



Workshop Summary

One Health Zoonotic Disease Prioritization for Multi-Sectoral Engagement in Côte d'Ivoire



Abidjan, Côte d'Ivoire
January 25–26, 2017



USAID
FROM THE AMERICAN PEOPLE

Preparedness & Response
ONE HEALTH IN ACTION

ATTENDANCE

PARTICIPATING ORGANIZATIONS

Ministry of Health and Public Hygiene (MSHP)

Office of Director General of Health (DGS)
Directorate of the National Institute and Public Hygiene (INHP)
Epidemiological Surveillance Service of INHP
GHSA Secretariat
Entomological Surveillance Service of INHP
Directorate of Planning, Foresight, Evaluation and Health Information (DPPEIS)

Ministry of Higher Education and Scientific Research (MESRS)

Cabinet
Institute Pasteur of Côte d'Ivoire (IPCI)
Center of Medical and Veterinary Entomology (CEMV)

Ministry for Agriculture and Rural Development (MINADER)

Cabinet Office of Director General for Food Production and Security (DGPSA)
National Laboratory for Agricultural Development Support (LANADA)
Bingerville Veterinary Central Laboratory (LCVB)

Ministry of Water and Forests (MINEF)

Cabinet Office of Director General of Water and Forests (DGEF)
Directorate of Wildlife and Hunting Resources (DFRC)
Abidjan Zoo

Ministry of Animal and Fisheries Resources (MIRAH)

Directorate of Veterinary Services (DSV)
Sub-Directorate Division of Animal Health (SDSA)
Sub-Directorate of Regulation and Zoo-sanitary Information (SDRIZ)
Animal Health and Veterinary Public Hygiene Improvement Project (PASA-HPV)

Ministry of Wholesomeness, Environment and Sustainable Development (MINEDD)

Cabinet Office of Director General for the Environment and Sustainable Development (DGEDD)
Ivorian Office of Parks and Reserves (OIPR)
Ivory Coast Anti-Pollution Center (CIAPOL)

VOTING MEMBERS

Dr KONE Atioumounan Blaise (MSHP/DGS)
Pr BENIE BI Vroh Joseph (MSHP/INHP)
Pr DOSSO Mireille (MESRS/IPCI)
Mr. AKAMOU Fataye (MINADER/DGPSA)
Dr DEMBELE Ardjouma (MINADER/LANADA)
Colonel KOUAME Brou Didié (MINEF/CABINET)
Commandant KONE Salimata (MINEF/DFRC)
Dr CISSE Diarra (MIRAH/DSV)
Mme FADIGA DIARRASOUBA Haida Kaly (MIRAH/DSV)
Dr KAMELAN Omer Pokou (MINSEDD/CABINET)
Colonel ADOMPO YAPO CELESTIN (MINSEDD/DGE)

WORKSHOP FACILITATORS

Dr COULIBALY Julien Kalpy (MESRS/IPCI)
Dr TETCHI Mathilde (MSHP/INHP)
Dr YAO K. Marc-Alain. (MIRAH/DSV)
Dr EGGERS Carrie (CDC/HQ)
Dr ALROY Karen (CDC/HQ)

WORKSHOP ORGANIZERS

Dr SAVANE Sita (MSHP/INHP)
Dr ANDRE Zandra (USAID)
Dr KONAN KOKO Regina (USAID)
Mme DEBRIMOU Jenny (USAID)
Dr NDIAYE Serigne (CDC)
Dr TOURE ADECHOUBOU Ramatou (CDC)
Dr SOUMARE Baba (P&R)
Dr GBAGUIDI Lionel (P&R)
Dr TAHA Raymond (P&R)
Mme BARRY Aidi (P&R)
Mr KOUASSI Espérance (P&R)
Mr KOUAME Jean Claude (Traducteur)

PARTICIPANTS

Dr COULIBALY M'Betiegué (MINADER/LANADA)
Lt/Colonel YAO Kouakou (MINEF/DFRC)
Dr KHANE Samouka (MINEF/Zoo d'Abidjan)
Dr YAPI Achi Désiré (MIRAH/DSV)
Dr DAGNOGO Komissiri (MIRAH/PASAHPV)
Dr OUATTARA Douyeri Thierry (MIRAH/DSV)
Dr FOFANA Diakaridja (MSHP/INHP)
Dr TRAORE Youssouf (MSHP/INHP)
Dr LATTAH Monique (MSHP/DPPEIS)
Dr N'GATTIA Anderson (MSHP/INHP)
Dr WOGNIN Affou Séraphin. (MINSEDD/CIAPOL)
Mme DIOMANDE FOFANA Alimata (MINSEDD/CIAPOL)
Dr KOFFI Eugene (MESRS/IPCI)

WORKSHOP OBSERVERS

Dr TANOBIAN (WHO)
Dr FOLEFACK Gervais (WHO)
Dr ANDRE Zandra (USAID)
Dr KONAN KOKO Regina (USAID)
Dr NDIAYE Serigne (CDC)
Dr ANDRE McKenzie (CDC)
Dr TOURE ADECHOUBOU Ramatou (CDC)
Dr BESSIN Rene (FAO)
Dr N'GUESSAN Monique (FAO)
Dr BOKA Marcel (FAO)
Dr SOUMARE Baba (P&R)
Dr GBAGUIDI Lionel (P&R)
Dr TAHA Raymond (P&R)
Mme NAHOUNOU Marie-Josiane (PREDICT)
Dr TRAORE Sylvain (Suisse Center for Scientific Research (CSRS))
Pr YAPI YAPI Grégoire (MESRS/Center of Medical and Veterinary Entomology (CEMV))



Photo 1. A little boy holding a baby Lesser Spot-Nosed Monkey (*Cercopithecus petaurista*).

TABLE OF CONTENTS

Attendance	ii
Participating Organizations	ii
Voting Members	iii
Workshop Facilitators	iii
Workshop Organizers	iii
Participants	iii
Workshop Observers	iii
Executive Summary	1
Table 1. Final zoonotic diseases selected during the One Health Zoonotic Disease Prioritization Workshop in Côte d’Ivoire, 2017.	2
Background	3
Methodology	5
Prioritization Process	5
Criteria Selected for Ranking Zoonotic Diseases	6
Results	8
Description of the Selected Diseases	8
Plans and Recommendations	10
Specific Next Steps	10
Reflections and Recommendations	10
Appendix A: Original List of Zoonotic Diseases of Possible Concern in Côte d’Ivoire	11
Appendix B: The Criteria and Questions in Ranked Order with Weights	12
Appendix C: Final Results of One Health Zoonotic Disease Prioritization Workshop in Côte d’Ivoire	13
Table 2. Zoonotic diseases considered for prioritization in Côte d’Ivoire:	13
References	14



Photo 2. The Guinea Turaco (*Tauraco persa*), a green bird native to the forests of West and Central Africa.

EXECUTIVE SUMMARY

Zoonotic diseases are diseases capable of spreading between animals and humans. Most known human infectious diseases and about three-quarters of newly emerging infections originate from animals. Some zoonoses pose a significant threat to human public health, while others may have tremendous agricultural and social or economic impacts. The cross-sectoral nature of zoonotic diseases has historically been a challenge in preparing for and responding to zoonotic disease threats at the animal-human-ecosystem interface, highlighting the critical need for a multi-sectoral and interdisciplinary One Health approach to address these emerging health threats.

Global security frameworks including the Global Health Security Agenda (GHSA) and International Health Regulations (IHR-2005) recommend that countries strengthen their surveillance capacity for zoonotic diseases. As part of implementing this recommendation, Côte d'Ivoire conducted a multi-sectoral zoonotic disease prioritization workshop.

The purpose of this 2-day One Health Zoonotic Disease Prioritization Workshop was to identify zoonotic diseases of greatest national concern for Côte d'Ivoire. This workshop used equal input from representatives of human health, livestock, environment, wildlife, research, and higher education sectors. During the workshop, representatives identified a list of zoonotic diseases relevant for Côte d'Ivoire (Appendix A), defined the criteria for prioritization, and determined questions and weights relevant to each criterion (Appendix B). Five zoonotic diseases/disease groups were identified as a priority (Table 1) by participants using a semi-quantitative selection tool, the One Health Zoonotic Disease Prioritization Tool, developed by the U.S. Centers for Disease Control and Prevention (CDC) (Rist, 2014; CDC OHZDP Overview, 2016).

The prioritized zoonotic diseases for Côte d'Ivoire are (1) *Mycobacterium* species, (2) *Brucella* species, (3) rabies virus, (4) viral hemorrhagic fevers and arboviruses, and (5) respiratory viruses: highly pathogenic avian influenza, SARS CoV, and MERS CoV (Table 1). The final results of the One Health prioritization process and normalized weights for all zoonotic diseases discussed in Côte d'Ivoire are shown in Appendix C. This report summarizes the One Health process used to prioritize the top zoonotic diseases for Côte d'Ivoire that should be jointly addressed using a multi-sectoral, One Health approach including human, animal, agricultural, and environmental health ministries and other sectors relevant to the prioritized zoonotic disease.



Goal of Workshop: The goal of this workshop was to prioritize zoonotic diseases that have an impact on human and animal health, with a view to strengthening inter-ministerial collaboration (human health, livestock, agriculture, environment, higher education and research, and wildlife) within the One Health approach in Côte d'Ivoire.

Expected Outcome of Workshop: The expected outcome was a list of five priority zoonoses that will be used to advocate for surveillance, prevention, and control across sectors in Côte d'Ivoire over the next five years.

Table 1. Final zoonotic diseases selected during the One Health Zoonotic Disease Prioritization Workshop in Côte d'Ivoire, 2017.

Zoonotic Disease	Causative Agent	Human Disease Burden	Animal Disease Burden	Diagnostics, Treatment, and Prevention
Tuberculosis (TB)	Bacteria	Overall prevalence of TB is 159/100,000 people (WHO, 2015). <i>M. bovis</i> in Africa ranges from 0–37% of all TB cases (Muller, 2013). 4% prevalence rate in cattle (abattoir Port Bouet 2008 FAO-CI).	Exact numbers are unknown, but cattle are the primary reservoir of <i>M. bovis</i> . The prevalence of <i>M. tuberculosis</i> in animals is unknown.	Effective treatment exists for people. Vaccination not widely used in animals, but candidate vaccines are under development (OIE).
Brucellosis	Bacteria	Human prevalence of 5.3% reported in Northern Côte d'Ivoire (Kanoute, 2016). Regional studies suggest pastoralists with high exposure to livestock may be at increased risk (Dean, 2013).	Prevalence of 4.8% in cattle herds in northern Côte d'Ivoire (Kanoute, 2016).	Effective animal vaccine and treatment for people exist.
Rabies	Virus	Approximately 10,000 people bitten and scratched by dogs (97%) with an average of 18 deaths each year (CI Medical Monitoring Report). Available data suggest significant under-reporting of cases (Dodet, 2009).	Exact numbers are unknown, but it is estimated that 90% of human cases come from a dog bite exposure.	Effective animal vaccine exists. Post-bite treatment for people is very effective. Once symptoms start, all patients die.
Viral Hemorrhagic Fevers (VHFs)	Viruses	Significant regional outbreaks in humans.	Evidence of disease in wildlife (Formenty, 1999).	Currently there are no animal vaccines. Human vaccines are available for some VHFs. Treatment for people is supportive care (WHO, Ebola).
Arboviruses	Viruses	Exact numbers for all arboviruses are unknown. However, yellow fever and dengue virus have been documented in people in Côte d'Ivoire.	Outbreaks of Rift Valley fever in livestock populations throughout Sub Saharan Africa.	For some arboviruses effective vaccines exist and for others not. Treatment in humans is largely supportive care.
Highly Pathogenic Avian Influenza, SARS CoV and MERS CoV	Viruses	No documented human cases of avian influenza, SARS, or MERS in Côte d'Ivoire.	Outbreaks of avian influenza in poultry have been reported in Côte d'Ivoire in recent years (Asante, 2015).	No animal vaccine exists. Treatment for avian influenza with oseltamivir and supportive care. MERS and SARS treated with supportive care.

BACKGROUND

Côte d'Ivoire is in West Africa, bordering the North Atlantic Ocean, between Ghana to the east and Liberia to the west. Côte d'Ivoire is in a transition zone between two types of climates: equatorial in the south (dense forest) becomes tropical in the north (savannah and forest). The south and center of the country are covered by dense forest and are subject to a humid, equatorial climate that is influenced by the ocean and characterized by abundant rainfall. The country has four seasons: a long rainy season from April to July; a short dry season from July to September, followed by another short, rainy season from September to November; and a long, dry season from December to March (www.diakadi.com). Most of the country's 23.7 million inhabitants live along the coast, and the forested interior is sparsely populated. Most of the country's forest, at one time one of the largest forests in West Africa, has been heavily logged (CIA World Fact book).

Côte d'Ivoire has eight national parks covering 1,732,100 hectares, five natural reserves covering 339,630 hectares, and 16 botanical reserves covering 198,418 hectares. Other than these legally protected sites, there are 231 identified forests, covering 4,200,000 hectares, which are particularly lush, and 6,702 sacred forests covering 36,434 hectares, as well as six wetlands designated as Wetlands of International Importance (Ramsar Sites), nature reserves and other areas of forest and savanna.

Côte d'Ivoire has four major rivers, which are the Comoé, the Bandama, the Sassandra, and the Cavally; three lagoon systems, Aby, Ebrié and Grand-Lahou; and a seaboard on the Gulf of Guinea (Atlantic Ocean).

Zoonotic diseases are diseases that are spread between animals and people. Most known human infectious diseases and about three-quarters of newly emerging infections originate from animals. Côte d'Ivoire is particularly vulnerable to the effects of zoonotic diseases because over



47% of the population is engaged in agriculture (FAO, 2005). (Directorate of Planning, Statistics and Programs from MIRAH). Côte d'Ivoire has significant biodiversity with nearly 1,000 vertebrate species recorded in Tai National Park, one of eight national parks. Côte d'Ivoire contains numerous endemic or near endemic wildlife species, including the pygmy hippopotamus, zebra duikers, Johnston's genet, Miller's striped mouse, red colobus, lesser spot-nosed monkey, and Western chimpanzee (WWF, 2017). Côte d'Ivoire abounds with numerous insects, approximately 5,493 species, and numerous birds including aquatic birds, approximately 712 species. The terrestrial fauna is characterized by richness and significant biological diversity. There are 11 phyla of animals distributed in 74 orders, 203 families, 731 genera and 6,994 species. The group of animals with the greatest number of species is insects (5,493). This group represents 79% of species counted versus 10.2% for birds, which occupy the second place, and only .01% for land mollusks which occupy last place. A total of 1,817 aquatic species have been reported, of which 581 are mollusks, 302 crustaceans, 496 fish, and three mammals (5th national report on biological diversity, 2014).

Zoonotic diseases that occur in large numbers of people or animals can impact society in three main ways:

- Threaten the health of animals resulting in illness, loss of productivity, and death.
- Threaten the livelihood of a large segment of the population dependent on livestock as a major source of income.
- Threaten the health of people with ability to cause a large number of illness and death, which is associated with significant social and economic losses.

The Government of Côte d'Ivoire is in the process of launching a National One Health Platform (NOHP) to spearhead collaborative efforts amongst four government sectors (human, animal, agriculture

and environment) to prevent, detect, and respond to existing zoonotic diseases as well as emerging pandemic threats. The country has built a national multi-sectoral coordination mechanism, called the One Health Platform, which incorporates a One Health approach on the basis of its experiences with cross-sector collaboration and cooperation. This national multi-sectoral coordination mechanism is in place for public health events, and was built on the experience of managing the Ebola virus crisis. This platform, currently being institutionalized, assembles all the ministries capable of contributing towards the management of a sanitary crisis as well as technical and financial partners around the issues of public health, animal health, and environmental health. The actors of this platform are familiar with each other and act together in this framework.



Photo 3. Island of Boulay lies in the Ebré lagoon, Northwest of Abidjan, Côte d'Ivoire.

METHODOLOGY

PRIORITIZATION PROCESS

Organizers began preparations more than two months in advance of the One Health Zoonotic Disease Prioritization Workshop. Three in-country facilitators representing human, animal, and laboratory sectors were trained in the two days prior to the workshop. Thirteen technical expert participants and 16 observers from the various participating organizations, including local and international partner and non-governmental organizations, provided subject matter expertise to 11 voting members from the six different ministries represented.

The prioritization process involved application of a semi-quantitative tool, the One Health Zoonotic Disease Prioritization Tool, developed by the CDC One Health Office (Rist, 2014). The first step of the process was to identify a country-specific list of potential zoonotic diseases of concern (Appendix A). This was achieved by combining Côte d'Ivoire's list of notifiable human diseases and list of notifiable animal diseases into a singular list of approximately 60 diseases considered potential candidates, which was then shared with all participating ministries and organizations. Through multiple revisions with subject matter experts from these ministries and organizations, the list was further refined to 40 zoonotic diseases of primary concern and formed the starting list for consideration during the workshop.

On the first day of the workshop, voting members jointly identified five criteria for quantitative ranking of these 40 diseases. The five criteria were: 1) seriousness of the disease; 2) epidemic/epizootic potential in humans and animals; 3) potential of transmission between humans, animals, and the environment; 4) the capacity for prevention and control; and 5) the socio-economic and environmental impact. Once criteria were chosen, each voting member individually ranked the relative



Photo 4. Common kusimanse (*Crossarchus obscurus*), also known as the long-nosed kusimanse.

importance of each criterion to help generate a final group of weighted criteria (Appendix B).

One categorical question for each criterion was selected through group discussion. All questions had either yes/no answers or ordinal multinomial answers, with weights assigned to each answer. These were then agreed upon through group consensus. Data for answering the questions for each of the 40 zoonotic diseases were identified through an extensive literature search, including information from the WHO, FAO, OIE, CDC, ProMED, and other relevant websites. If disease information for a particular disease was not available for Côte d'Ivoire specifically, regional data from West Africa or global data were used.

A decision tree tool developed within Microsoft Excel™ was used for determining the final disease ranking. Each weighted criterion was applied across all diseases, and scores were assigned based on the response to each question. The scores for all five questions were summed and then normalized such that the highest final score was 1 (Appendix C).

On day two of the workshop, the list of zoonotic diseases and their normalized scores was presented to the group for discussion. After much debate among groups comprising an array of sectors,

the voting panel of 11 representatives from the six different ministries agreed on a final list of priority zoonotic diseases or disease groups for Côte d'Ivoire: 1) *Mycobacterium* species, (2) *Brucella* species, (3) rabies virus, (4) viral hemorrhagic fevers and arboviruses, and (5) respiratory viruses: highly pathogenic avian influenza, SARS CoV, and MERS CoV (Table 1).



Photo 5. Cocoa tree with cocoa pods in Zambakro close to Yamoussoukro, the capital city of Côte d'Ivoire.

CRITERIA SELECTED FOR RANKING ZOOONIC DISEASES

The criteria that were used to rank the zoonotic diseases are listed below according to their order of importance as determined by the voting representatives at the workshop. A detailed description of the criteria, questions, and corresponding weights can be found in Appendix B.

Criteria 1. Seriousness in humans

and animals: The seriousness of the disease in humans and animals was determined to be the most important criterion. Diseases with a case fatality rate between 50% and 100% were given 3 points. Diseases with a case fatality rate from 30% to <50% were given 2 points. Diseases with a case fatality rate 10% to <30% were given 1 point, and diseases with a case fatality rate of 0 to <10% in humans and animals were given 0 points.

Criteria 2. Potential of epidemic/pandemic in humans and epizootic in animals:

The potential for the disease to cause an epidemic or pandemic in humans and an epizootic in animals was determined to be the second most important criterion. Diseases that were capable of causing both an epidemic and an epizootic were given 3 points. Diseases that were capable of causing an epidemic in humans, but not an epizootic in animals were given 2 points. Conversely, diseases that were capable of causing an epizootic in animals, but not an epidemic in humans, were given 1 point. Diseases that were not capable of causing either an epidemic or an epizootic received a score of 0.

Criteria 3. Potential of transmission between humans, the environment, and animals:

The potential of transmission between humans, the environment, and animals was determined to be the third most important criterion. Food and/or waterborne pathogens were given 3 points. Diseases transmitted by direct contact were



Photo 6. A close up of a female rhinoceros and her calf.

given 2 points. Vector-borne diseases received a score of 1, and airborne diseases received 0 points. While some diseases have multiple modes of transmission, this criterion focused on the principal mode of transmission between humans and animals.

Criteria 4. Capacity for prevention and control:

The fourth most important criterion was whether or not a prevention or control measure existed for the disease. Diseases with both a prevention and control measure were given 3 points. Diseases with a prevention but no control measure received 2 points. Diseases with a control measure but no preventive strategy received 1 point, and diseases with neither prevention nor control measures received 0 points. The original design of this criterion was the capacity for multi-sectoral prevention and control. To answer the question for each zoonotic disease, the multi-sectoral terminology was modified and a prevention or control strategy was considered in the ranking if

one existed for either humans or animals, but did not require prevention or control strategies for both humans and animals.

Criteria 5. Socio-economic and environmental impact:

The fifth most important criterion was socio-economic and environmental impact of the disease. Examples of socio-economic impact included diseases that threatened agriculture or livelihoods and examples of environmental impacts included disease associated with large-scale wildlife die-offs or contamination into the environment. Diseases with socio-economic impacts and environmental impacts in Côte d'Ivoire or in the world received 3 points. Diseases with socio-economic impacts but no environmental impacts received 2 points. Diseases with environmental impacts but no socio-economic impacts received 1 point, and diseases with neither socio-economic nor environmental impacts received 0 points.

RESULTS

DESCRIPTION OF THE SELECTED DISEASES

With regard to these criteria, five groups of zoonotic diseases were identified. In order of priority, we chose:

- 1. *Mycobacterium* species**
- 2. *Brucella* species**
- 3. Rabies**
- 4. Viral hemorrhagic fevers and arboviruses**
- 5. Respiratory viruses: highly pathogenic avian influenza, SARS CoV, and MERS CoV**

1. *Mycobacterium* species—These pathogens fall within the *Mycobacterium* genus of Actinobacteria. They have the potential to cause tuberculosis, a pulmonary disease that can also affect other parts of the body. There are two species, *Mycobacterium bovis* and *M. tuberculosis*, which are included in this grouping. Bovine tuberculosis, caused by *M. bovis*, is more traditionally considered a zoonotic

pathogen. In Africa, infection by *M. bovis* is nearly twice as common as it is elsewhere in the world (Muller, 2013). This may not be the only zoonotic strain, however, as the pathogen *M. tuberculosis*, a species not commonly associated with animals, has been isolated from wild chimpanzees in Côte d'Ivoire (Coscolla, 2013).

2. *Brucella* species—These pathogens, which are gram-negative intracellular cocci, fall within the genus *Brucella*. Species are often associated with a particular animal host; however, numerous *Brucella* species are capable of causing disease in humans. In people, brucellosis can cause an undulant fever along with headache, weakness and fatigue. In livestock, infection by *Brucella* species can negatively impact fertility and production and subsequently impact international trade. Animal-to-human transmission can occur through ingestion of contaminated dairy and meat products as well as direct exposure to infected animals or animal products. In Côte d'Ivoire, prevalence in livestock is highest in pastoral and agro-pastoral regions in the North, where prevalence in cattle is estimated to be 4.8% (Kanoute, 2016).



Photo 7. Two chimpanzees sharing food.

3. Rabies—Rabies is a fatal disease caused by a *Lyssavirus*. The virus is transmitted primarily through the bite of an infected animal. While globally it is estimated that 59,000 people die from rabies each year (Ali, 2015), within Côte d'Ivoire, significant under reporting is suspected (Dodet, 2009). Rapid administration of post-exposure prophylaxis can help to prevent the development of illness; however in developing countries such as Côte d'Ivoire, if proper treatment is not given after exposure, all cases will become fatal after the onset of symptoms.

4. Viral Hemorrhagic Fevers (VHF)—This group of diseases is caused by a variety of viruses and can cause severe illness and death in humans and animals. VHFs are caused by an RNA virus within one of the following five viral families: Arenaviridae, Filoviridae, Bunyaviridae, Flaviviridae, and Rhabdoviridae. VHFs include Ebola virus, Marburg virus, Lassa virus, and Crimean-Congo hemorrhagic fever to name a few. Clinically, these diseases are characterized by fever and bleeding disorders, which in some cases can lead to shock and death. Treatment for these diseases is largely supportive. While Côte d'Ivoire was spared involvement in the 2014–2015 neighboring West African outbreak of Ebola virus, in 1994 an ecologist was exposed to Ebola virus in Côte d'Ivoire after exposure to an infected chimpanzee (Formenty, 1999).

Arboviruses—Diseases within this group are transmitted through insect vectors. Taxonomically, these pathogens may be from one of the following viral families: Bunyaviridae, Flaviviridae, Reoviridae, and Togoviridae. Clinically, arboviruses may cause a wide spectrum of signs and symptoms depending on the virus, however, they are often associated with fever, malaise, and in some cases encephalitis. Some arboviruses cause large-scale die offs in animals, such as Rift Valley fever virus, and others can cause significant morbidity and mortality in human populations, such as yellow fever and dengue viruses. Vector control is a common control strategy; however, vaccines have been developed for some arboviruses as well.



Photo 8. The saddle-billed stork (*Ehippiorhynchus senegalensis*) is a large wading bird in the stork family.

5. Respiratory viruses: highly pathogenic avian influenza, SARS CoV, and MERS CoV—

These viruses cause severe respiratory disease with pandemic potential. Highly pathogenic avian influenza is a disease in birds, both poultry and wild birds, however, transmission to humans can occur from direct exposure or contaminated environments. Human-to-human transmission of avian influenza is possible but rare. If it occurred, this type of transmission could cause a devastatingly severe respiratory outbreak with pandemic potential. Avian influenza occurs in West Africa in poultry, including in Côte d'Ivoire (Asante, 2015). Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) are both coronaviruses that have animal origins but also have great potential for human-to-human transmission. Treatment for all of these diseases is generally supportive in nature, however avian influenza can be treated with oseltamivir (Tamiflu™).

PLANS AND RECOMMENDATIONS

After finalizing the list of priority zoonotic diseases, the workshop participants discussed recommendations and further actions that could be taken to address the prioritized zoonotic diseases. This was done in a 2-stage process. To begin, participants were asked to make general recommendations for how to approach the priority diseases without considering the constraints of their respective institution. A summary of the most prominent recommendations organized by theme follows:

SPECIFIC NEXT STEPS

The Action Plan that will be developed from the results of the recent Joint External Evaluation (JEE) in Côte d'Ivoire will offer an outline for the most appropriate plan for strengthening surveillance and laboratory capacity for the identified priority diseases. In the meantime, workshop attendees discussed next steps and further actions that could be taken to address the prioritized zoonotic diseases:

- Set up a multi-sectoral, One Health committee to combat the prioritized zoonotic diseases.
- Define specific objectives and operating procedures of the One Health Committee.
- Develop and adopt a National One Health Strategy to combat the prioritized zoonotic diseases.
- Develop and implement preparedness and response plans and multi-sectoral programs to combat each prioritized zoonotic diseases.
- During the discussion of the aforementioned steps, the workshop attendees described the multi-sectoral committee that would develop the Côte d'Ivoire National One Health Strategy. Representatives from all the ministries and organizations at the workshop will be included in the committee. One organization would be

identified to administratively coordinate the committee. The committee would develop specific activities for each sector active in zoonotic diseases, framed in terms of short- and long-term goals, and these activities would include capacity building and information sharing between sectors.

REFLECTIONS AND RECOMMENDATIONS

- Strong government ownership of the process of selecting the priority zoonotic diseases was evident as the workshop attendees actively engaged in robust multi-sectoral discussions.
- Compromise, trust, transparency, and collaboration were hallmarks of the One Health prioritization process.
- Formalize the establishment of a multi-sectoral committee on zoonotic diseases
- To advance coordination of the proposed committee, it will be useful to utilize structures already in place through GHSA, such as the GHSA goals for the zoonotic disease action packages. Existing GHSA mechanisms and workplans can be used for coordination purposes as well as for furthering ongoing capacity building efforts.
- Findings from this workshop can be used to focus resources necessary for the prevention and control of the priority zoonotic diseases identified, to enable more in-depth capacity building such as training of local human and animal health workforce to address the needs related to fighting these zoonotic diseases.
- The activities developed by the committee should focus primarily on the prioritized zoonotic diseases to ensure the greatest impact and promote future sustainability. If necessary, the workshop can be repeated with the assistance of the trained in-country facilitators at any time.

APPENDIX A: Original List of Zoonotic Diseases of Possible Concern in Côte d'Ivoire

1. *Bacillus anthracis* (Anthrax)
2. *Bartonella* species
3. *Borrelia* (Lyme disease)
4. *Brucella* species (*B. abortus*, *B. melitensis*, *B. ovis*, *B. suis*, *B. canis*)
5. *Burkholderia mallei* (Glanders)
6. *Campylobacter jejuni*
7. *Chlamydia psittaci* (Psittacosis)
8. *Chlamydia trachomatis* (Trachoma)
9. *Clostridium chauvoei* (Blackleg)
10. *Coxiella burnetii* (Q fever)
11. *Ehrlichia* species
12. *Erysipelothrix* (Swine Erysipelas)
13. *Escherichia coli*
14. *Francisella tularensis* (Tularemia)
15. *Leptospira* species
16. *Listeria monocytogenes*
17. *Mycobacterium bovis*
18. *Orientia tsutsugamushi* (Scrub typhus)
19. Pasteurellosis
20. *Rickettsia africae* (African tick-borne fever)
21. *Rickettsia rickettsia* (Rocky Mountain spotted fever)
22. *Salmonella* species (Clinical disease in healthy animals is serovar-host specific)
23. *Shigella* species (Dysentery)
24. *Streptococcus suis*
25. Tuberculosis
26. *Yersinia pestis*
27. Cysticercosis/*Taenia solium*
28. Echinococcosis/hydatidiosis
29. Leishmaniasis
30. Sarcoptic mange
31. Geo-helminths
32. *Schistosoma japonicum*/*S. mekongi*
33. *Toxoplasma gondii*
34. Trichinellosis
35. *Trypanosoma* species
36. Chikungunya
37. Crimean-Congo hemorrhagic fever virus
38. Dengue fever viruses
39. Eastern equine encephalitis virus
40. Ebola viruses
41. Hantaviruses
42. Hendra virus
43. Hepatitis B virus
44. Hepatitis E virus
45. Japanese encephalitis virus
46. Lassa virus
47. Marburg virus
48. MERS-CoV
49. Nipah virus
50. Rabies virus
51. Rift Valley fever virus
52. Rubeola virus (Measles)
53. SARS (coronavirus)
54. Venezuelan equine encephalitis virus
55. West Nile virus
56. Western equine encephalitis virus
57. Yellow fever virus
58. Zika virus
59. Zoonotic avian influenza viruses
60. Meningitis

APPENDIX B: The Criteria and Questions in Ranked Order with Weights

Criteria 1: Seriousness in humans and animals

(0.2099) Q: What is the fatality of the disease in humans and in animals?

- A. 50% to 100% (3)
- B. 30% to <50% (2)
- C. 10% to <30% (1)
- D. 0% to <10% (0)

Criteria 2: Potential of epidemic/pandemic in humans and epizootic in animals

(0.2032) Q: Is the pathogen likely to cause an epidemic or an epizootic?

- A. Yes—Yes (3)
- B. Yes—No (2)
- C. No—Yes (1)
- D. No—No (0)

Criteria 3: Potential of transmission between humans, the environment and animals

(0.1997) Q: What is the principal mode of transmission between humans and animals?

- A. Waterborne and foodborne (3)
- B. Direct contact (2)
- C. Vectorborne (1)
- D. Airborne (0)

Criteria 4: Capacity for prevention and control

(0.1937) Q: Do measures exist for prevention and for control?

- A. Yes—Yes (3)
- B. Yes—No (2)
- C. No—Yes (1)
- D. No—No (0)

Criteria 5: Socio-economic and environmental impact

(0.1935) Q: Is there an important socio-economic impact and environmental impact in Côte d'Ivoire or in the world?

- A. Yes—Yes (3)
- B. Yes—No (2)
- C. No—Yes (1)
- D. No—No (0)

APPENDIX C: Final Results of One Health Zoonotic Disease Prioritization Workshop in Côte d'Ivoire

Table 2. Zoonotic diseases considered for prioritization in Côte d'Ivoire:

Final results of prioritization and normalized weights for 40 zoonotic diseases. The top prioritized zoonotic diseases selected by the voting members representing all ministries active in zoonotic disease work are shown in bold.

Rank	Disease/Pathogen	Score	Rank	Disease/Pathogen	Score
1	<i>Bacillus anthracis</i> (Anthrax)	1.0000	20	MERS-CoV	0.5058
2	<i>Trypanosoma</i> species	0.9287	21	<i>Campylobacter jejuni</i>	0.5008
3	<i>Mycobacterium</i> species (<i>M. bovis</i>; <i>M. tuberculosis</i>)	0.9214	22	Hepatitis E virus	0.5008
4	Echinococcosis/hydatidosis	0.8571	23	Dengue fever viruses	0.4963
5	<i>Brucella</i> species (<i>B. abortus</i>, <i>B. melitensis</i>, <i>B. ovis</i>, <i>B. suis</i>, <i>B. canis</i>)	0.8464	24	Rift Valley fever virus	0.4963
6	Rabies virus	0.7926	25	West Nile virus	0.4963
7	Hemorrhagic fever viruses (Ebola, Lassa, Marburg)	0.7925	26	Geo-helminthiases	0.4904
8	<i>Yersinia pestis</i>	0.7904	27	<i>Orientia tsutsugamushi</i> (Scrub typhus)	0.4331
9	Zoonotic avian influenza viruses	0.7191	28	SARS CoV	0.4309
10	<i>Leptospira</i> species	0.7081	29	<i>Francisella tularensis</i> (Tularemia)	0.4284
11	Salmonellosis	0.7081	30	<i>Escherichia coli</i>	0.4282
12	Cysticercosis/ <i>Taenia solium</i>	0.6390	31	<i>Erysipelothrix</i> (Swine erysipelas)	0.4225
13	Yellow fever virus	0.6370	32	<i>Streptococcus suis</i>	0.4191
14	Sarcoptic mange	0.6368	33	<i>Chlamydia psittaci</i> (Psittacosis)	0.3581
15	<i>Listeria monocytogenes</i>	0.5757	34	<i>Ehrlichia</i> species	0.3581
16	<i>Schistosoma</i> species (<i>S. hematobium</i> ; <i>S. japonicum</i> ; <i>S. mekongi</i>)	0.5664	35	Zika virus	0.3547
17	<i>Shigella</i> species (Dysentery)	0.5664	36	Pasteurellosis	0.3535
18	<i>Toxoplasma gondii</i>	0.5630	37	Leishmaniasis	0.2845
19	Hantaviruses	0.5102	38	Borrelia (Lyme disease)	0.2787
			39	Rickettsia species (<i>R. africae</i> ; <i>R. rickettsia</i>)	0.2787
			40	Chikungunya	0.2164

REFERENCES

1. Ali, Mohsin, et al. "Global epidemiology of Human Rabies: Systematic Review and Meta-Analysis." *Open Forum Infectious Diseases*. Vol. 2. No. suppl 1. Oxford University Press, 2015.
2. Asante, Ivy Asantewaa, et al. "Highly Pathogenic Avian Influenza A (H5N1) Virus among Poultry, Ghana, 2015." *Emerging infectious diseases* 22.12 (2016): 2209.
3. Coscolla, Mireia, et al. "Novel Mycobacterium tuberculosis complex isolate from a wild chimpanzee." *Emerging infectious diseases* 19.6 (2013): 969–976.
4. Centers for Disease Control and Prevention: Overview of the One Health Zoonotic Disease Prioritization Workshop <https://www.cdc.gov/onehealth/pdfs/zoonotic-disease-prioritization-workshop.pdf>
5. Central Intelligence Agency Factbook, <https://www.cia.gov/library/publications/the-world-factbook/geos/iv.html>
6. Dean, Anna S., et al. "Epidemiology of brucellosis and q Fever in linked human and animal populations in northern togo." *PLoS One* 8.8 (2013): e71501.
7. Côte d'Ivoire. (n.d.). Retrieved February 06, 2018, from <https://www.ramsar.org/wetland/cote-divoire>
8. Dodet, Betty. "The fight against rabies in Africa: From recognition to action." *Vaccine* 27.37 (2009): 5027–5032.
9. FAO 2005 Livestock Sector Brief in Côte d'Ivoire http://www.fao.org/ag/againfo/resources/en/publications/sector_briefs/lb_CIV.pdf
10. Formenty, Pierre, et al. "Human infection due to Ebola virus, subtype Côte d'Ivoire: clinical and biologic presentation." *Journal of Infectious Diseases* 179.Supplement 1 (1999): S48–S53.
11. Jones, Kate E., et al. "Global trends in emerging infectious diseases." *Nature* 451.7181 (2008): 990–993.
12. Kanouté, Youssouf B., et al. "Epidemiology of brucellosis, Q fever and Rift Valley fever at the human and livestock interface in northern Côte d'Ivoire." *Acta tropica* 165 (2017): 66–75.
13. Muller, Bornha, et al. "Zoonotic *Mycobacterium bovis*: induced tuberculosis in humans." (2013).
14. OIE Bovine Tuberculosis http://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/Disease_cards/BOVINE-TB-EN.pdf
15. Rist, Cassidy Logan, Carmen Sofia Arriola, and Carol Rubin. "Prioritizing zoonoses: a proposed one health tool for collaborative decision-making." *PloS one* 9.10 (2014): e109986.
16. WHO Ebola <http://www.who.int/mediacentre/factsheets/fs103/en/>
17. WHO 2015 Tuberculosis in Côte d'Ivoire. https://extranet.who.int/sree/Reports?op=Replet&name=/WHO_HQ_Reports/G2/PROD/EXT/TBCountryProfile&ISO2=CI&outtype=html
18. World Wildlife Fund 2017 Western Africa: Coastal areas of Guinea, Côte d'Ivoire, Liberia, and Sierra Leone <https://www.worldwildlife.org/ecoregions/at0130>