Food and Agriculture Organization of the United Nations
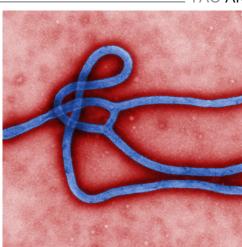
report

UNDERSTANDING EBOLA VIRUS AT THE ANIMAL-HUMAN INTERFACE

Technical meeting
Rome, Italy
19-20 January 2016

UNDERSTANDING EBOLA VIRUS AT THE ANIMAL-HUMAN INTERFACE

Technical meeting
Rome, Italy
19-20 January 2016

Table of contents

Acknowledgments

Abbreviations & Acronyms

BSL	Biosafety Level
CDC	Centers for Disease Control and Prevention, USA
CFIA	Canadian Food Inspection Agency
CIRMF	International Centre for Medical Research of Franceville, Gabon
EBOV	Ebola Viruses
ECTAD	Emergency Centre for Transboundary Animal Diseases, FAO
EFSA	European Food Safety Authority
EPT	Emerging Pandemic Threats
EVD	Ebola virus disease
FAO	Food and Agriculture Organization of the United Nations
FLI	Friedrich Loeffler Institute, Germany
GHSA	Global Health Security Agenda
GOARN	Global Outbreak Alert and Response Network, WHO
IAEA	International Atomic Energy Agency
ILRI	International Livestock Research Institute
IRD	Research Institute for Development
OIE	World Organisation for Animal Health
P&R	Preparedness and Response
PCR	Polymerase Chain Reaction
PPE	Personal Protective Equipment
PVS	Performance of Veterinary Services, OIE
RKI	Robert Koch Institute
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SAR	Special Administrative Region
SOP	Standard Operating Procedure
USAID	United States Agency for International Development
WHO	World Health Organization

Introduction

The Technical Meeting on Understanding Ebola Virus at the animal-human interface was convened by the Food and Agriculture Organization of the United Nations (FAO) to determine the current status of the scientific knowledge on Ebola Viruses (EBOV), identify major gaps that require further research studies in order to better understand the disease dynamics at the interface between animals and humans, identify factors that potentiate the emergence, transmission and spread of EBOV, and develop practical approaches to better prevent and minimize the impacts of this virus. It was also aimed at fostering collaboration and partnerships between institutions and organizations working on Ebola viruses at the human-animal interface. The meeting was organized by FAO and the United States Agency for International Development (USAID), from 19-20 January 2016 in Rome, and was attended by 59 participants from Cameroon, Canada, Democratic Republic of Congo, France, Gabon, Germany, Guinea, Hong Kong Special Administrative Region (SAR), Italy, Kenya, Liberia, Senegal, the United Kingdom and the United States, as well as from EcoHealth Alliance, Metabiota, the International Medical Corps, the World Organisation for Animal Health (OIE), the International Atomic Energy Agency (IAEA), the International Livestock Research Institute (ILRI), the European Food Safety Authority (EFSA), the World Health Organization (WHO) and FAO. This report provides the key objectives for the meeting, summarizes the gaps and needs identified, and presents the conclusions reached by the meeting participants.

BACKGROUND

The Ebola virus causes severe viral haemorrhagic fever in humans often with a fatal outcome, and is considered a global public health threat. As of 17 January 2016, the World Health Organization (WHO) has been notified of 28 638 laboratory-confirmed human cases in the ongoing West African outbreak (Ebola Zaire species), which includes 11 316 fatalities since 2014.

Ebola viruses affect a range of mammalian species, from humans to wild and domestic animals. Fruit bats are considered as probable natural hosts for the Ebola virus in Africa. People likely to be exposed to EBOV in its natural environment are (bushmeat) hunters and those in contact with contaminated animal products. However, the precise factors that result in EVD outbreaks remain unknown and require a better understanding of the linkages between ecological and socio-economic factors as well as the constantly evolving interface between humans, animals and their ecosystems.

Critical gaps remain in our knowledge of the routes of EBOV transmission to humans and other potential animal host species. Addressing these gaps is crucial for developing and implementing measures to reduce the risks to public and animal health.

MEETING OBJECTIVES

1. Share information on ongoing research projects and studies on the role of livestock and wildlife in the epidemiology of EVD.

2. Identify and prioritize knowledge gaps in disease dynamics at the human-wildlife-domestic animal interface.

3. Peer-review scientific and technical approaches that aim at better understanding the Ebola virus disease at the human-animal interface, including the dynamics of viral emergence and evolution, surveillance design, laboratory diagnostics, and risk factors along animal value chains.

4. Analyse complementarities and synergies between programmes and projects implemented by various partners, and explore opportunities for collaboration and partnerships.

The meeting was structured around these objectives, and followed the same format as the framework of the collaborative approach between FAO and PREDICT-2 under the Emerging Pandemic Threats Programme – Phase 2 (EPT-2), organized under three "pillars":

- Epidemiology and risk factors;
- Laboratory diagnosis;
- Value chains and behavioural studies.

Knowledge gaps

The key needs and knowledge gaps identified by the participants during the meeting are summarized below.

EPIDEMIOLOGY AND RISK FACTORS
Before the spillover: animal reservoir, sensitive species and distribution
1. What is the animal reservoir? What are the intermediate and/or amplification hosts?
2. What is the geographic distribution of the virus and the animal reservoir? Which countries are at risk?

Spillover: animal to human transmission
3. What are human (and animal) behaviours that favour transmission?
4. What are the mechanisms and routes of transmission between animals and from animals to humans?
5. What are the other (ecological, economic, social) drivers for emergence and spillover, such as: seasonality, temperature, rainfall, poverty, landscape, etc.

After the spillover: mostly human to human transmission and (potential) spillback to animals
6. What is the role of animals during an ongoing epidemic? Is there a possibility of reverse zoonosis?
7. Is there potential impact of persistence in, and shedding of, the virus in humans or animals (including domestic species)?
8. What are the peri-urban / urban dynamics and consequences of introduction into urban areas in the 2014-15 outbreak: is there now a new ecology of the virus?

LABORATORY DIAGNOSTICS
Test development and validation
1. There is a need for validation and standardization of serological assays for EBOV in different animal species:
    a. Screening assays with sufficient sensitivity (for which more knowledge on cross-reactivity of filovirus antibodies is required)
    b. Reliable confirmatory tests
    c. Positive control panels
2. There is a need for development and validation of rapid field diagnostic tests
3. What testing methods are optimal for diagnosing infection in the different species at different stages of an outbreak or in a surveillance situation?
4. What tests are most appropriate for screening tests? What tests are suitable to confirm results?
5. There is a need to develop optimized and standardized tests and protocols and to advocate for their wide usage to facilitate comparing results of different surveillance activities/projects.

Laboratory and diagnostics for surveillance and outbreak investigations

1. There is a lack of knowledge on transmission/shedding routes, and a need for experimental infection studies to understand pathogenesis of infection in suspected hosts (dogs, goats, pigs), as well as field studies to identify antibodies/viruses in different putative hosts.

2. More information on viral shedding is required not only to identify which animal species should be sampled, but also what the optimal sample types/times are for diagnosis. Until this is known, should sampling be broad, so as not to miss any potential transmission routes?

3. What samples, transport and preservation modalities are optimal for diagnosing infection in the different species?

4. Sampling protocols and algorithms for both surveillance and outbreak situations are needed.

5. Biosecurity and biosafety, especially for field sampling: which precautions to take? There is a need to assess the risk of sampling activities.

6. Are animal samples available that were taken in/around human outbreak areas, and if so, are these available for testing?

VALUE CHAIN AND BEHAVIOURAL STUDIES

1. What are the interface points between wildlife, livestock and humans (e.g. at various points along the livestock value chain), what human behaviours and practices result in higher contact rates? What socio-economic aspects drive this change?

2. How important is bushmeat in Ebola transmission, and how is risk of transmission characterized (e.g. species, type of meat, preparation, etc.)?

3. There is a need for mapping bushmeat and livestock value chains, practices and drivers and understanding the interface between animals and humans in their habitats.

4. What are the drivers and patterns of bushmeat consumption and where can we intervene? What is the social value of bushmeat? How do cultural events affect consumption?

5. What is the impact of cross-border movements, migration, refugees, wildlife interactions, on the dynamics of livestock and bushmeat value chains?

6. What are the roles and perceptions of communities, and how can they be included in decision-making and communication strategies (both risk mitigation and public health interventions)?

7. How are cultural and religious practices linked to value chains and behaviours (both livestock and wildlife)?

8. How do changes in the value chain (through food insecurity, poverty, climate change, etc.) impact transmission risk?

OVERARCHING NEEDS

In addition to the topic-specific knowledge gaps, the following overarching needs were identified:

1. One health-driven investigation of human outbreaks, involving public health, animal health and social scientists: there is a need to establish standard operating procedures (SOPs) and lists of focal points with contact details, roles and

responsibilities. These latter can be facilitated through high-level advocacy by international organizations such as FAO.

2. Focused animal studies around human outbreaks: there is a need for guidelines and tools for animal surveillance during human outbreaks.

3. Risk assessment and risk communication.

4. Capacity building and training for local partners.

5. Coordination of Ebola virus research field activities at national level.

Addressing needs and knowledge gaps

Conclusions by meeting participants are summed up by topic area below. In addition, participants were encouraged to discuss and propose their involvement in addressing the needs and knowledge gaps and to liaise with each other and FAO for future collaboration.

EPIDEMIOLOGY AND RISK FACTORS
- Focus research to identify host infection dynamics, reservoirs and intermediate hosts.
- Conduct additional research to identify environmental and other ecological factors, and the geographic range of virus incidence and persistence.
- Conduct additional research to identify human behaviours that affect transmission.
- Under the Tripartite Agreement, FAO, OIE and WHO should work together to improve/strengthen the capacities of the public health and veterinary services to detect, diagnose and respond to the emergence of Ebola viruses and other diseases originating from animals.

LABORATORY DIAGNOSTICS
- Standardize protocols for sampling and testing of filoviruses across species and countries.
- Develop/validate better (rapid) diagnostic tests for use in the field, with reliable confirmatory tests.
- Develop and validate serological assays for domestic animal species for use in the investigation of their potential roles in EBOV epidemiology.

VALUE CHAIN AND BEHAVIOURAL STUDIES
- Identify critical intervention points along livestock and wildlife value chains to inform surveillance, policy, risk management and communication.
- There is a need for tools and training to guide entry of researchers, surveillance teams, etc. into sensitive communities post-Ebola.
- Identify appropriate behaviour change options to reduce spillover and disease transmission risk.
- Explore options for individual animal identification to facilitate longitudinal surveillance.

Activities undertaken by participating partners

- United States Centers for Disease Control and Prevention (CDC): epidemiological and laboratory capacity, ecology (One Health), outbreak investigation, risk assessment, rapid response, capacity building for EBOV detection (36 countries).
- Canadian Food Inspection Agency (CFIA): reagent production for diagnostic tests (including positive test controls), experimental animal infections (swine) in BSL4 laboratory facilities, confirmatory testing (virus isolation, virus neutralization), development of ELISA for swine serology, real-time reverse transcriptase polymerase chain reaction (rRT-PCR) and immunohistochemistry.
- PREDICT-2 (Metabiota, EcoHealth Alliance, UC Davis): supporting governments (national response), rapid response, monitoring agriculture intensification and land use, biological surveillance, diagnostic capacity development.
- International Medical Corps: training in personal protective equipment (PPE) usage and Ebola response, supports Global Health Security Agenda (GHSA) in prevention and response.
- International Centre for Medical Research of Franceville (CIRMF): a.) Field surveillance: Risk factor and disease dynamic at the animal-human interface; viral emergence and evolution; virology and serology; samples: whole blood, serum, (faeces); viral emergence and evolution; route of transmission; surveillance design. b.) Laboratory research: routes of transmission; molecular determinants of Ebola pathogenesis; routes of transmission to humans. c.) Other: BSL-4 laboratory facilities.
- University of Hong Kong: studies on infection at the animal-human interface, development of serological assay on Ebola (based on pseudoparticles).
- OIE: capacity building in emerging disease control, Performance of Veterinary Services (PVS) pathway, training for disease notification.
- Robert Koch Institute (RKI): laboratory confirmation and diagnostics, animal experimental infections in BSL4 laboratory facilities, assay development, laboratory capacity building in biosafety, field studies.
- University of Marburg: laboratory support in West Africa (under WHO/ Global Outbreak Alert and Response Network - GOARN umbrella), research on sample stability (e.g. swabs samples), training in PPE usage, diagnostics, inactivation of viruses for immunization studies (antibody production).
- IAEA: training courses (PPE usage, laboratory diagnosis, wildlife sampling), provision of field sampling SOPs.
- EFSA: risk assessment, literature review on risk factors for spillover.
- ILRI: slaughterhouse surveillance in pigs (serology and virus isolation), mapping of pig trade volume and routes, description of pig trader knowledge and practices around biosecurity.

- Research Institute for Development (IRD)/CIRAD (Agricultural Research for Development): testing of human, primate, bat, bushmeat samples (Cameroon, Democratic Republic of Congo, Guinea), ELISA development (bats), development of Luminex technology, Bayesian modelling of test performance evaluation.
- WHO: supporting governments; guiding community entries.

Action points

Meeting participants highlighted the need for the following actions:

- FAO to engage with OIE and WHO to develop a decision-support tool to aid countries in the decision-making process in the case of the detection of positive cases in domestic animals, through sampling and surveillance activities.
- Collaborate with EPT2 Preparedness and Response (P&R) to assist the creation/strengthening of national One Health platforms and reinforce networks by running simulation exercises for different scenarios, etc.
- Promote regular international scientific and field consultations (physical and virtual) to fill in EPT2 knowledge gaps, develop guidance documents, share information and standardize approaches.
- Develop and test a Risk Communication Toolkit, in collaboration with OIE and WHO.
- Engage local research institutions in EPT2 country consultations.
- Facilitate policy dialogue on filovirus surveillance-related issues at different levels.
- Continue to strengthen national capacity building of veterinary services for early detection.
- FAO to coordinate and foster collaboration for the development, validation and refinement of diagnostic tests for livestock.
- Establish a multi-laboratory collaboration beetween IAEA, RKI, FLI, and the University of Marburg, Germany, the Canadian Food Inspection Agency (CFIA) and ILRI for the generation of Ebola antibodies in dogs, pigs, sheep, goats, cattle, and bats, through animal inoculation with inactivated virus. In this regard, IAEA will assist in the generation of antibodies in dogs, CFIA in pigs, sheep and goats, ILRI in cattle, and RKI and FLI in bats. The CFIA has also agreed to explore infecting pigs, sheep and goats with live Ebola virus.
- Ensure that the defined positive antisera against the Ebola virus are available as a global resource for development and validation of serological tests in targeted domestic animals. The University of Marburg to provide a defined dose of gamma-irradiated inactivated Ebola virus for this collaborative work.

Annex 1
Agenda

AGENDA

Understanding **Ebola Virus** at
the **animal-human interface**

Technical Meeting
Rome, Italy • 19-20 January 2016

Food and Agriculture Organization
of the United Nations

19 January	Tuesday
08:30-09:00	**Morning coffee and registration**
09:00-09:30	**Welcome, introductions and expectations**
09:30-10:15	Scientific overview presentations: • Epidemiology and risk factors *(15 min.)* • Laboratory diagnosis *(15 min.)* • Supply chains and behavioural studies *(15 min.)*
10:15-10:45	**Coffee break**
10:45-11:15	Plenary discussion
11:15-12:35	Break up into groups to discuss knowledge gaps, by thematic area as follows: • Epidemiology and risk factors • Laboratory diagnosis • Supply chains and behavioural studies
12:35-13:45	**Lunch**
13:45-14:00	Collect results from group discussion
14:00-14:30	Plenary debriefing from group discussions *(15 min. each)*
14:30-15:00	Q&A, wrap up of knowledge gaps, plenary discussion, agreement on final statements
15:00-15:20	Mapping of ongoing and planned activities of participating institutions
15:20-15:30	Plenary session
15:30-16:00	**Coffee, networking + review/completion of mapping exercise**
16:20-17:20	Q&A and open discussion on opportunities for collaboration: • Field surveillance • Behavioural studies • Capacity building, training • Test development and validation • Laboratory research • Other
17:20-18:00	Wrap-up
18:30-20:00	**Poster session and aperitivo**

20 January Wednesday

09:00-09:15	Recap of activities from day 1 and moving forward
09:15-10:45	Presentation of One Health implementation approach under Emerging Pandemic Threats Programme Phase 2 (EPT-2), by thematic area as follows:
	• Surveillance and risk factors *(20 min. ppt + 10 min. discussion)*
	• Laboratory diagnosis *(20 min. ppt + 10 min. discussion)*
	• Supply chains and behavioural studies *(20 min. ppt + 10 min. discussion)*
10:45-11:15	Coffee Break
11:15-12:15	Facilitated discussion on cross-cutting collaboration:
	• Stakeholder participation
	• Information sharing
	• Communication: awareness raising, disseminating information, and risk communication
	• Capacity development
12:15-12:45	Implementation approach wrap-up
12:45-13:45	Lunch
13:45-14:30	Coffee over topic discussions
14:30-16:00	Collaboration building and way forward (3 pillars: surveillance and risk factors, laboratory diagnosis, supply chains and behavioural studies):
	• Technical
	• Institutional
	• Stakeholder Level
16:00-16:00	Coffee Break
16:30-17:00	Recommendations
17:00	Closure

USAID
FROM THE AMERICAN PEOPLE

Annex 2
List of participants

Canadian Food Inspection Agency (CFIA) – Canada
Hana Weingartl
Head, Special Pathogens Unit
hana.weingartl@inspection.gc.ca

Centers for Disease Control and Prevention (CDC) – USA
Frederick J. Angulo
Associate Director for Science – Global Health Protection Division
FAngulo@cdc.gov

Casey Barton
Director, One Health
dlx9@cdc.gov

Sean Shadomy
CDC Secondment to FAO
auf4@cdc.gov

Centre International de Recherches Medicales de Franceville (CIRMF) – Gabon
Dr Gaël Maganga
Researcher
gael_maganga@yahoo.fr

EcoHealth Alliance – USA
Billy Karesh
karesh@ecohealthalliance.org

Jonathan Epstein
Associate Vice President
epstein@ecohealthalliance.org

European Food Safety Authority (EFSA) – Italy
Franck Berthe
Franck.Berthe@efsa.europa.eu

Friedrich-Loeffler-Institut (FLI) – Germany
Kristina Schmidt
Scientist
Kristina.Schmidt@fli.bund.de

Martin Groschup
Department Head
Martin.Groschup@fli.bund.de

Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) / Institut de Recherche pour le Développement (IRD) – France
Martine Peeters
Director of Research
martine.peeters@ird.fr

Institut National de Recherche Biomédicale (INRB) – DRC
Jean Jacques Muyembe
Director General
jjmuyembet@gmail.com

International Atomic Energy Agency (IAEA) – Austria
Hermann Unger
Technical Officer
H.Unger@iaea.org

International Livestock Research Institute (ILRI) – Kenya
Christine Atherstone
Scientist
c.atherstone@cgiar.org

International Medical Corps – USA
David Tarantino
Senior Physician
dtarantino@InternationalMedicalCorps.org

Marburg University – Germany
Thomas Strecker
Scientist
strecker@staff.uni-marburg.de

Metabiota – USA/Canada/Cameroon
Kimberly Dodd
Scientist
kdodd@metabiota.com

Matthew Lebreton
Technical Advisor
mlebreton@metabiota.com

Damien Joly
Director, Epidemiology
djoly@metabiota.com

Ministry of Agriculture – Liberia
Joseph R.N. Anderson
Director of Animal Health Services
Joeelson2007@gmail.com
janderson@moa.gov.lr

Leelia Andrews-Freeman
Veterinary Epidemiologist
Leerandrews13@ymail.com
landrews@moa.gov.lr

Ministère de l'Elevage et des Productions Animales – Guinea
Mamadou Lamarana Souare
Veterinary Epidemiologist
ml.souare@hotmail.fr

Pasteur Institute – France
Jean Claude Manuguerra
Research Director
jean-claude.manuguerra@pasteur.fr

Robert Koch Institute – Germany
Andreas Kurth
Scientist
KurthA@rki.de

United States Department of Agriculture (USDA) – Senegal
Cheikh Fall
Agricultural Specialist
Cheikh.s.Fall@aphis.usda.gov

United States Agency for International Development (USAID) – USA
Andrew Clements
Scientific Advisor
aclements@usaid.gov

Zandra Andre
Team Leader
zandre@usaid.gov

University of Durham – UK
Jesse Bonwitt
Scientist
jesse.bonwitt@gmail.com
jesse.bonwitt@durham.ac.uk
University of Hong Kong

Malik Peiris
Virologist / Professor
Malik@hku.hk

World Organisation for Animal Health (OIE) – France
Mariano Ramos
Chargé de mission
m.ramos@oie.int

Tianna Brand
Chargé de mission
t.brand@oie.int

World Health Organization (WHO) – Switzerland
Ruth Kutalek
Anthropologist/Consultant
Ruth.Kutalek@meduniwien.ac.at

Yolanda Bayugo
Technical Officer
bayugo@who.int
Individuals

Scott Naysmith
Antrhopologist
scottnaysmith@gmail.com

Jeff Gilbert
Epidemiologist
Dr.Jeffrey.Gilbert@gmail.com

Food and Agriculture Organization (FAO), National – Egypt
Yilma Makonnen
Emergency Centre for Transboundary Animal Diseases (ECTAD) Team Leader, Egypt
Yilma.Makonnen@fao.org

Food and Agriculture Organization (FAO), Regional – Africa and Asia
Charles Bebay
ECTAD Manager, West and Central Africa
Charles.Bebay@fao.org

Bouna Diop
ECTAD Manager, East Africa
Bouna.Diop@fao.org

Scott Newman
Senior Technical Coordinator, Viet Nam
Scott.Newman@fao.org

Food and Agriculture Organization (FAO), Headquarters – Italy
Juan Lubroth
Chief, Animal Health Service
Juan.Lubroth@fao.org

Hubert Boulet
Wildlife Specialist
Hubert.Boulet@fao.org

Subhash Morzaria
Coordinator, EPT-2
Subhash.Morzaria@fao.org

Eran Raizman
Senior Animal Health Officer
Head of EMPRES-Animal Health
Eran.Raizman@fao.org

Julio Pinto
Animal Health Officer,
Disease Intelligence and Information
Systems
Julio.Pinto@fao.org

Silvia Kreindel
Veterinary Medical Officer
Risk Assessment
Silvia.Kreindel@fao.org

Astrid Tripodi
Animal Health Officer
Value Chains
Astrid.Tripodi@fao.org

Sophie von Dobschuetz
Veterinary Epidemiologist
Surveillance Coordinator
Sophie.VonDobschuetz@fao.org

Gwenaelle Dauphin
Animal Health Officer
Laboratory Coordinator
Gwenaelle.Dauphin@fao.org

Ian Sprouse
EMPRES Volunteer
Ian.Sprouse@fao.org

Guillaume Belot
Veterinary Epidemiologist
Guillaume.Belot@fao.org

Claudia Pittiglio
Ecologist
Claudia.Pittiglio@fao.org

Emma Gardner
Veterinary Epidemiologist
Emma.Gardner@fao.org

Henk Jan Ormel
Senior Advisor to the Chief
Veterinary Officer
HendrikJan.Ormel@fao.org

Raffaele Mattioli
Senior Officer,
Parasitic Diseases and Disease Ecology
Raffaele.Mattioli@fao.org

Lidewij Wiersma
Laboratory Specialist
Lidewij.Wiersma@fao.org

Angelique Angot
Laboratory Specialist
Angelique.Angot@fao.org

Martina Escher
Veterinary Epidemiologist
Martina.Escher@fao.org

Baukje Andela
EMPRES Volunteer
Baukje.Andela@fao.org

Akiko Kamata
Animal Health Officer
Disease Management
Akiko.Kamata@fao.org