birds. An enhanced surveillance system based on a network of fixed mosquito traps (in grids from 10 to 20 km) and on the collection of residential wild birds, mainly Corvidae is done. Timely data on viral circulation triggers preventive measures to avoid the virus transmission via blood, tissue, and organ donations. Data collected through the Veterinary Plan are registered using an information system (SISMAN) that records and manages laboratory results and publishes weekly and daily reports describing the outcomes of the surveillance activities. A web-based geographic information system (WebGIS) was developed for displaying thematic maps and to help the veterinary services to explore the area surrounding the outbreak, and to create buffers around the reported cases.

Human cases are notified by regional and local authorities to the Ministry of Health using a specific password-protected web-based system, which permits to report probable and confirmed cases, adding available epidemiological (including the province of exposure), clinical and laboratory information. The web-based system is accessible also to the National Blood Centre (NBC) and to the National Transplant Centre (NTC), which implement precautionary measures on blood donation and transplant activities also based on data on WNV human cases.

To rapidly identify, define and update the map of the affected areas, i.e., provinces during the vector activity period, a real-time data exchange protocol is in place between the two systems. Surveillance of WNV circulation requires an interdisciplinary approach given the complexity of the viral biological cycle. For this reason, the integration of entomological, veterinary, and human surveillance systems is an essential tool for public health.

Regional Disease Surveillance Systems Enhancement (REDISSE) Project in West Africa

The WARDS project, launched in 2014, provided Economic Community of West African States (ECOWAS) with an epidemiological surveillance mechanism, powerful early detection tools, qualified staff to provide an appropriate response, and communication tools. The project was set up, equipped, and got 60 Epidemiological Surveillance Centres (ESC) up and running in 15 ECOWAS countries.

As a continuation of this project, to prevent new outbreaks and other public health emergencies or provide an appropriate response when they occur, the Commission of the Economic Community of

Central African States (ECCAS) and the West African Health Organization (WAHO) founded the REDISSE project, with support from the World Bank, to respond to gaps and weaknesses noted in this region in terms of disease surveillance and epidemic response systems. This project aims to support the efforts of countries to increase the resilience of animal and human health systems in order to better prevent and control epidemics of infectious diseases and to put in place regional health strategies for better organization and optimal use of resources available in the sub-region. As part of this regional program, the WAHO decided to keep establishing Epidemiological Surveillance Centres (ESC) at the health district level and implementing epidemiological Surveillance.

The REDISSE Program is an interdependent Series of Projects (iSOP) to strengthen national, regional, and cross-sectoral capacity for integrated disease surveillance and response in West Africa. The REDISSE Program was developed jointly by the Health, Nutrition and Population and the Agriculture Global Practices using a One-health (OH) approach to ensure that the human-animal-environment interface is addressed in strengthening West Africa's disease surveillance and response systems.

The objectives of the Project are: (i) to strengthen national and regional cross-sectoral capacity for collaborative disease surveillance and epidemic preparedness in West Africa, thereby addressing systemic weaknesses within the animal and human health systems that hinder effective disease surveillance and response; and (ii) in the event of an Eligible Emergency, to provide immediate and effective response to said Eligible Emergency.

The project will support the efforts of the ECOWAS countries to harmonize policies and procedures; facilitate countries to participate in the joint planning, implementation, and evaluation of program activities across borders at regional and national levels; promote the sharing of resources of high-cost specialized assets, such as reference laboratories and specialized training and research institutions.

The monitoring and response capacity of regional systems depends on open collaboration and the combined strength of individual national systems, from central to community level. The REDISSE IV program will strengthen the complete 'value chain' of disease surveillance and response from the lowest community level down to district, province/state, country, and country levels of the region.

The REDISSE IV project is structured around four components that will collectively strengthen the preparedness and response to emerging threats to public health in the region:

Component 1: Surveillance and Information Systems

Component 2: Strengthening of Laboratory Capacity

Component 3: Preparedness and Emergency Response

Component 4: Human Resource Management for Effective Disease Surveillance and Epidemic Preparedness.

Component 5: Institutional Capacity Building, Project Management, Coordination, and Advocacy.

Overall, the ongoing REDISSE Program supports 11 countries in West Africa: Guinea, Senegal, Sierra Leone (Phase 1); Togo, Guinea-Bissau, Liberia, Nigeria (Phase 2) and Benin, Niger, Mauritania, Mali (Phase 3). Currently, the REDISSE project is in Phase 4 and the program is expanded to five countries in neighbouring Central Africa (Angola, Central African Republic, Chad, Congo, and Democratic Republic of Congo (DRC).

Key outcomes from REDISSE project include -

1) A regional network of the Biobanks and a regional stockpile for the personal protective equipment (PPE), drugs, and vaccines for epidemic response has been created.
2) A total of 47 district-level centres for Epidemiologic Surveillance have been set up.
3) Advanced Field Epidemiology and Laboratory Training Programs were conducted.
4) A regional network of 15 Regional Reference Laboratories (RRLs) for human and animal health has been created.
5) One Health platform to promote intersectoral collaboration is established.
6) One Health implementation roadmap was adopted.
7) Inter-country agreements have been made on the policies and the strategies.
8) The protocols have also been established for the laboratory standards and biological specimen transport.
9) The regional policies on the implementation of one health including enforcing biosafety and biosecurity as well as utilizing bioinformatics data in disease modelling and epidemiology.

Key Learnings –

1) One Health integrated surveillance may lead to faster disease detection, more efficient disease control and tangible financial savings when formally compared against separated surveillance.
2) One Health surveillance consisting of community-based Active Surveillance and district-based passive surveillance is considered suitable for detecting and containing infectious diseases in animal and human populations in countries with limited resources.
3) Adoption of mobile telephone technologies and appropriate surveillance approaches helps in improving timely and complete capture of events that would otherwise have been missed using routine surveillance systems in the animal and human health sectors.
4) Development of cross-sectoral surveillance and laboratory networks with open sharing of data and coordination on disease outbreak response will make One Health model successful.
5) Monitoring for zoonotic viruses in wild animals can be a valuable early detection tool for preventing disease outbreaks, particularly in landscapes undergoing substantial alteration, such as deforestation.
6) A real-time data exchange protocol in between the surveillance systems to rapidly identify occurrence of human and animal cases and to define and update the map of affected areas is an important aspect of integrated surveillance.
7) Integrated disease surveillance and response should also work on strengthening the regional and cross-border capacity along with development of national cross-sectoral capacity for collaborative disease surveillance and epidemic preparedness.
8) The monitoring and response capacity of regional systems requires strengthening of the complete 'value chain' of disease surveillance and response from the lowest community level down to district, state, country, and country levels of the region.

B. HUMAN RESOURCE TRAINING

Joint FETP in Thailand

The Field Epidemiology Training Program (FETP) in Thailand was initiated following a demand by health authorities for competent field epidemiologists who can effectively respond to acute health problems in a timely manner. The curriculum of the Thai FETP was jointly developed by a collaborative effort of the Thai Ministry of Public Health (MoPH), WHO and U.S. CDC.

The Field Epidemiology Training Program for Veterinarians (FETPV) curriculum was developed under close consultation with FETP faculty and veterinary experts and FAO. Thai veterinarians and physicians are trained and work together to respond to any possible zoonotic disease outbreaks, thereby contributing to the public health sector mandate. The program aims not only to strengthen capacity of animal health personnel but also to promote self-sufficiency and multi-disciplinary response capacity for animal diseases that improves technical services for DLD.

From its inception, FETPV was envisioned as a model that addresses both public health and animal health sector needs for both zoonotic and animal-specific diseases to be relevant and sustainable.

In Thailand, the evidence shows that animal health and human health sectors working closely together can effectively control many important zoonotic diseases. Joint training in surveillance and outbreak investigation has led to improved surveillance and control of zoonotic diseases by young professionals from human health and animal health sectors.

The Field Epidemiology Training Network of FETP in Southeast Asia is a useful platform for further strengthening regional disease surveillance and improving response to both public and animal health problems of international concern. (www.tephinet.org)

One Health Training, Egypt

Responding to zoonotic diseases requires a workforce trained in multi-disciplinary approaches to respond and control. It is difficult to deliver multidisciplinary and one health training globally because of the limited number of higher education programs that support such training. In low and middle-income countries where the impacts of emerging zoonotic diseases are felt more directly, there is enthusiasm for such training and the use of e-technology can foster international, long-term collaborations.

Interactive on-site workshops are suitable for providing multi-disciplinary training for disease surveillance, research, and disease control. The trainings emphasis is on the use of mobile technologies to enhance emerging infectious diseases (EIDs) surveillance and research for public health professionals in Egypt.

While online training programs provide theoretical knowledge and are conveyed as solutions to meet the demand for training, they are still inadequate in providing practical multi-disciplinary or One Health training. Thus, the traditional training model favoured by Western donors which involves a single on-site workshop focused on one scientific area with limited follow-up must be expanded to include follow-up on-site workshops or training sessions enhanced with web-based activities and must incorporate multi-disciplinary and One Health scientists.

Latin America Coalition for Escherichia coli Research (LACER)

During the XXV Brazilian Congress of Microbiology, a group of E. coli researchers from Brazil, Argentina, Mexico and the United States had an informal meeting to discuss future actions to promote and increase

scientific collaboration among laboratories, enhance scientific excellence and to develop opportunities to train the next generation of Latin American investigators. As result of this meeting, the Latin America Coalition for Escherichia coli Research (LACER) was created in 2009, with an initial roster of researchers dedicated for promoting and study E. coli research in the region].

The objective of the LACER group from the beginning has always been aligned with the central goal of the One Health initiative, which is dedicated for improving the health of humans and animals, integrating human medicine, veterinary medicine, and environmental science. The LACER group utilized a holistic approach to understand E. coli disease and to find different therapeutic approaches for treatment and prevention, involving experts in a wide variety of scientific disciplines. LACER is also committed to the dissemination of scientific knowledge within the region, because it is essential to increase collaborations and to promote the interest of young investigators.

Since its establishment, the investigators made a commitment to share resources and promote education of the trainees, as well as published their findings in the form of peer-review publications, review articles, posters, and books.

The LACER initiative has focused in One Health-related efforts to combat E. coli infections. For example, members have established joint educational efforts between physicians and veterinarians, together with public health officials to prevent and treat E. coli O157:H7 infections caused by the consumption of contaminated meat products and resulting in the high prevalence of HUS cases. Second, LACER members are working to generate joint communications in journals, conferences, and social media. An example of this collaborative effort is evident in the increase of peer-review publications within the region.

A third area of intense interest has to do with effort to establish a better cross-species disease surveillance and control efforts in public health. As depicted in the example listed above, research efforts are directed to identify the reservoir of aEPEC isolates and whether domestic or wild animals are the source of human infections. Similarly, joint efforts have been established to better understand cross-species E. coli disease transmission within animal species or as zoonotic infections. Finally, LACER members have established collaborative efforts in the development and evaluation of new diagnostic methods, experimental therapeutic approaches and vaccines for the prevention and control of E. coli infections across species. The most notable are development of an EHEC (STEC) vaccine for cattle and humans and a vaccine against ETEC.

Nigeria Field Epidemiology and Laboratory Training Program (NFELTP)

To strengthen public health systems in Africa, especially for disease surveillance and response, several countries have adopted a competency-based approach of training - Field Epidemiology and Laboratory Training Program (FELTP). The Nigeria FELTP was established in October 2008 as an in-service training program in field epidemiology, veterinary epidemiology and public health laboratory epidemiology and management. The Nigeria Field Epidemiology and Laboratory Training Program (NFELTP) is a workforce development strategy implemented by the African Field Epidemiology Network (AFENET) with technical and financial support from the U.S. CDC.

The program supports competencies in four key scientific domains: epidemiology, public health surveillance, biostatistics, and scientific communication. Other minor domains include veterinary epidemiology, preventive effectiveness, leadership, and management, teaching and mentoring as well as laboratory skills. Since its inception, the program has responded to 133 suspected outbreaks ranging from environmental related outbreaks, vaccine preventable diseases, water and food borne, zoonoses, (including suspected viral haemorrhagic fevers) as well as neglected tropical diseases. With its emphasis on one health approach of solving public health issues the program has recruited physicians, veterinarians,

and laboratorians to work jointly on human, animal, and environmental health issues. Residents have worked to identify risk factors of disease at the human animal interface for influenza, brucellosis, tick-borne relapsing fever, rabies, leptospirosis, and zoonotic helminthic infections. The program has been involved in polio eradication efforts through its National Stop Transmission of Polio (NSTOP).

The commencement of NFELTP was a novel approach to building sustainable epidemiological capacity to strengthen public health systems especially surveillance and response systems in Nigeria. Joint training in class and field activities is bearing fruits in strengthening collaborations between the human and animal health sectors and may be an important platform for addressing zoonoses in the country.

NFELTP is serving an unmet need for public health workforce to operate surveillance and response for both infectious and non-infectious diseases. Involving NFELTP has improved response to outbreak particularly thorough investigation, laboratory support and rapid effective response hence reducing morbidity and mortality from leading causes of death. Even though the program is funded by disease-specific resources; it is contributing to workforce development for the specific disease control efforts - HIV, malaria, polio, but also health systems strengthening. All these need skilled workforce for effective implementation. The One Health approach has helped in bridging the communication and collaboration gaps in addressing surveillance and response required for zoonoses, EIDs, and food safety

Operational research by residents has guided implementation of programs. Residents have demonstrated increased efficiencies by use of new technologies in disease control such as use of smart phones, Open Data Kit and are involved in assessments for implementations of District Health Information Systems (DHIS2) a platform that has been adopted to improve health information systems in Nigeria and other African countries. (www.tephinet.org)

Vietnam One Health University Network (VOHUN)

In 2016, Partnership on Avian and Human Influenza (PAHI) evolved into the Vietnam One Health Partnership for Zoonoses (OHP) to strengthen One Health coordination in Vietnam and support the development and implementation of the Vietnam One Health Strategic Plan on Zoonotic Disease (2016–2020).

The Vietnam One Health University Network (VOHUN), a member of OHP, is part of the regional South East Asian One Health University Network (SEAOHUN), a university-led network of 24 universities and 30 faculties (public health, veterinary science, medicine, nursing, environment, and food technology) in Vietnam. Since its inception in 2011, VOHUN supported institutional changes in higher education by integrating competency-based One Health training and research into the curriculum. Notably, VOHUN developed a field-based training course for health and veterinary professionals who are working on infectious disease prevention and control at provincial and district levels, promoting the interaction between universities, government agencies, professionals, and community members.

During COVID-19, VOHUN implemented a number of activities, including: a series of training workshops on Emergency Risk Communication, and Community Engagement for local health workers in Northern, Southern, Central, and Highland provinces in Vietnam; training needs assessment on laboratory bio-risk management; training of trainer's course on biosecurity procedures for laboratory staff at Vietnamese universities; and, the establishment of the Student Outbreak Response Team. The One Health Communication Network and the Pandemic Prevention Taskforce are also bringing together human health, animal health, livestock, wildlife, and ecosystem health experts together from academic institutes in Vietnam.

Vietnam is also contributing to global initiatives. The country is co leading the Zoonotic Diseases Action Package of the Global Health Security Agenda, a 70-country effort to build capacities to prevent, detect,

and respond to infectious disease threats. As in East Africa, the Middle East, South Asia, and Europe, there exist regional One Health initiatives in Southeast Asia, such as the Association of Southeast Asian Nations, Asia-Pacific Economic Cooperation, and the Southeast Asia One Health University Network (SEAOHUN). For instance, SEAOHUN is a forum facilitating sharing, connection, and close cooperation in One Health education and research projects in Southeast Asia. (https://www.seaohun.org/vohun).

Key Learnings –

1. FETPV was envisioned as a model that addresses both public health and animal health sector needs for both zoonotic and animal-specific diseases through joint training of veterinarians and physicians to respond to any possible zoonotic disease outbreaks.

2. Joint training in surveillance and outbreak investigation has led to improved surveillance and control of zoonotic diseases.

3. Use of e-technology for training of field epidemiologists, veterinarians, physicians, and lab technicians can be a sustainable model in low and medium economic countries.

4. These offline trainings can be supplemented with interactive on-site workshops for providing multi-disciplinary training for disease surveillance, research, and disease control.

5. Joint educational and research efforts between physicians and veterinarians, together with public health officials should also be explored for utilization of holistic approach to understand zoonotic disease and to find different therapeutic approaches for treatment and prevention.

6. FELTP is a novel competency-based approach of training to building sustainable epidemiological capacity through Field Epidemiology and Laboratory Training in field epidemiology, veterinary epidemiology and public health laboratory epidemiology and management.

7. A One Health University Network consisting of university-led network and faculties (public health, veterinary science, medicine, nursing, environment, and food technology) can be formed to support institutional changes in higher education by integrating competency based One Health training and research into the curriculum.

C. LABORATORY CAPACITY BUILDING

HEVnet for enhanced epidemiological investigations in EU

At the first HEVnet meeting in October 2017, 16 network members, RIVM's (RIVM: Dutch National Institute for Public Health and the Environment) HEVnet team and representatives of ECDC (European Centre for Disease Prevention and Control) and EFSA (European Food Safety Authority) agreed that the objectives of HEVnet are to use molecular typing to assess trends in circulating Hepatitis E virus (HEV) genotypes and subtypes in humans at an international level and to analyse the distribution of HEV subtypes in humans for better understanding of the epidemiology (e.g., characteristics) of the affected populations and the geographical relationships between viruses.

Objectives of HEVnet

Objective 1: to use molecular typing to assess the distribution and trends of HEV genotypes and subtypes circulating in humans.

Objective 2: to analyse the distribution of subtypes in humans, leading to a better understanding of the underlying epidemiology of HEV.

Objective 3: to combine human sequences with provided metadata of human cases, for cluster investigation.

Objective 4: to trace the most likely reservoirs and sources of HEV by identifying connections between human and non-human (food, animal and environmental) samples via source attribution studies.

Objective 5: to do population genetics studies into the spread and evolution of HEV.

Objective 6: to assess the pathogenicity of strains through assessment of relationships between viral subtypes and severity of disease, looking.

The HEVnet network consists of HEV experts, such as virologists or epidemiologists in the public health, veterinary health, food, environmental and blood safety sectors. The HEVnet database is a password-protected online environment for sharing and analysing HEV sequence data accompanied by metadata. The metadata provide information on the specimen origin (country of sampling, date, type), sample origin (human, food, environmental or animal), patient's passport information (sex, year of birth, symptoms, hospitalisation, underlying conditions, etc.), behavioural exposure (food worker, animal contact, wastewater contact, other) and clinical parameters such as organ transplant or blood transfusion.

Data can be queried, analysed and visualised as pie charts, geographical maps and phylogenetic trees, using a set of analysis modules within the protected online working space. Members can retrieve whole sequences or a queried selection of the sequences in FastA format for phylogenetic analyses. The metadata, with a link to the sequences, can be downloaded in Excel format for data analyses. The combination of phylogenetic and epidemiological data enables virological, epidemiological, or combined investigations.

Furthermore, HEVnet supports the investigation of clusters across countries. The pooled analysis of sequences across disciplines generates evidence about the relationships between isolates from human,

animal, food, and environmental specimens, and may help to identify sources of infection and transmission routes. Increased availability of sequence information should enable more in-depth virological analysis to study viral evolution. Linking of case-based patient data with molecular information could also support clinical studies on the pathogenicity and severity of viral types and subtypes, as well as the association of genotypes and clinical manifestations. Using a joint repository of molecular and epidemiological data, HEVnet enables cross-sectoral and supranational collaborations to conduct molecular epidemiological investigations on HEV. (https://www.rivm.nl/en/hevnet)

BSL-4 Labs in Canada

The Public Health Agency of Canada designed their biosafety level-4 laboratory in National Centre for Foreign Animal Diseases (NCFAD) Winnipeg, Manitoba, at the Canadian Science Centre for Human and Animal Health (CSCHAH) to co-locate the animal health and human health sector laboratories, streamlining communication, emergency outbreak preparedness and response, and facilitating sample sharing and joint research.

The Canadian Food Inspection Agency (CFIA) leads an international group of government labs called the Biological Safety Level 4 Zoonotic Disease Laboratory Network (BSL4ZNet). The BSL4ZNet is a coordinated global alliance of high containment laboratories that seek to address the increasing threat posed by emerging and re-emerging zoonotic infectious diseases. This network separates itself from other global networks as it provides a One Health approach bridging human and animal health while emphasising zoonotic disease, with a real focus on work in the laboratory. Of significant importance is the pursuance of establishing best practices and safety procedures to provide the best protection for individuals working in high containment. Furthermore, the network aims to integrate sample sharing and generation of scientific knowledge transfer which promotes collaboration (https://inspection.canada.ca/science-and-research/science-collaborations/ biosafety-level-4-zoonotic-laboratory-network/eng/1597148065020/1597148065380).

A reconfiguration project at the CSCHAH that will convert existing laboratory space to the highest level of biosafety - CL4. Enhancements to Canada's Containment Level 4 (CL4) laboratory facility are critical to strengthening Canada's capability to respond to global public health and domestic public safety events. The increased CL4 lab space will improve Canada's capacity to detect and respond to the growing number of emerging human and animal pathogens such as Ebola, Middle East Respiratory Syndrome, and new types of avian influenza. It will allow the Government of Canada to respond in a timely and proactive manner to increasing global demands for investigating, testing, and researching high risk infectious diseases.

Key Learnings –

1) A network consisting of experts, such as virologists or epidemiologists in the public health, veterinary health, food and environmental can be created which can substantially assist through research work in enhancing cross-sectoral and supranational collaborations for epidemiological investigations and to analyse the distribution of zoonosis subtypes in humans for better understanding of the epidemiology (e.g. characteristics) of the affected populations and the geographical relationships between viruses.

2) A network of lab can also be created to address the increasing threat posed by emerging and re-emerging zoonotic infectious diseases and promoting promotes regional and cross-sectoral collaboration, critical to strengthening capability to respond to disease outbreak with an aim to integrate sample sharing and generation of scientific knowledge transfer.

D. RESPONSE AND CONTROL

Sleeping Sickness Control in Uganda

"Stamp Out Sleeping Sickness" (SOS) Campaign in Uganda made use of research knowledge to have large-scale impact on the livelihoods and health of rural people in its target area. The campaign was intended to control the deadly disease of human sleeping sickness. To do so, it used mass treatment of cattle to destroy trypanosomes, the parasites that cause human sleeping sickness but also live in cattle, and insecticidal spraying of cattle to control the tsetse flies that are vectors of both human sleeping sickness and the related disease of trypanosomiasis in cattle. The campaign mobilised private and public resources for a mass treatment of almost 1,80,000 cattle — belonging to around 50,000 households — with trypanocidal drugs and insecticidal sprays over five districts.

For the remaining areas of the five districts, a different sort of intervention was planned and set in motion. In May 2008, IKARE13 and Ceva arranged for five veterinarians to be sent to the field for six months. These five became known as the "3V Vets" after Vectocid, Veridium and VerebinB12. The overall aim of mobilising the 3V Vets was to inculcate a habit of regular insecticidal spraying, preferably using Vectocid, among cattle owners. Spraying would serve a public health objective of controlling tsetse fly as a vector of sleeping sickness, but also assist farmers by controlling ticks. This second benefit was both more urgent and more visible to farmers. Some rival preparations on the market killed ticks without killing tsetse flies.

Private sector players have been vital in both the realisation of mass treatment and spraying, and the subsequent attempts to build sustainable institutions for drug delivery. The campaign is probably better thought of as an exercise of Corporate Social Responsibility (CSR) rather than Public Private Partnership (PPP). (https://ctph.org/one-health-program/)

Joint Human and Animal Vaccination Delivery in Republic of Chad

Vaccination services for people and livestock often fail to achieve sufficient coverages in Africa's remote rural settings because of financial, logistic, and service delivery constraints. In Chad, combining vaccination programs for nomadic pastoralists and their livestock has been practiced. Sharing of transport logistics and equipment between physicians and veterinarians reduced total costs. Joint delivery of human and animal health services is adapted to and highly valued by hard-to-reach pastoralists. By optimizing use of limited logistical and human resources, public health and veterinary services both become more effective, especially at the district level.

Privatization of veterinary services was initiated in many parts of Africa and Asia as part of a broader effort to improve delivery of animal healthcare in the face of decreasing governmental expenditure and poor public sector performance. Numerous incentive schemes were designed to stimulate the privatization process. Subcontracted veterinarians can be effective in the implementation of vaccination campaigns, given that the government subsidizes work in more remote zones.

Sustained vaccination programs are essential tools for both the public health and veterinary sectors. Combined human and livestock vaccination reduces operational costs of interventions requiring costly transportation and is adapted to livestock holders who highly value the approach that considers the health both of the family and of the animals that contribute importantly to their livelihood. By optimizing the use of limited logistical and human resources, public health and veterinary services will be strengthened, especially at the district level, and, in turn, will be more prepared and operational in responding to endemic and epidemic diseases.

Rabies Control in Tanzania

Tanzania was among the three countries globally implementing the Rabies Elimination Demonstration Project through financial and technical assistance from the Bill and Melinda Gates Foundation (BMGF) and WHO. The project aimed to improve delivery of post-exposure prophylaxis to exposed patients; control and eliminate rabies in domestic dogs, and, therefore, its transmission to humans; & build a strategy to ensure sustainability after project completion.

Mass dog vaccination campaigns were conducted in phases, according to logistic constraints. Initially, the vaccination project focused on urban areas and then expanded to the entire project area, aiming to revaccinate each district annually. The training sessions were conducted for district veterinary officers, district medical officers, health workers, and laboratory staff. In addition, standard operating procedures (SOPs) were established for control, prevention, and surveillance activities. Health information relevant to rabies was continuously delivered to community leaders, students, teachers, and the public throughout the project. Household surveys and post-vaccination transects were used at different times during the project to estimate dog populations and vaccination coverage.

Under current national policy in Tanzania, Post-Exposure Prophylaxis (PEP) is distributed only to district hospitals. However, for this project, decentralized provision of PEP was established through training of staff and distribution of vaccines to four additional health facilities in each district. Healthcare workers were trained in the more immunogenic and cost-effective intradermal (ID) administration of vaccine to animal bite victims and in the use of human rabies immunoglobulins (RIG).

A mobile phone-based surveillance system was established to collect more detailed information needed for evaluation of project progress. Phones were distributed to the four health facilities responsible for district-level provision of PEP and to the district livestock officers. Livestock field officers and health workers were trained on how to report using mobile phones, enabling rapid collection of extensive data than routine paper-based approaches. Variables collected included animal bite patient records, human rabies deaths (based on clinical criteria), PEP doses (demand and shortages), animals vaccinated during village-level vaccination campaigns, and results from laboratory investigation of samples and rabies suspect cases for animals. Livestock Field Officers and health workers collected and submitted these data as events occurred (vaccination campaigns, suspect rabid animals identified, animal bite patients reported to clinics). Researchers from Ifakara Health Institute monitored these records and followed up with users if they identified gaps without any submissions or if they received calls on a helpline indicating that difficulties had been encountered. The mobile phone-based surveillance provided relevant government stakeholders with more detailed accessible data for evaluation of the project.

In laboratory diagnosis, there were several logistical challenges in sample handling and submission but compared to the situation before the project started, there was a moderate increase in the number of laboratory samples submitted and tested for rabies in the project areas with a decrease in the proportion of rabies-positive samples over time. Training and materials for sample collection and for diagnostic capacity were also provided by the project to District Veterinary Officers and Livestock Field Officers. Fluorescent microscopes at two laboratories were also refurbished with the support of the US Centres for Disease Control (USCDC).

The project had a major impact on public health policy and practice with the formation of a One Health Coordination Unit at the Prime Minister's Office and development of the Tanzania National Rabies Control Strategy, which lays a roadmap for elimination of rabies in Tanzania by 2030 by following the Stepwise Approach towards Rabies Elimination (SARE). Overall, the project generated many important lessons relevant to rabies prevention and control and disease surveillance in general. Lessons include the need for: (1) a specific unit in the government for managing disease surveillance; (2) application of innovative

data collection and management approaches such as the use of mobile phones; (3) close cooperation and effective communication among all key sectors and stakeholders; and (4) flexible and adaptive programs that can incorporate new information to improve their delivery and overcome challenges of logistics and procurement. (http://www.missionrabies.com/projects/tanzania/)

Joint response to disease outbreak in Cameroon

Cameroon has developed a three-tiered multisectoral coordination mechanism under the supervision of the Prime Minister. In Cameroon, different ministries lead subgroups for various lines of work within the Multisectoral Coordination Mechanism (MCM). These include: (1) surveillance and response led by Ministry of Public Health; (2) training led by Ministry of Higher Education; (3) research led by Ministry of Scientific Research and Innovation; and (4) communication led by Ministry of Communication.

In 2014, Monkeypox was suspected in Cameroon. All three ministries worked together with USAID PREDICT to initiate multisectoral planning and response. This included literature reviews, on-site investigation, observations, sampling, and laboratory diagnostics, and reporting to international organizations. Transmission was contained within the sanctuary and was limited to six infections in chimpanzees and no spill over to humans. Requiring only a single government travel authorization to send a multi-ministry investigation team reduced investigation cost by an estimated two-thirds and response time by 10 days.

In 2016, the Ministry of Livestock, Fisheries and Animal Industries in Cameroon reported cases of highly pathogenic avian influenza H5N1. Based on Cameroon's One Health Strategy, the Strategic Orientation Committee of the Zoonotic Program initiated a rapid outbreak response. The Program assessed the outbreak response technical activities and fast tracked the elaboration of an eradication plan. The incident management systems were activated including the deployment of public health rapid response teams in collaboration with the Veterinary Services, and issue of daily joint outbreak situation reports by the Directorates of Disease Control and of Veterinary Services.

The Cameroon Oil Transport Company/Exxon Mobil (COTCO) holds more than 300 simulation exercises every year to train and prepare its staff for emergencies, including infectious disease outbreaks. These simulations include logistics and supply chain management before, during, and after a disease outbreak, and sometimes including other partners. Experts facilitate the exercise planning and rollout tabletop simulations and develop and harmonize multi-risk preparedness and response plans.

Yellow fever in Brazil

The principal factors for increased yellow fever (YF) were absence of appropriate vaccination campaigns and increased urbanization and population growth in forest areas, with prevalence of the virus in the species inhabiting of these areas. When it comes to governmental combative teams, there was the 'Training School for Police Personnel on Outbreaks', which trained qualified professionals to eliminate the foci of reproduction of the mosquito. Individual protection and the prevention of the reurbanization of the disease are the main aspects to be considered in the prophylaxis and control of the YF in Brazil.

The main route of protection against the virus is the vaccine. However, there are alternative functional ways to avoid the bite of a potentially infected mosquito. These may include the use of mosquito nets on beds and windows, the use of clothes that cover large areas of the body, application of repellents with N-diethyl-meta toluamide. In addition, there are constant efforts to raise awareness to combat the vector, including policies against leaving stagnant water exposed for the deposition of Ae. aegypti eggs.

The Brazilian government aggressively responded, reforming the countries' prophylactic measures, including vaccination implementation, switching from the former double dose regimen of the vaccine to a single dose protocol, deemed as adequate. Therefore, those individuals who had been vaccinated at any time in their life did not require the application of a booster dose and were consequently considered immunized.

Because of the potential shortage of the YF vaccines, the WHO Strategic Advisory Group of Experts analysed the existing evidence and demonstrated that using one fifth of the standard dose of the vaccine (0.1 mL instead of 0.5 mL) would still provide protection against the disease for at least 12 months and possibly for much longer. SAGE concluded that this available evidence was enough to determine that the fractional dosing of the vaccine could be a safe and effective option for mass vaccination campaigns to control urban outbreaks in acute vaccine shortages. Fractional dosage is considered a short-term measure to preserve stock.

In Brazil, the updates on epizootic outbreaks and to record places where human contamination has occurred are made through epidemiological notes published by the Ministry of Health, which organizes the data by time and place, broadcasting it on official government websites, and administering the correct distribution of funds to control the disease.

The logistics involved in the prevention of Urban Yellow Fever (UYF) are based mainly on measures to combat the vector. The insect control is directly related to its resistance to insecticides in places where this control method is used. One known mechanism of resistance is the biodegradation by detoxifying enzymes. However, there have been genomic changes included in this mechanism that have rarely been identified, which hinders individual resistance genotyping.

Behavioural measures include disruption of the Ae. aegypti life cycle through improvements in water distribution and collection systems, garbage collection, health education campaigns to eliminate potential outbreaks of mosquito egg deposition, and the larvicide use in places where such elimination is not possible. In addition, health surveillance at border and immigration locations (such as ports and airports) and appropriate guidance for travellers in infected areas is necessary.

Key Learnings –

1) Mobilization of private and public resources for a mass treatment of livestock to destroy the parasites and insecticidal spraying of livestock to control the vectors.

2) Veterinarians were sent to the field to inculcate a habit of regular insecticidal spraying among livestock owners.

3) Incentivization of private sector players for response activities to build sustainable institutions. The campaign might probably better think of as an exercise of Corporate Social Responsibility (CSR) rather than Public Private Partnership.

4) Combining vaccination programs for human and their livestock is an effective approach as it reduce total cost and improve outreach.

5) Incentive schemes for privatization of veterinary services and subcontracting helps in improving delivery of animal healthcare and vaccination services in remote areas. The response programs

should be made flexible and adaptive that can incorporate new information to improve their delivery and overcome challenges of logistics and procurement.

6) A single government travel authorization to send a multi-ministry investigation team can reduce the investigation cost and response time.

7) The incident management systems including the deployment of public health rapid response teams in collaboration with the Veterinary Services, and issue of daily joint outbreak situation reports can fast track the elaboration of an eradication plan.

8) Individual protection and the prevention of the reurbanization of the disease are the main aspects to be considered in the prophylaxis and control of the disease.

9) Behavioural measures including improvements in water distribution and collection systems, garbage collection, health education campaigns to eliminate potential outbreaks of mosquito egg deposition, and the larvicide use in places where such elimination is not possible should be propagated.

10) Health surveillance at border and immigration locations (such as ports and airports) and appropriate guidance for travellers in infected areas is necessary.

E. Risk Communication

Model One Health Clinic

In One Health USA, a unique approach was implemented in which a coordinated clinical care for humans and companion animals were established and it has proven to be a successful application of the One Health concept. In these clinics, the physicians and veterinarians work together and play a critical role in One Health efforts to identify and control emerging infectious diseases. The integration of healthcare can give providers the ability to assess an individual's health, not just in a moment in time, but within the context of the complex interactions with other humans, animals, and their encompassing environment.

These clinics focus on preventive health and wellness of both human and veterinary patients. For human patients; primary care services such as blood tests, physical examinations, treatment of acute non-emergent illnesses, management of chronic diseases, mental healthcare, reproductive healthcare (PAP smears and birth control), and nutritional counselling are provided. For animal patients; physical examinations, vaccinations for dogs and cats, external and internal parasite prevention, on-site cytology, blood tests (including heartworm, feline retrovirus, and tick-borne disease testing), and basic grooming have been provided, along with low-cost spay and neuter through the UC Davis Veterinary Medical Teaching Hospital. In this environment, veterinary and human clinicians help each other develop the full community-health picture, making diagnoses easier and allowing identification of sentinel cases. (www.onehealthclinic.org)

"Bottom-up" Grassroots Movements - Brazil

Since 2002, Veterinary Medicine students and residents at São Paulo State University (UNESP) in Jaboticabal, Northeast São Paulo state, South-eastern Brazil, have performed animal and public health outreach in rural communities which would later be regarded as One Health. Students accompanying community

health agents assessed health risk factors related to the interaction between humans, animals, and the environment in homes and surrounding areas with attention to the main zoonoses as determinants of the health and disease processes in their ecosystems. Educational actions were applied, mainly, in primary and secondary schools with an expectation that children were the messengers for their parents and their behaviour to be changed. All these activities generate research for postgraduate studies. The Universities already had inter-disciplinary outreach programs with One Health, such as approaches working directly with rural and diverse communities through the Unified Health System.

Similarly, "The One Health Summer School Brazil", which started in 2013, focuses on topics of infectious diseases, food safety, and public policies as part of an international collaboration between the School of Veterinary Medicine and Animal Sciences at Unesp, Prefeitura de Botucatu/SP, and the University of Saskatchewan, Canada. Postgraduate training was developed through international collaborations.

After 2017, Federal and Professional Associations (CFMV, CRMV, COREM, CNS, CFM, SBM) have collaborated by disseminating the concept of One Health. The Preventive Medicine and Public Health sectors have always covered aspects of preventing and maintaining the health and wellbeing.

Village Health and Conservation Teams- Uganda

Conservation Through Public Health (CTPH), Uganda has been implementing a successful community health and conservation model. Community health is implemented through Village Health Teams, a recognized Ministry of Health (MOH) structure in Uganda who are trained as Village Health and Conservation Teams (VHCTs) to promote health together with conservation as well as community livelihoods. The VHCTs are local community volunteers who deliver integrated community-based public health services to promote good health-seeking behaviour, hygiene practices, infectious disease prevention and control, family planning, nutrition, and conservation education to individual households. The VHCT networks are sustained through group livestock income generating projects, which they reinvest into Village Saving and Loan Associations (VSLA). The CTPH focuses especially on engaging women, both as VHCTs as well as during VHCT activities as women are primarily responsible for their families' health and wellbeing and are, therefore, in the best position to make positive changes for improved household health. As VHCTs, women take on a leadership role in the community, elevating their status and supporting improved gender balance in the community. (https://ctph.org/)

Key Learnings –

1) A coordinated clinical care for humans and companion animals and it has proven to be a successful application of the One Health concept. In this environment, veterinary and human clinicians help each other develop the full community-health picture, making diagnoses easier and allowing identification of sentinel cases.

2) The animal and public health outreach in rural communities by community health agents (with researchers and graduate/post graduate students) assesses the health risk factors related to the interaction between humans, animals, and the environment in homes and surrounding areas with attention to the main zoonoses.

3) Education in primary and secondary schools on One Health & Zoonoses was done, with an expectation that children were the messengers for their parents and their behaviour to be changed.

4) Local community volunteers can be engaged to deliver integrated community based public health services to promote good health-seeking behavior, hygiene practices, infectious disease prevention and control, family planning, nutrition, and conservation education to individual households.

5) Women should be engaged in leadership role in the community which will elevate their status and supporting improved gender balance in the community as women are primarily responsible for their family's health and wellbeing and are, therefore, in the best position to make positive changes for improved household health.

4. Conclusion

Thus, from all the study of global best practices in One Health, it may be inferenced that a multi-sectoral coordination at the animal, human, and ecosystem interfaces, both at policy making level and deployment level is necessary for a successful implementation of the One Health action plans. One of the useful strategies for One Health is to leverage existing programs to institutionalize the One Health approach. These structures can be used as models for other disease programs under the One Health approach.

It has also been observed that One Health integrated surveillance consisting of community-based active surveillance and district-based passive surveillance may lead to faster disease detection and more efficient disease control and tangible financial savings when formally compared against separated surveillance. The adoption of mobile telephone technologies and real-time data exchange protocol in between the surveillance systems helps in improving timely and complete capture of events which can further strengthen the routine surveillance systems in the animal and human health sectors.

Joint training in surveillance and outbreak investigation with physicians and veterinarians together with public health officials, field epidemiologists; lab personnel should also be explored for improved surveillance and control of zoonotic diseases through various training programs such as Field Epidemiology Training Program (FETP), Field Epidemiology Training Programs for Veterinarians (FETPVs), and Field Epidemiology and Laboratory Training Program (FELTP). Novel methods of trainings such as mixed mode of offline and onsite workshop can be a sustainable model in low and medium economic countries. A One Health University Network consisting of university-led network and faculties (public health, veterinary science, medicine, nursing, environment, and food technology) can be formed to support institutional changes in higher education by integrating competency based One Health training and research into the curriculum.

A network of laboratories can also be created to address the increasing threat posed by emerging and re-emerging zoonotic infectious diseases and promoting regional and cross-sectoral collaboration critical to strengthening capability to respond to disease outbreak with an aim to integrate sample sharing and generation of scientific knowledge for transfer. This network of labs can be assisted with a network consisting of experts, such as virologists or epidemiologists in the public health, veterinary health, food and environmental which can substantially assist through research work in enhancing cross-sectoral and supranational collaborations for epidemiological investigations and to analyse the distribution of

zoonosis subtypes in humans for better understanding of the epidemiology (e.g., characteristics) of the affected populations and the geographical relationships between viruses.

The response programs to disease outbreak should be made flexible and adaptive that can incorporate new information to improve their delivery and overcome challenges of logistics and procurement. The Mobilization of private and public resources could be done for an effective response and control to zoonotic diseases outbreak. The incentive schemes for privatization of veterinary services and subcontracting may help in improving the delivery of animal healthcare and vaccination services in remote areas and these activities can also be thought of as an exercise of Corporate Social Responsibility (CSR) rather than Public Private Partnership (PPP) to build sustainable institutions. Behavioural measures including improvements in water distribution and collection systems, garbage collection, health education campaigns to eliminate potential outbreaks of mosquito egg deposition, and the larvicide use in places where such elimination is not possible should be propagated. Also, at large health surveillance at border and immigration locations (such as ports and airports), appropriate guidance for travellers in infected areas is necessary.

For a better communication of information among the community, a coordinated clinical care for humans and companion where veterinary and human clinicians help each other develop the full community-health picture, making diagnoses easier and allowing identification of sentinel cases could be a successful model. The inclusion of One Health in primary and secondary schools can be explored at community level as children could be a messenger for behavioural change in their parents. The local community volunteers can be engaged along with veterinarians to deliver integrated community-based public health services to promote good health-seeking behavior, hygiene practices, infectious disease prevention and control, family planning, nutrition, and conservation education to individual households. Women should be engaged in leadership role in the community which will elevate their status and supporting improved gender balance in the community as women are primarily responsible for their family's health and wellbeing and are, therefore, in the best position to make positive changes.

A number of the learning of these global practices have also been considered while formulating the action plan of One Health Support Unit (OHSU) at Department of Animal Husbandry and Dairying, Government of India. Further, this compilation of global best practices will serve as a resource document for parties and institutions working on one health implementation in practice.

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6. Appendix

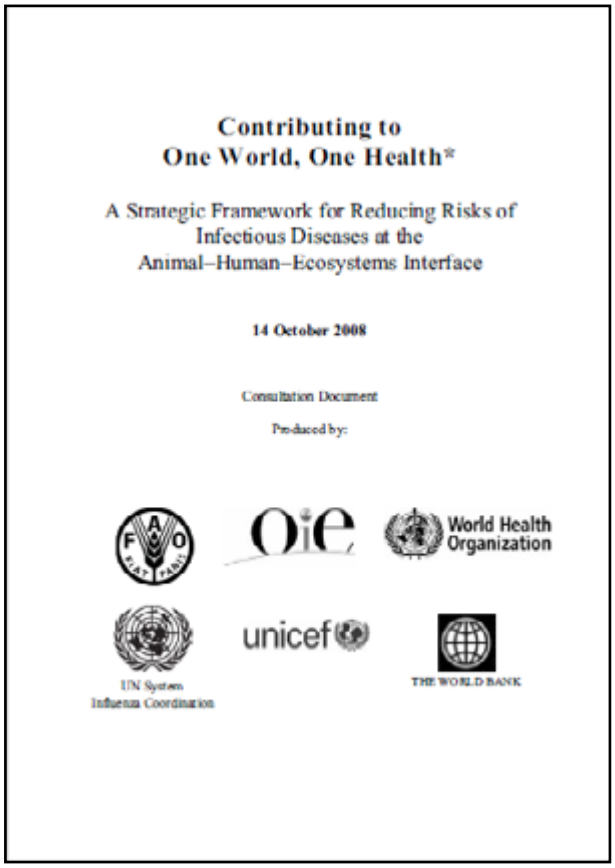
A. KEY AGENCIES AND PROJECT IN ONE HEALTH DOMAIN

Apart from major organization namely, World Health Organization (WHO), Food & Agricultural Organization (FAO) & World Organization for Animal Health (OIE) that lays the basis of One Health, other major organizations for reference purpose are listed below -

Key Organizations and project	Website links
GIZ	https://www.giz.de/en/worldwide/95590.html
Penn State University – College of Agricultural Sciences	https://agsci.psu.edu/academics/undergraduate/minors/one-health
Pandemic Preparation Institute, Rockefeller Foundation	https://www.rockefellerfoundation.org/pandemicpreventioninstitute/
One Health Institute, UC Davis Veterinary Medicine	www.ohi.vetmed.ucdavis.edu
SEAHUN - Southeast Asia One Health University Network	www.seaohun.org
AFROHUN - Africa One Health University Network	www.afrohun.org
PREDICT - Pandemic Preparedness for Global Health Security, USAID's Emerging Pandemic Threats (EPT) Program	WWW.p2.predict.global
PREEMPT – Preventing Viral Spillover Potential, U.S. Défense Advanced Research Projects Agency (DARPA)	www.preemptproject.org
REDISSE - Regional Disease Surveillance Systems Enhancement Project of World Bank	https://www.wahooas.org/web-ooas/en/projets/redisse-regional-disease-surveillance-systems-enhancement-project-west-africa

Key Organizations and project	Website links
One Health | Swiss Tropical and Public Health Institute	https://www.swisstph.ch/fr/about/eph/human-and-animal-health/one-health/
One Health | Biovision	www.biovision.ch/en
PREZODE - Preventing Zoonotic Disease Emergence, Un Environment Programme	www.prezode.org
One Health Commission	www.onehealthcommission.org
One World, One Health	www.oneworldonehealth.org

B. IMPORTANT DOCUMENTS ON ONE HEALTH



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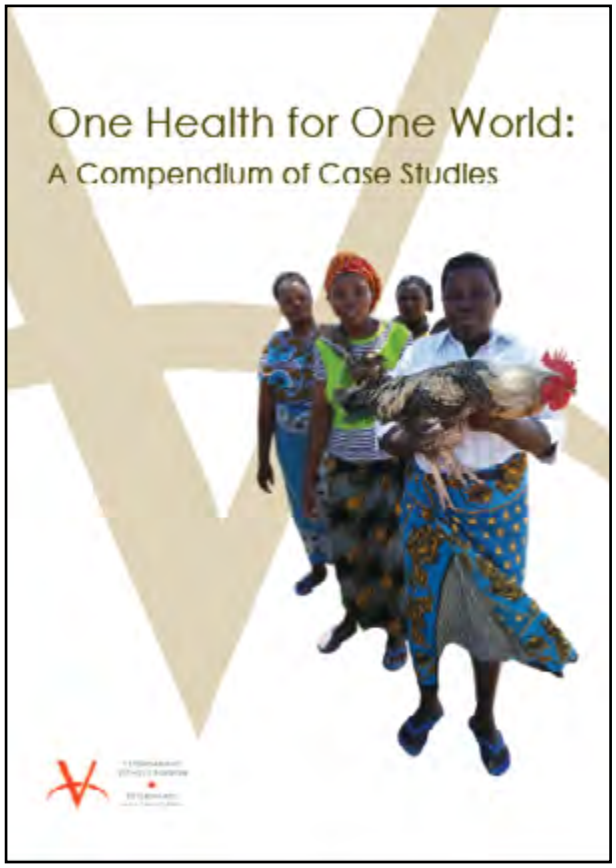

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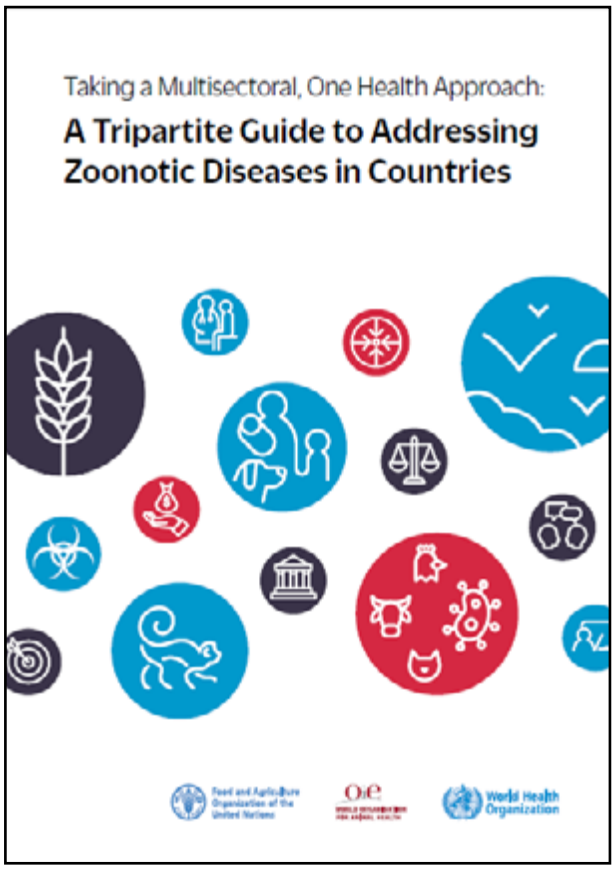

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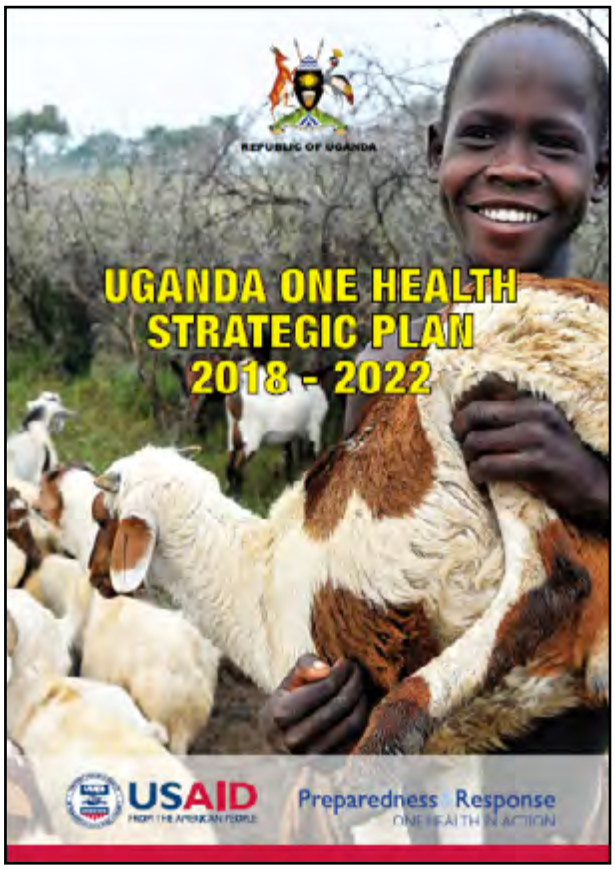

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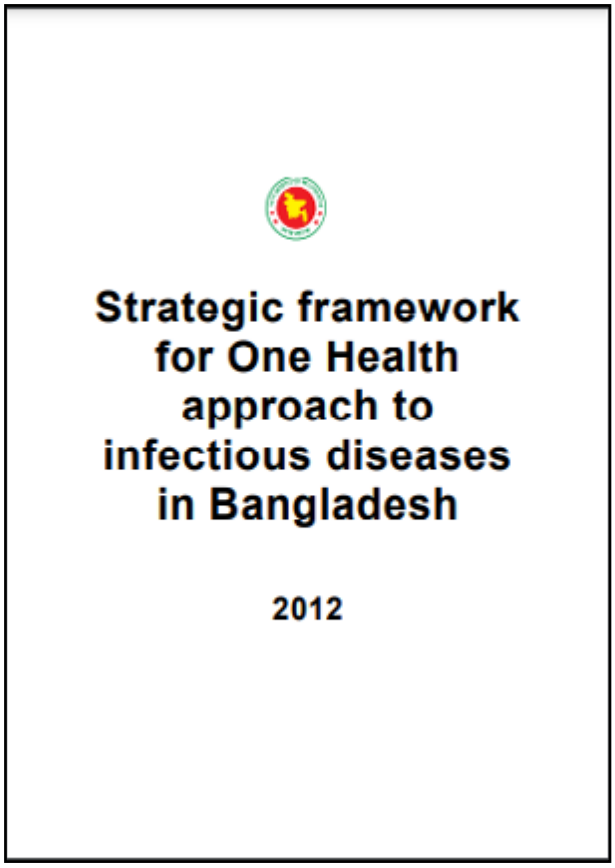

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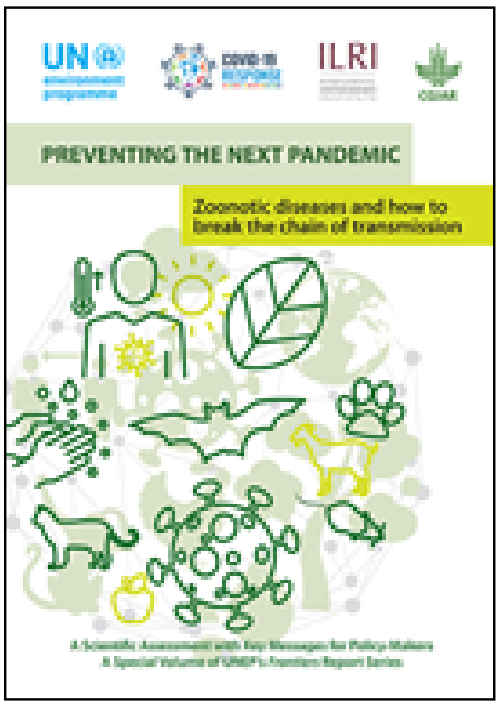

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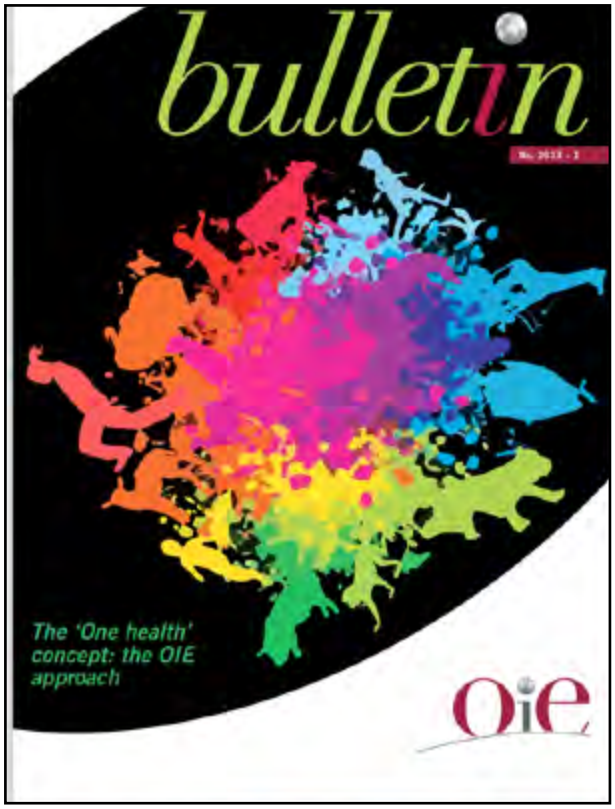

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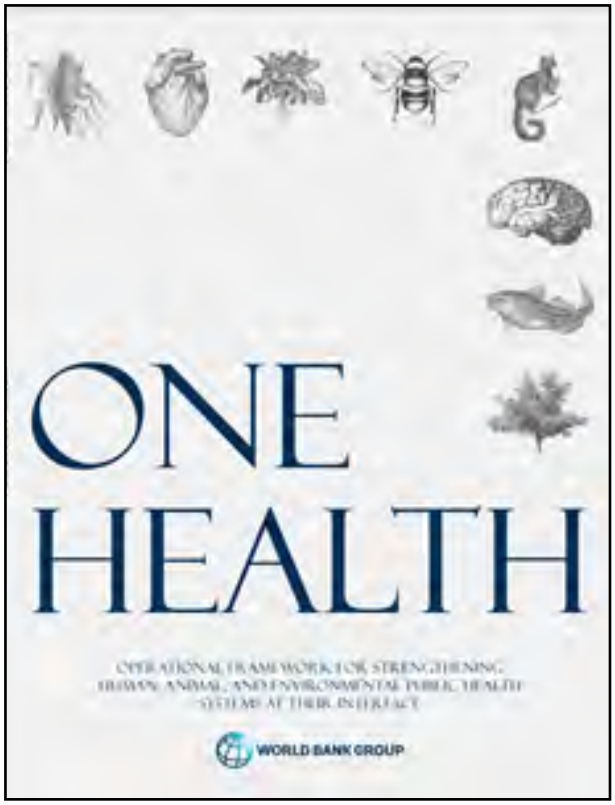

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ONE HEALTH

HEALTHY ANIMALS, HEALTHY PEOPLE, HEALTHY NATIONS

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