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EMERGING PANDEMIC THREATS

ONE HEALTH IN ACTION

Reducing Pandemic Risk, Promoting Global Health

This publication was prepared by the PREDICT Consortium headquartered at the One Health Institute (OHI), School of Veterinary Medicine, University of California, Davis.

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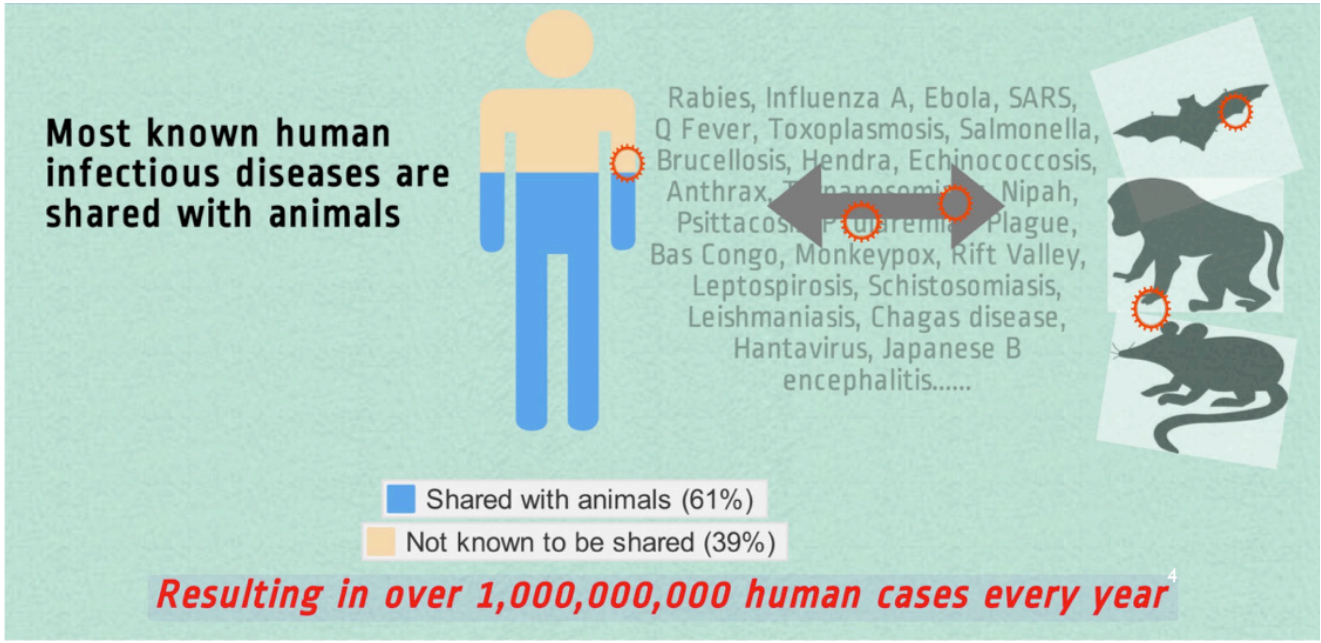
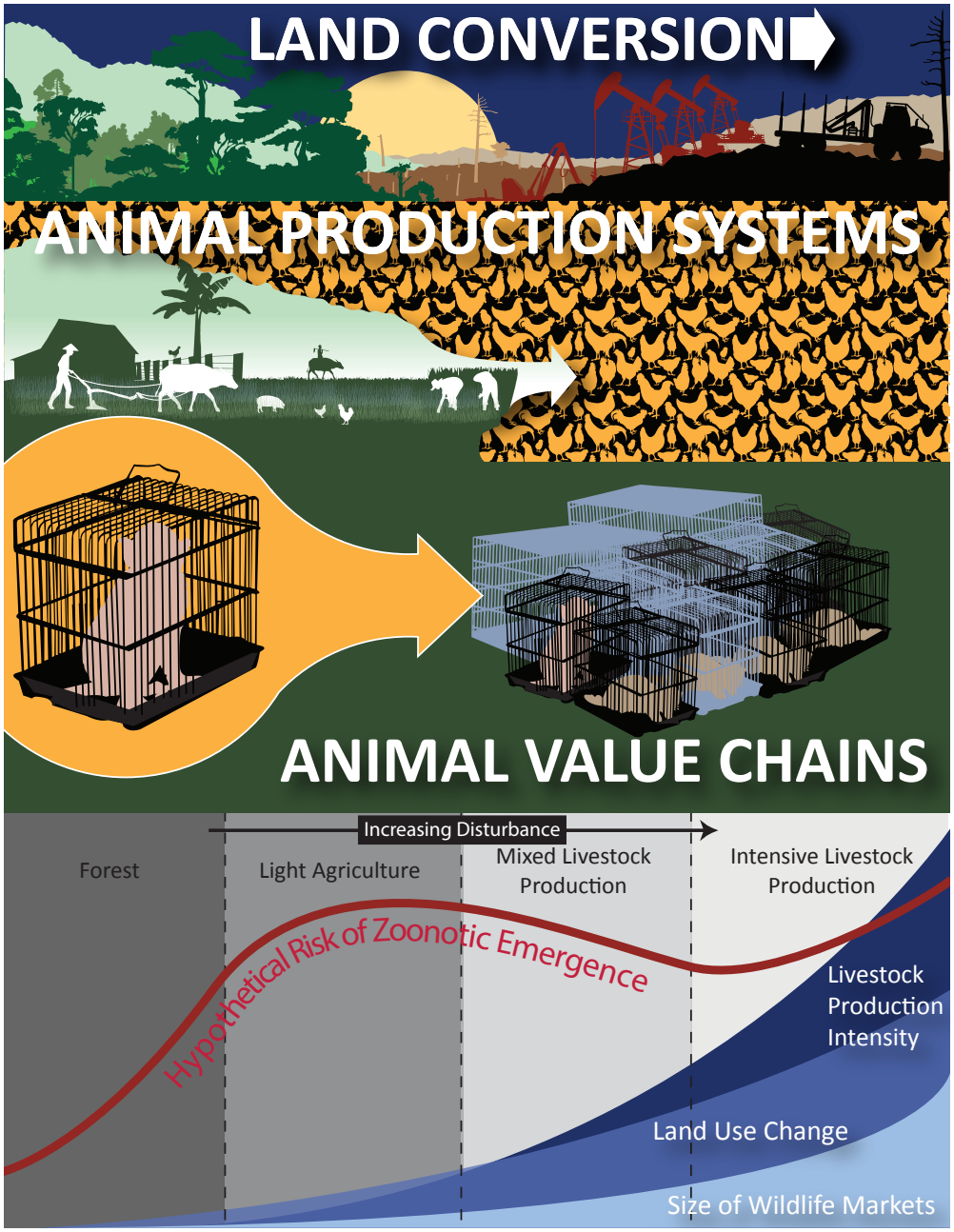
BRIDGING HUMAN, ANIMAL AND ENVIRONMENTAL HEALTH TO ADVANCE GLOBAL HEALTH AND DEVELOPMENT

Recent disease outbreaks have drastically threatened local and global health as well as country development. The Ebola outbreak in West Africa, beginning in late 2013 and continuing into 2016, resulted in over 28,600 cases, reducing gross domestic product growth in all three highly affected countries as well as disrupting progress in other key development priorities, including educational attainment, vaccination campaigns and management or treatment of disease such as HIV/AIDS, and malaria, food security, and poverty reduction.[1] Agricultural production has been heavily affected by past zoonotic disease outbreaks such as highly pathogenic avian influenza viruses, Nipah virus, and Rift Valley fever virus, resulting in economic impacts to the agricultural industry and livelihoods associated with it.



While focusing recovery efforts for affected countries is critical, the world still remains unprepared to tackle new disease outbreaks in the future. As such, in February 2014 the Global Health Security Agenda was launched to pursue a multilateral and multi-sectoral approach to strengthen both the global capacity and nations' capacity to prevent, detect and respond to human and animal infectious disease threats whether naturally-occurring or accidentally or deliberately spread.[2] With regard to Ebola virus, avian influenza virus, SARS-Coronavirus, HIV and many other recent outbreaks, all have been linked to infections from animals. But this trend is not new — in fact, the majority of known human infectious have originated at some point from animals ("zoonotic diseases").[3,4] The distinctions between so-called "emerging" diseases and established diseases are not static: as seen with HIV, a relatively new disease may quickly become established in human populations. The recent spread of Zika virus in the Americas represents the potential for new diseases to emerge and have rapid nation-level impacts.

WHAT IS CAUSING ZOONOTIC DISEASE OUTBREAKS?



Disease transmission events from animals or environmental sources to humans appear to be increasing. This has been prompted by major changes to ecosystems (brought on by human activities), and associated activities that increase human-animal contact. In turn, globalization's rapid trade and travel is enabling the spread of new diseases between countries and continents, resulting in pandemics.[5]

The underlying causes of diseases being transmitted from animals to humans include: conversion of landscapes, as often associated with deforestation for agriculture, timber logging, mining, oil extraction, changing agriculture and food production systems, and wildlife trade.[6] These pressures are providing more opportunities for pathogens to move between species and cause new outbreaks. They also are among main drivers of biodiversity loss.[7]

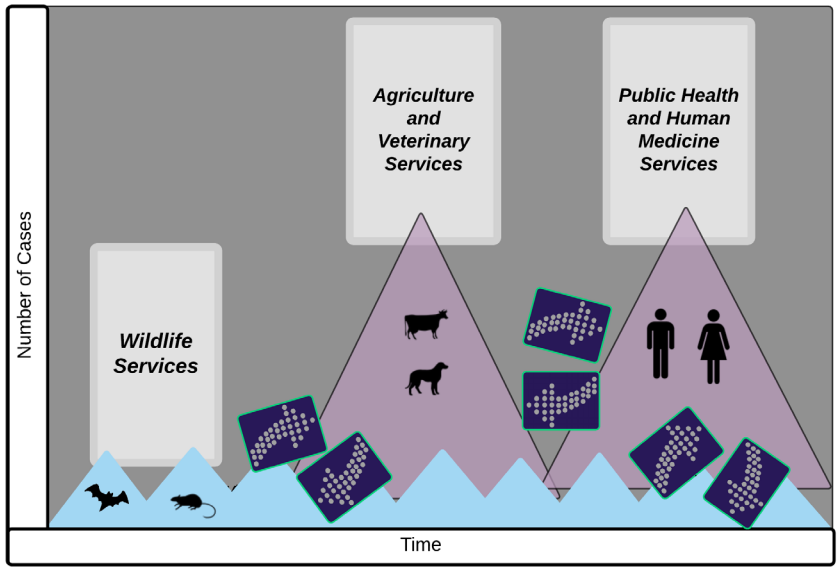
While wild and domestic animals may serve as sources for human disease, many also provide critical functions to ecosystems that support human health. Animals may also be affected by disease outbreaks (including, in some cases, diseases from humans). Past outbreaks of Ebola virus in Central Africa have taken their toll on humans as well as endangered great ape populations. Domestic animals, such as livestock, may also be affected by disease, threatening food production and food security.[7]

A HISTORICAL LOOK

Zoonotic disease outbreaks over recent decades have led to lasting public health and economic impacts. The 2003 outbreak of Severe Acute Respiratory Syndrome (SARS) cost the global economy an estimated US$30-40 billion.[8] HIV/AIDS, which was originally acquired from Great Apes (likely from hunting or butchering an infected animal), remains a public health crisis in several parts of the world, with 34 million infection-associated deaths to date.[9] Despite the ongoing impact of HIV/AIDS on public health and development, the systems in place to detect new diseases from other species have not changed significantly since the first detection of HIV/AIDS thirty-five years ago.

To date, only 1% of the estimated viruses in mammals have been detected.[10] While technological advancements have allowed us to discover pathogens more efficiently and affordably, to date there has been very limited screening of wildlife and livestock for pathogens they carry. Without knowing the pathogens circulating in our environments, we have limited information about diseases that may threaten our health in the future, thereby losing critical opportunities for prevention and risk reduction.

Health systems operate in a highly reactive fashion for emerging diseases, identifying and responding to a disease risk once an outbreak occurs. Human, veterinary/agriculture, and wildlife health sectors tend to work separately. This lack of coordination and information sharing limits our opportunities to prevent pathogens from 'spilling over' from one species to another.[11]



Gaps in authority and weak institutional capacity currently limit action in preventing the transmission of pathogens between humans, domestic animals, and wildlife. Each discipline typically responds once they see an outbreak in their own sector.

An alternate approach, with ongoing collaboration across sectors, could help identify critical transmission risks and potential solutions among these sectors.

ONE HEALTH GOES BEYOND ZOONOTIC DISEASE

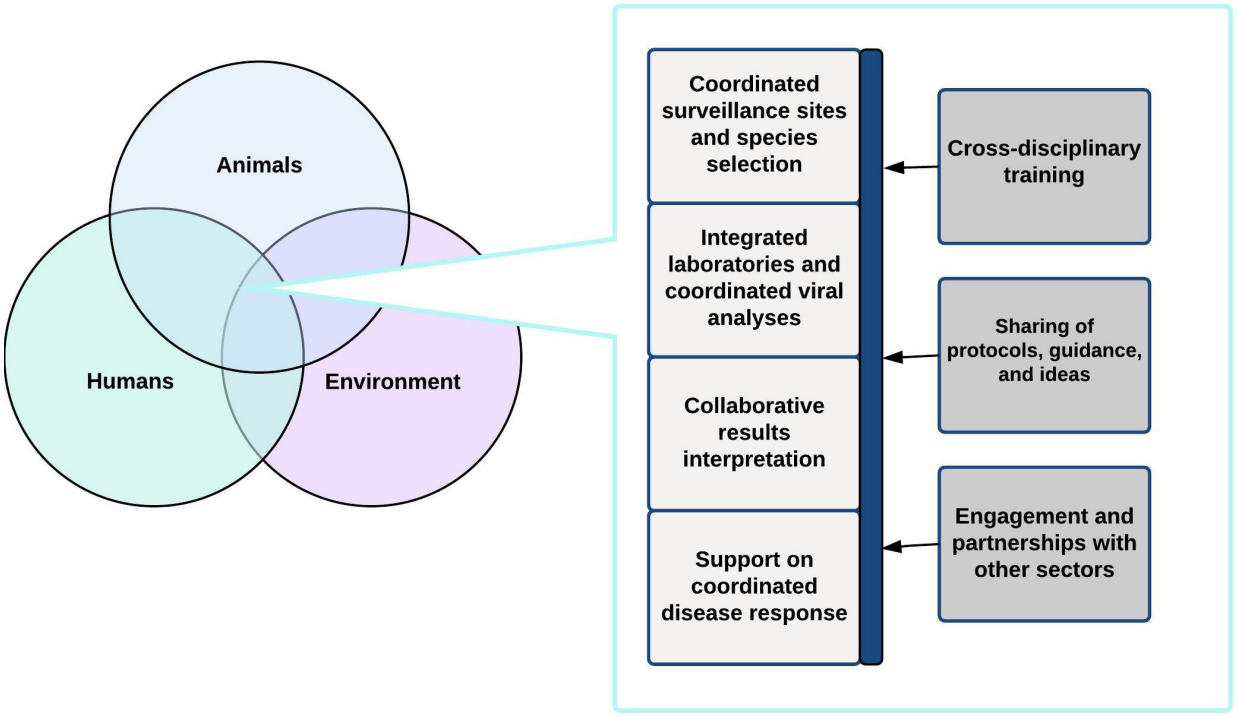
One Health is an interdisciplinary collaborative effort to attain optimal health for people, animals, and our environment.

One Health is founded on the need for a more integrated understanding of the connections among humans, animals and ecosystems within the political, economic and social systems in which they operate. By better understanding the full picture of disease transmission, the public health, veterinary, agriculture, and environmental communities can work together to identify more effective solutions. Their collaboration can result in more comprehensive, as well as cost-effective, outcomes than in single-discipline operations.

A One Health approach is especially needed in light of the rapid global environmental and agricultural changes that are presently occurring and expected to increase over the coming decades. These are creating pressures on natural systems and increasing contact between humans and other species, facilitating emergence of both infectious and noninfectious disease problems.

Support for One Health has been expressed at high levels, but its implementation on the ground remains limited due to a wide range of competing priorities. Over the course of the past six years, the USAID Emerging Pandemic Threats program has advanced One Health operations in 30+ developing countries.[1,2] This booklet provides case studies from partner countries to demonstrate the type of approaches, partnerships and benefits that One Health can yield.

The following case studies represent a compiliation of examples to date, noting that One Health examples will be further established and refined in the work of Emerging Pandemic Threats projects and partners.



National One Health Networks

Bangladesh has a strong legacy of interest and leadership in One Health efforts, with participation from a wide range of collaborating institutions. A Pandemic Influenza Preparedness and Response plan was initiated in 2005 and involved veterinary, public health, and wildlife health sectors working together. One of the pillars of the plan was coordination. Experts at Chittagong Veterinary & Animal Sciences University (CVASU) began informal discussions with stakeholders from public health, animal health, wildlife, and environmental communities. The need for a One Health approach was identified based on Bangladesh's high population density, vulnerable food and water security, threatened ecosystems, close contact between humans and animals, and its identification as a "hotspot" for disease emergence.[4] A "One Health Bangladesh" organization was soon established, with representatives from 12 national and international organizations. One Health Bangladesh has co-hosted eight conferences since its establishment, including an event hosted by USAID Emerging Pandemic Threats program partners with participation by representatives of the Food and Agriculture Organization, the World Health Organization, the country's Public Health and Livestock Departments, and the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b).

In 2012 One Health Bangladesh — jointly with Ministry of Health and Family Welfare, Ministry of Fisheries and Livestock, Ministry of Environment and Forestry, and UN Agencies — developed a National One Health Strategic Framework and Action Plan for Infectious Diseases in Bangladesh. The Framework identified nine components

for undertaking various activities involving relevant stakeholders and has been officially approved by the aforementioned three Ministries, which have given instruction to the relevant agencies for its implementation. One component is One Health Governance under which a One Health Secretariat would be established to coordinate implementation of activities. One Health Bangladesh now has nearly 400 members — including physicians, veterinarians, agriculturists, environmentalists, wildlife experts, ecologists, anthropologists, economists, allied scientists and practitioners, and activists. One Health Bangladesh is also a member of the One Health Alliance of South Asia, a regional network of governmental and non-governmental scientists and policy makers working on human, animal and environmental issues. Partners report a "new professional culture is emerging" in the country that acknowledges the value of cross-sectoral collaboration.

One Health partners: Institute of Epidemiology, Disease Control and Research, Bangladesh Ministry of Health and Family Welfare; Department of Livestock Services, Ministry of Fisheries and Livestock; Forest Department, Ministry of Environment and Forests; Chittagong Veterinary & Animal Sciences University; International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b); EcoHealth Alliance; FAO; WHO; U.S. CDC; Massey University; UNICEF; USAID Emerging Pandemic Threats PREDICT, PREVENT, Preparedness and Response.

One Health Partners: Ministry of Public Health; Ministry of Environment; Wildlife Conservation Society; EcoHealth Alliance; Pan-American Health Organization; Ambue Ari wildlife sanctuary; University of San Andres' Institute of Molecular Biology; the Vesty Pakos Zoo; USAID Emerging Pandemic Threats PREDICT.

Early Warnings from Wildlife and Effective Collaboration to Prevent Human Outbreaks

Yellow Fever is a mosquito-borne virus that infects humans as well as non-human primates, potentially resulting in hemorrhagic fever leading to death. Yellow Fever transmission can occur if infected monkeys and any of the mosquito vector species are present. In 2012, after One Health training by partners from the PREDICT program, staff at a wildlife sanctuary in Santa Cruz, Bolivia, reported six dead Howler Monkeys near the park. Early investigation during specimen collection and analysis at University of San Andres' Institute of Molecular Biology suggested that the infection was associated with a Flavivirus (a family of viruses transmitted from mosquitos or ticks). PREDICT partners alerted the Bolivian Ministry of Health while conducting further analysis for the specific pathogen — ultimately identified as Yellow Fever virus. A transdisciplinary, collaborative and coordinated response was undertaken in the region, including preventive human vaccination campaigns, mosquito control, and public outreach. Although infected monkeys had never been previously reported in Bolivia, the response to this outbreak was rapidly mobilized — within eight days from the detection to resolution of the outbreak. No human cases were reported, suggesting the benefit of awareness of risks, early warning systems in animals (including local laboratory capacity to screen for pathogens), and effective collaboration channels with a wide range of partners.

Collaboration for a Successful Outbreak Response

The monkeypox virus causes an infectious disease with clinical symptoms similar to smallpox. In parts of West and Central Africa, monkeypox virus has been found in small mammals including certain types of rats, mice, and squirrels, but can occasionally spill over into monkeys, chimpanzees, and human populations. Death occurs in about 10% of human cases, and there is no known treatment, and very little is known about transmission from animal reservoirs to human populations. Monkeypox is endemic to some countries in the region and there had been a single human case recorded in Cameroon in the past decades, but no recent cases had been observed in the country until March 2014. At this time, several chimpanzees fell ill at the Sanaga Yong Chimpanzee Rescue Center. Cameroon's newly adopted One Health Strategy and Zoonotic Program, with One Health focal persons appointed to four ministries, was put into action shortly after the suspected cases were reported to the Ministry of Health.

The cross-sectoral planning and response, which included literature reviews, on-site risk investigation, observations, sampling and laboratory diagnostics, as well as reporting to international agencies such as the World Animal Health Organisation (OIE) and the International Health Regulation of WHO, allowed for better knowledge sharing, faster response time, and decreased cost. Of the 72 chimpanzees in the sanctuary, the outbreak was limited to 6 cases of infection, with only one fatality and no spillover to human contacts. The PREDICT project and Cameroon Epidemiological and Veterinary Public Health Association provided support to the ministries during the investigation planning and response phases, helping to reinforce a One Health approach and practice.

After the outbreak ended and the investigation was complete, agencies compared this response to previous outbreak responses. The use of a One Health approach in this case was estimated to provide a two-third reduction in the total cost of the investigation and a response time that was a full 10 days faster. This was achieved through sending a single investigation team with representatives from multiple ministry sectors and requiring only a single government travel authorization.

One Health Partners: Sanaga Yong Chimpanzee Rescue Center; Ministry of Public Health; Ministry of Livestock, Fisheries and Animal Industries; Ministry of Forestry & Wildlife; U.S. CDC; U.S. National Institutes of Health; Centre de Recherche pour la Santé des Armées; Metabiota; Mosaic; Global Viral; Cameroon Epidemiological and Veterinary Public Health Association; USAID Emerging Pandemic Threats PREDICT and Preparedness and Response.

One Health Partners: Ministry of Enrivonment and Forestry; Ministry of Agriculture; Ministry of Health; Ministry of Research and Technology; Coordinating Ministry of People's Welfare; Indonesian Institute of Science (LIPI); KomNas Zoonosis Control; Primate Research Center at Bogor Agricultural University; Eijkman Institute for Molecular Biology; Universitas Sam Ratulangi (Manado Sulawesi Utara); Universitas Negeri Gorontalo; Padjadjaran University (Bandung, Javaz); EcoHealth Alliance; Metabiota; Smithsonian Institution; USAID Emerging Pandemic Threats PREDICT project.

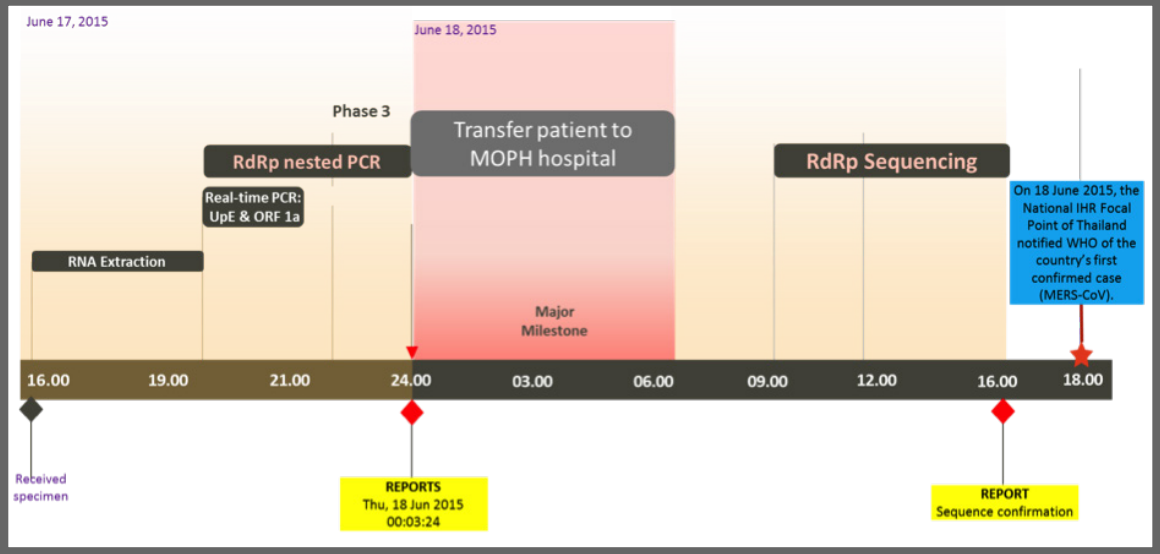
Coordinated Information Sharing and Interpretation

PREDICT developed a systematic One Health approach to surveillance results sharing, review, and approval for public release. The information flow process involved designated points of contact in each country at the ministries representing human health, livestock, and wildlife who received each results report. In many cases, sampling and/or laboratory screening occurred in partnership with Ministries, so surveillance results were directly relevant, but the routine results dissemination to all three ministries was emphasized as a way to showcase One Health intersections and opportunities for identifying coordinated solutions. Integrated discussions of results were encouraged in inter-ministerial forums (e.g. at task force meetings). In Indonesia, PREDICT's reporting efforts helped initiate a government mandate for a national reporting framework for wildlife and human disease surveillance. These streamlined and more comprehensive reporting systems assist the country in disease monitoring, as well as in meeting its reporting obligations to the World Health Organization (WHO) under the International Health Regulations as well as to the World Organisation for Animal Health (OIE).

Identifying Animal Reservoirs to Mitigate Risk

One Health efforts in Cameroon also helped identify gorillas as the animal reservoir for human T-lymphotropic virus type 4 (HTLV-4) in 2014.[13] The source of the first known human infection, discovered in a hunter in 2005, was unknown. In a strong collaboration with the Cameroonian ministry responsible for wildlife, the Limbe Wildlife Centre and Ape Action Africa who is responsible for managing primates in Mfou National Park sanctuary, and with rural communities throughout the country, PREDICT program partners tested specimens for HTLV-4, finding the virus in a number of captive and wild gorillas. Given that other HTLV strains are known to cause severe illness in humans, this finding was important for informing risk mitigation practices. Hunters were educated about risks of contact with wildlife and informed on protection measures. Given their critically endangered conservation status, as well as previous findings of other zoonotic viruses in gorillas, this finding provides further support for protection of gorillas from illegal hunting to promote both public health and conservation.

One Health Partners: Ministry of Forestry and Wildlife; Centre de Recherche pour la Santé des Armées; Limbe Wildlife Centre; Ape Action Africa; Mosaic; Global Viral; Metabiota; U.S. CDC; Ape Action Africa; USAID Emerging Pandemic Threats PREDICT.



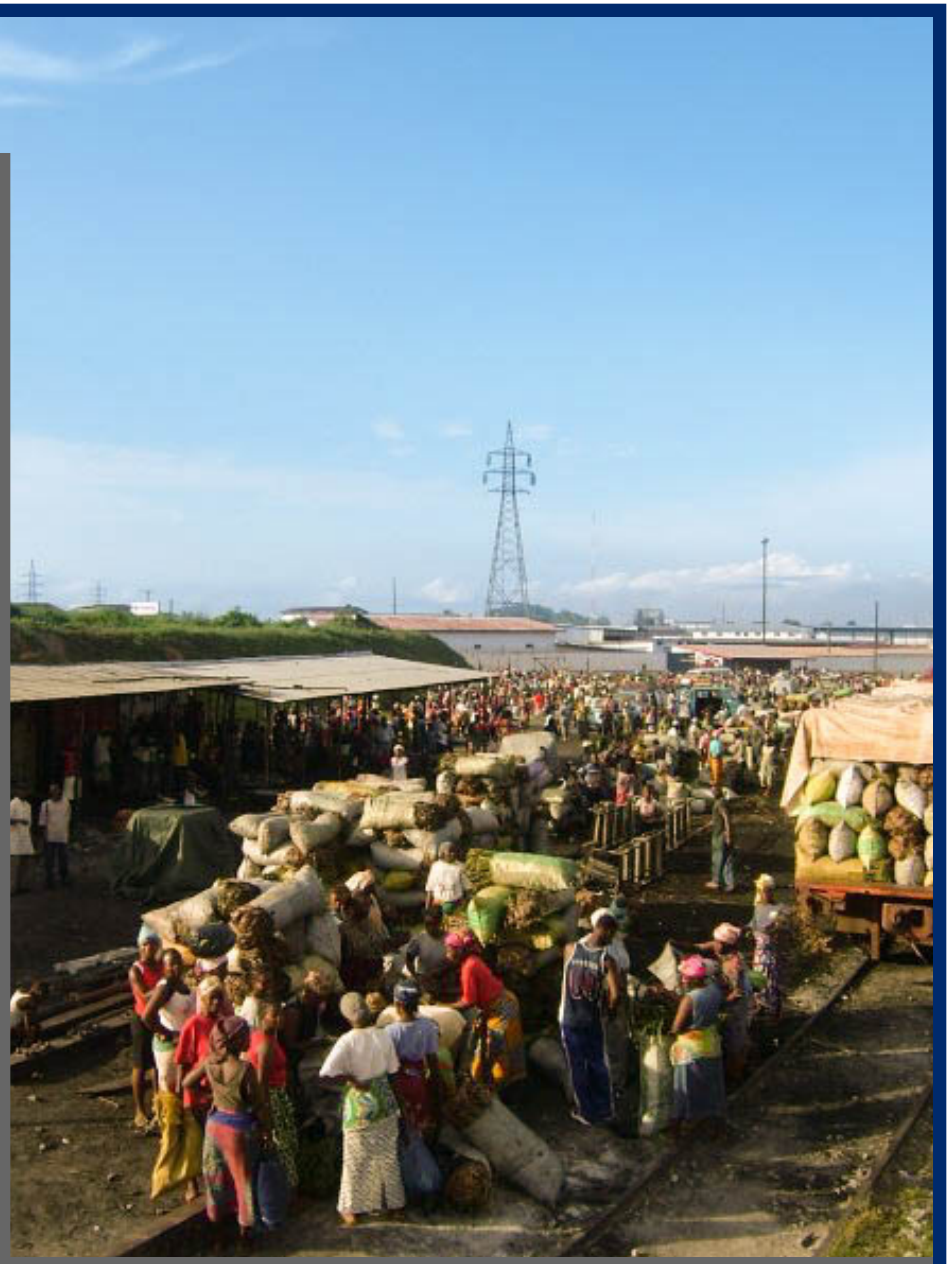
One Health Partners: Ministry of Public Health; WHO Collaborating Center for Research and Training on Viral Zoonoses at Chulalongkorn University; World Health Organization; EcoHealth Alliance; Department of National Parks, Wildlife and Plant Conservation; USAID Emerging Pandemic Threats PREDICT.

Surveillance Preparedness

The Middle East Respiratory Syndrome Coronavirus (MERS-CoV), caused by a Coronavirus, is an emerging infectious disease that was first detected in 2012. MERS-CoV is thought to have an animal source, but infections may also be transmitted between humans through airborne spread or direct contact. In June 2015, Thailand saw its first case of MERS-CoV, brought into the country by an international traveler. As a result of prior preparedness efforts, including viral discovery for human infections as part of the PREDICT program, training on sampling for potential MERS-CoV infections, and MERS-CoV laboratory screening protocols, the country had strong capacities in place. Paired with infection control practices, intensive surveillance was rapidly implemented in high-risk settings including points of entry into the country and in healthcare settings. Specimens were rapidly tested (only seven hours for first results and 24 hours for confirmation) at the WHO Collaborating Center for Research and Training on Viral Zoonoses at Thailand's Chulalongkorn University (which reports to the Ministry of Health). No secondary infections were detected in Thailand suggesting no human to human transmission occurred. Given the limited knowledge on coronaviruses, surveillance efforts have also been undertaken by the One Health partners involved in the human MERS outbreak to screen for coronaviruses in wildlife and domestic animals in the country to help improve understanding about this group of viruses.

Rapid Identification and Containment of Disease Outbreaks

In July 2014, in the midst of the Ebola virus crisis in Guinea, Liberia, and Sierra Leone, a separate outbreak of Ebola virus occurred in the Democratic Republic of Congo (DRC). When it occurred, several virology experts from DRC's Institut National de Recherche Biomédicale (INRB), the national infectious disease laboratory responsible for haemorrhagic fever diagnostics, were out of the country responding to the West African outbreak. However, the country had experienced prior Ebola virus outbreaks and had preparedness capacity in place. Through a long-standing INRB-PREDICT partnership, the PREDICT laboratory (which is hosted at INRB), was requested to assist with conducting the diagnostic testing. Samples were collected from suspected cases and screened, with preliminary confirmation of Ebola virus within a day of receiving the samples. Based on the early results of the laboratory tests, the DRC government was able to enact rapid disease control measures such as control of travel, dispatch of a mobile laboratory, and infected patient contact tracing, among other measures, leading to containment of the outbreak. Sequencing of the positive cases indicated that the DRC outbreak was an independent outbreak from the outbreak in West Africa, and the source of the outbreak (the butchering of an infected animal that had been found dead and collected for food) was identified through trace-back efforts, helping to elucidate the transmission chain and target high-risk practices to prevent future infections. The outbreak response demonstrated the value of strong partnerships between institutions as well as efficient and effective communication systems, diagnosis capabilities, and disease control measures. The PREDICT team was also requested to conduct wildlife sampling in the affected area to determine the presence of *Ebolaviruses* circulating in wildlife, and to participate in the training of health care providers and epidemiologists to be deployed in the Ebola affected countries of West Africa.



One Health Partners: Institut National de Recherche Biomédicale (INRB); Ministry of Health; Metabiota; Ministry of Environment; Institut Congolais pour la Conservation de la Nature (ICCN); Direction of animal production and health at the Ministry of Agriculture; USAID Emerging Pandemic Threats PREDICT.

WAYS FORWARD

One Health approaches have been employed in a range of situations over the past six years in partner countries. These have helped enhance understanding of and solutions to emerging infectious disease threats. The case studies demonstrate the relevance and benefits of One Health to economic, public health, agricultural, and environmental issues, as well as tourism and development, food and nutrition, climate and weather, and more.

Successful approaches include interdisciplinary surveillance, reporting and laboratory collaboration, coordinated data sharing and interpretation, and strong communication channels for disease reporting and rapid action. While One Health is adaptable to country-specific contexts, in addition to the direct contribution to the Global Health Security Agenda, best practices established abroad can provide valuable lessons for domestic health systems on efficiencies across sectors, outbreak preparedness, and overall greater focus on preventing disease.

Given the high economic and societal cost of recent outbreaks, policy decisions and global and local health capacity investments can be oriented to create incentives for advancing a One Health approach aimed at preventing, not just responding to, disease outbreaks.

Future case studies and evaluation can offer further insight into other potential applications. In addition to predicting, preventing and preparing for pandemic threats, One Health may be beneficial for addressing many complex problems involving humans, animals, and their shared environments such as addressing pollution, food security, and sustainable development goals.




ADDITIONAL RESOURCES

To learn more about the Global Health Security Agenda and One Health, please visit:

Global Health Security Agenda
- Program background: http://ghsagenda.org/

USAID Emerging Pandemic Threats program
- Program background: https://www.usaid.gov/what-we-do/global-health/pandemic-influenza-and-other-emerging-threats
- PREDICT: http://www.predict.global
- PREDICT project report: http://www.report.predict.global
- Preparedness & Response: www.preparednessandresponse.org

Additional One Health Case studies
- ISID competition: http://www.syndromic.org/cop/one-health-surveillance/957-ohs-resources
- Network for Evaluation of One Health: http://neoh.onehealthglobal.net/

Disease Monitoring Resources
- Subscribe to ProMED (Program for Monitoring Emerging Diseases) Mail: http://ww4.isid.org/promedmail/subscribe.php
- HealthMap: http://www.healthmap.org/en/
- HealthMap PREDICT: http://www.vetmed.ucdavis.edu/ohi/predict/predict_surveillance.cfm

Open Access Publications
- OIE Scientific and Technical Review: "One Health" edition: http://web.oie.int/boutique/index.php?page=ficprod&id_produit=1308&fichrech=1&lang=en

PHOTO CREDITS

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