From: Jonna Mazet <jkmazet@ucdavis.edu>
To: Peter Bogner <peter@gisaid.org>
CC: Dennis Carroll <dcarroll@usaid.gov>;Eddy Rubin <erubin@metabiota.com>
Sent: 2/6/2018 8:07:09 PM
Subject: Re: Thank you ...

Dear Peter -- thank you!
It was wonderful to spend time with you, learn from your experiences, and begin what I hope will be a wonderful collaboration.
I hope we can add value to your endeavors, as you have most seriously already enriched ours,
Jonna

On Tue, Feb 6, 2018 at 2:04 PM, Peter Bogner <peter@gisaid.org> wrote:
Hi guys,

Just a quick note to say thank you for sharing your enthusiasm about the importance of GVP. It is your strong conviction and true team spirit that reminds me of when we got our Initiative of the ground, no less against all odds. Moments ago, another group lead by Elon Musk showed they can inspire to prevail, successfully sending a peculiar test payload into orbit, while making their booster rockets land safely. http://www.spacex.com/webcast

You have the team and most of the right ingredients to be successful. Do count on our support!

Thanks you for your very sincere interactions with me in Bangkok 🙏

Peter
Santa Monica

From: Andrew Clements <aclements@usaid.gov>
Sent: Wed, 13 Jun 2018 17:42:15 +0200
Subject: Re: EN / Suspected Ebola breaks out in Kiryandongo
To: Kirsten Gilardi <kvgilardi@ucdavis.edu>
Cc: Jonna Mazet <jkmazet@ucdavis.edu>, Mike Cranfield [REDACTED] David John Wolking <djwolking@ucdavis.edu>, "predictmgt@usaid.gov" <predictmgt@usaid.gov>

Either is fine.

Andrew Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
E-mail: aclements@usaid.gov

For more information on USAID's Emerging Pandemic Threats program, see: http://www.usaid.gov/ept2

On Wed, Jun 13, 2018 at 5:31 PM, Kirsten Gilardi <kvgilardi@ucdavis.edu> wrote:

> Thanks Andrew: I will communicate with Benard this morning, and let him know that if the GOU/UVRI asks PREDICT to test samples from this case using PREDICT viral family protocols, that we are approved to move forward. Benard could also proactively reach out to Owe on this, if that is preferred or acceptable? Just let me know.

I'll keep you all posted.

-Kirsten

> On Jun 13, 2018, at 3:05 AM, Andrew Clements <aclements@usaid.gov> wrote:

See below for some talk about Predict possibly being asked to test for other pathogens.
If Predict is asked by GOU/UVRI and you have budget, you have my pre-approval to proceed.

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

Begin forwarded message:

From: Lisa Kramer <lkramer@usaid.gov>
Date: June 13, 2018 at 11:46:46 AM GMT+2
To: Wilberforce Owembabazi <wowembabazi@usaid.gov>
Cc: Gregory Adams <gadams@usaid.gov>, Andrea Long-Wagar <alongwagar@usaid.gov>, Mark Meassick <mmeassick@usaid.gov>, Jo Lesser-Oltheten <jlesser@usaid.gov>, Laura Gonzales <lgonzales@usaid.gov>, Michelle Lang-Alli <mlang-alli@usaid.gov>, Kassahun Belay <kbelay@usaid.gov>, Sarah Paige <spaige@usaid.gov>, "ETD Unit Mail List (USAID)" <ghsdunitmaillistusaid@usaid.gov>, outbreak@usaid.gov, Andrew Clements <aclements@usaid.gov>
Subject: Re: EN / Suspected Ebola breaks out in Kiryandongo

> Thank you Owe and thank you for keeping the broader group informed of the status.

For the specific request to PREDICT, please copy Andrew Clements, Mandy, Sarah and me. This should help to expedite PREDICT's

contractual approval process for supporting the lab response. Andrew is the PREDICT AOR.

Best,
Lisa

Lisa Kramer
Regional Emerging Pandemic Threats Advisor
USAID/Kenya and East Africa
+254-20-862-2107 (Office)
REDACTED (Mobile)

On Wed, Jun 13, 2018 at 9:58 AM, Wilberforce Owembabazi <wowembabazi@usaid.gov> wrote:

> Hi Lisa,
> Thank you for the quick turn round with alternative solution to identifying cause of Ebola-like symptoms with negative VHF laboratory results. We will get in touch with USAID PREDICT to run more tests and additional investigations to determine the cause of deaths. This complicates the GOU reluctance to declare outbreaks where communities suspect that labs are influenced by GOU to falsify results.
> In the past we have had situations where communities have protested results from central labs especially where people are dying and laboratory tests are negative for usual suspect infections.
> We will follow this up and update you accordingly.
> Thank you.

WILBERFORCE OWEMBABAZI, MD, MPH
PMS- Global Health Security Agenda, Office of Health and HIV
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
REDACTED
Telephone: Office: (256) 414-306-002 ext. 6637|Mobile: REDACTED
USAID.gov | wowembabazi@usaid.gov | @USAID

On Wed, Jun 13, 2018 at 9:20 AM, Lisa Kramer <lkramer@usaid.gov> wrote:

> Thank you Owe. Is UVRI continuing with other tests to try to determine the cause?

The USAID PREDICT project supported lab is also located at UVRI and they may be able to run the samples through the PREDICT protocols to determine if the pathogen to help narrow the diagnosis.

Lisa

Lisa Kramer
Regional Emerging Pandemic Threats Advisor
USAID/Kenya and East Africa
+254-20-862-2107 (Office)
REDACTED (Mobile)

On Wed, Jun 13, 2018 at 9:09 AM, Wilberforce Owembabazi <wowembabazi@usaid.gov> wrote:

> Hi All,
> This is to update you that UVRI results for the Ebola suspect in Kiryandogo are negative for all Viral Hemorrhagic Fevers (VHF).
> Thanks,

WILBERFORCE OWEMBABAZI, MD, MPH
PMS- Global Health Security Agenda, Office of Health and HIV

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
REDACTED
Telephone: Office: (256) 414-306-002 ext. 6637|Mobile: REDACTED
USAID.gov | wowembabazi@usaid.gov | @USAID

On Tue, Jun 12, 2018 at 2:56 PM, Gregory Adams <gadams@usaid.gov> wrote:

> Dear Andrea,
> I have reached out to our contact at WHO Kampala for updates. Nothing more to report yet. We'll get the UVRI test results as soon as they are available. No Government mobilization at this point in time. No NTF meeting called.

We will keep you posted.

Gregory J. Adams
Global Health Security Agenda (GHSA) Advisor
USAID Mission Kampala
Cellphone: REDACTED
Office Phone: +256 0414 306001 ext. 6599
Email: gadams@usaid.gov

On Tue, Jun 12, 2018 at 1:43 PM, Andrea Long-Wagar <alongwagar@usaid.gov> wrote:

> Dear Greg,
> Thank you for this information. Please keep us posted on the results from uvri. Is there anymore information about the suspected case? Has the government mobilized an investigation team to trace potential contacts?

Thank you
Andrea

Andrea Long-Wagar, ScM, MPH, CPH
Senior Infectious Disease Advisor
USAID Africa Bureau
Phone: 202-712-4514
Cell phone: REDACTED
E-mail: alongwagar@usaid.gov

Sent from my iPhone

On Jun 12, 2018, at 1:00 AM, Gregory Adams <gadams@usaid.gov> wrote:

> FYI Urgent - Suspected case of Ebola/Marburg in Kiryandongo District in the Western Region of Uganda. Sample from deceased victim has been sent to UVRI for testing. We will track this with the Emergency Operations Center.
> Regards,

Gregory J. Adams
Global Health Security Agenda (GHSA) Advisor
USAID Mission Kampala
Cellphone: REDACTED
Office Phone: +256 0414 306001 ext. 6599
Email: gadams@usaid.gov

---------- Forwarded message ----------

From: **Ricardo Echalar** <rechalar@usaid.gov>
Date: Mon, Jun 11, 2018 at 5:59 PM
Subject: Fwd: EN / Suspected Ebola breaks out in Kiryandongo
To: ghsdunitmaillistusaid@usaid.gov, Wilberforce Owembabazi <wowembabazi@usaid.gov>, Gregory Adams <gadams@usaid.gov>

FYI - sample sent to UVRI for confirmation

– –

Ricardo Echalar, MPH
Senior Public Health Advisor
Office of Infectious Diseases, Emerging Threats Division
Bureau for Global Health
U.S. Agency for International Development (USAID)
2100 Crystal Drive, 8th Floor - 8088B
Arlington, VA 22202
(m) REDACTED | **New number** (w) +1.571.551.7456 | E-mail: rechalar@usaid.gov

USAID Contractor
GHSI-III - CAMRIS International, Inc.

---------- Forwarded message ----------
From: **GPHIN Alert - Alerte RMISP** <gphin-rmisp@phac-aspc.gc.ca>
Date: Mon, Jun 11, 2018 at 10:53 AM
Subject: EN / Suspected Ebola breaks out in Kiryandongo
To: rechalar@usaid.gov

This is an automated alert from the GPHIN System; please do not reply to this e-mail. The following article is brought to your attention and may require action on your part.

Publication language: EN

Article ID: 1003418616

Received: 2018-06-11 14:02 UTC

Published: 2018-06-11 14:01 UTC

Location:

- Uganda
  - Central Region
    - Kayunga District
    - Bweyale
  - Western Region
    - Kiryandongo

News provider: MANUAL

Publication name: pmldaily.com

Suspected Ebola breaks out in

Kiryandongo

Posted on June 11, 2018

KIRYANDONGO – A disease, suspected to be Ebola or Marburg haemorrhagic fever, has broken out in Kiryandongo district.

On Sunday morning, a woman patient identified as Cungi Odoki, a resident of Bweyale town council, was admitted with signs of the two ailments but died shortly after arrival.

According to the district Secretary for Health Rashid Okecha, health officials tried all they could to give her treatment but in vain.

"The woman was admitted at around 8am on Sunday with a severe fever and blood was flowing out of her body passing through every opening,"Okecha said.

He, however said a blood sample has been taken to the Uganda Virus Research Institute.

"After testing, we shall be able to ascertain what the patient was suffering from. The deceased will however be buried today Monday to avoid any chances of contact being made,"Okecha said.

According to Okecha, burial will be carried out by the medical control team.

Efforts to get additional information from the hospital's medical superintendent were futile as our calls went unanswered.

Okecha said the community is going to be sensitised to take preventive measures against the virus.

The original article is available at http://www.pmldaily.com/news/2018/06/0935723-49723.html.

Sent: Mon, 9 Jan 2017 11:38:15 -0800
Subject: Fwd: FW: Beijing Meeting: canceling participation
From: Jonna Mazet <jkmazet@ucdavis.edu>
To: Carlos Morel <[redacted]>, rcuri@cdts.fiocruz.br, r[redacted], Carlos M Morel <morel@cdts.fiocruz.br>, Dennis Carroll <DCarroll@usaid.gov>
Cc: Katie Leasure <kaleasure@ucdavis.edu>, Cara Chrisman <cchrisman@usaid.gov>
Untitled attachment 00094.htm
20170115_MEDICIS_ZEZ5GI.PDF

Dear Carlos,
I'm very sorry to hear this decision. Katie has looped me into the chain. Please know that we are doing everything we can to comply with US federal funds policy, as we are subject to all of the US government rules with our USAID funding. A couple of years ago, the US government increased their stringency on business class travel, and most US employees are now asked to spend extra days on layover mid-trip to avoid their traveling business class. Unfortunately, UC Davis has implemented policies to make sure we comply with those regulations and policies. For Bellagio, we had requested an exception, but it was not granted. Hence our encouragement of other approved exceptions to policy, including medical and need to travel expediently without time for rest. Those are US federal exceptions, not UC Davis'.
Because of your email and our desire to make this project feasible for those involved, we are again requesting an exception that is appropriate and auditable for US federal funds. I am hopeful but can't yet be optimistic. Perhaps Dennis can weigh-in. There is a "more than 14 hour rule" that we haven't been able to use recently, but it is still in the regulations. We are hoping that regulation will help us to acquire a blanket exception for GVP.
Please know that Katie and our team are doing absolutely everything we can to comply with the US federal rules and make the travel most comfortable and appropriate for full participation.
All my best and still hoping to see you,
Jonna

From: Carlos Morel [mailto:morel@cdts.fiocruz.br]
Sent: Saturday, January 07, 2017 1:41 AM
To: Dennis Carroll
Cc: Cara Chrisman; Renata Curi Hauegen; katherine Leasure
Subject: Beijing Meeting: canceling participation
Importance: High

Dear Dennis,

I am terribly sorry to inform you that, due to the travel policy of the University of California at Davis, I decided to cancel my travel to Beijing. I am, I repeat, very sorry to take this decision and I know I owe you the reasons that made me take it:

- From January 15 to January 19 I will travel Rio-Paris-Geneva and back to Rio, as you may see in the attached document; the travel to Beijing means another very tiring travel in less than a month;
- I have been serving at boards of directors of several organizations (TB Alliance, MMV, DNDi, FIND), twice as the chairperson; I never asked any salary or consultation fees, my participation has always been “pro bono” because I believed and trusted in their mission and goals; my only request, to fly business class, was not a problem, as their travel policies allowed that **for long travels** (with no need to present a doctor’s note);
- I have already traveled to China, back in 2007, and know how hard it is; for me it was then quite a big surprise that UC at Davis does not have, in its policy, any differentiation between short and long travels; this reminds me the life and death of my good friend John La Montagne who, submitted to another bad travel policy, had to travel economy very frequently and died in Mexico airport;
- As a MD myself, of course I do have several colleagues who could give me a "*doctor’s note supporting your need for business class*”; the day I would consider myself a sick person I will stop traveling immediately and will not ask a colleague to give me a fake certificate; what is the purpose to adopt a strict bureaucratic rule if you acdept such a simple way to avoid or bypass it?
- The travel policy is so unbelievable that it would allow a business ticket if I would arrive the day the meeting would

start - but if I want to rest 1-2 days I must fly economy...

A global program (as the GVP should be), has to adopt a much more flexible and less bureaucratic policy. I was really surprised we could not receive a simple, non-binding preliminary air travel reservation in order to comply with our own legal procedures - getting a travel license from the Government and applying for an official passport which would waive the need to get a visa from Chinese authorities.

I hope my decision will not harm Renata's participation or her decision to join the GVP. She is a young and brilliant lawyer who can contribute a lot to the program.

Best regards,

Carlos

DELTA Voyages SA
Quai du Seujet 28
Case Postale 192
1211 Genève 8

Tel.: +41 22 - 731 35 35
Fax: +41 22 - 738 25 55
Email: annemarie.imobersteg@delta-voyages.ch
Web: www.delta-voyages.ch

Date: 04.01.2017 **Time:** 14:10h

Your travel agent: Annemarie Imobersteg

Travel Document - E-Ticket and Itinerary Receipt

Passenger: MEDICIS MOREL/CARLOS MR

Booking reference Amadeus: ZEZ5GI

Booking reference Airline: AF/ZEZ5GI

Ticket number: 057-1218215790, issued

Issued by: AIR FRANCE

Date	Route	Flight/Service	from/to	Class
Sun, 15. Jan	RIO DE JANEIRO RJ - PARIS FR	AF 443	17:40 - 07:40 +1	BUSINESS
Mon, 16. Jan	PARIS FR - GENEVA CH	AF 1842	10:00 - 11:10	BUSINESS
Wed, 18. Jan	GENEVA CH - PARIS FR	AF 1043	20:30 - 21:40	BUSINESS
Wed, 18. Jan	PARIS FR - RIO DE JANEIRO RJ	AF 442	23:35 - 08:10 +1	BUSINESS

Flight

AIRFRANCE

AF 443
operated by
AIR FRANCE

Date	From	To	Departure	Arrival
Sun, 15. Jan - Mon, 16. Jan	RIO DE JANEIRO RJ GALEAO A.C JOBIM INTL TERMINAL 2	PARIS FR CHARLES DE GAULLE TERMINAL 2E - AEROGARE 2 TERMINAL E	17:40 h Check-in before: 16:40 h	07:40 h Flight duration: 11:00 h

Reservation Class: I - BUSINESS, CONFIRMED
Seat: 04B

Free Baggage Allowance 2 piece(s) per traveller MEDICIS MOREL/CARLOS MR
Fare Basis: ISFBR
Not valid before/after 15JAN / 15JAN
Info Aircraft: BOEING 777-300ER (subject to change)
On board:SNACK/MEAL
Check-In

Flight

AIRFRANCE

AF 1842
operated by
AIR FRANCE

Date	From	To	Departure	Arrival
Mon, 16. Jan	PARIS FR CHARLES DE GAULLE TERMINAL 2F - AEROGARE 2 TERMINAL F	GENEVA CH GENEVA INTERNATIONAL TERMINAL 1	10:00 h Check-in before: 09:20 h	11:10 h Flight duration: 1:10 h

Reservation Class: J - BUSINESS, CONFIRMED
Seat: 05C

Free Baggage Allowance 2 piece(s) per traveller MEDICIS MOREL/CARLOS MR
Fare Basis: ISFBR
Not valid before/after 16JAN / 16JAN
Info Aircraft: AIRBUS INDUSTRIE A318 (subject to change)
On board:SNACK
Check-In

Flight	Date	From	To	Departure	Arrival
AIRFRANCE AF 1043 operated by AIR FRANCE	Wed, 18. Jan	GENEVA CH GENEVA INTERNATIONAL TERMINAL 1	PARIS FR CHARLES DE GAULLE TERMINAL 2F - AEROGARE 2 TERMINAL F	20:30 h Check-in before: 19:50 h	21:40 h Flight duration: 1:10 h

Reservation Class: J - BUSINESS, CONFIRMED
Seat: 03C

Free Baggage Allowance 2 piece(s) per traveller MEDICIS MOREL/CARLOS MR

Fare Basis: ISFBR

Not valid before/after 18JAN / 18JAN

Info Aircraft: AIRBUS INDUSTRIE A321 (subject to change)
On board:MEAL
Check-In

Flight	Date	From	To	Departure	Arrival
AIRFRANCE AF 442 operated by AIR FRANCE	Wed, 18. Jan - Thu, 19. Jan	PARIS FR CHARLES DE GAULLE TERMINAL 2E - AEROGARE 2 TERMINAL E	RIO DE JANEIRO RJ GALEAO A.C JOBIM INTL TERMINAL 2	23:35 h Check-in before: 22:35 h	08:10 h Flight duration: 11:35 h

Reservation Class: I - BUSINESS, CONFIRMED
Seat: 02E

Free Baggage Allowance 2 piece(s) per traveller MEDICIS MOREL/CARLOS MR

Fare Basis: ISFBR

Not valid before/after 18JAN / 18JAN

Info Aircraft: BOEING 777-300ER (subject to change)
On board:MEAL/BREAKFAST
Check-In

Ticket and price details **Ticket number:** 057-1218215790 **for** MEDICIS MOREL/CARLOS MR **Issued by:** AIR FRANCE

Issuing Agency:	DELTA VOYAGES SA	**IATA number:**	81200136
Place of Issue:	GENEVE 8	**Date of Issue:**	04JAN17
Form of payment:	TP XXXXXXXXXXX1758		
Endorsements:	-ORIG BR- 2PC/32KG NON ENDO/ FARE RSTR COULD APPLY		

This Itinerary/Receipt constitutes the 'passenger ticket' for the purpose of Article 3 of the Warsaw Convention and the Montreal Convention, except where the carrier delivers to the passenger another document complying with the requirements of Article 3. Carriage and other services provided by the carrier are subject to conditions of carriage, which are hereby incorporated by reference. These conditions may be obtained from the issuing carrier or online at: http://www.iatatravelcentre.com/tickets.
Please ensure you have obtained and read these important conditions prior to the commencement of travel.

The flight(s) calculated average CO_2 emissions is 1953,77 kg per person.
Source: ICAO Carbon Emissions Calculator

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oneandonlyresorts.com/dubai

Sent: Tue, 31 Jan 2017 09:40:09 -0800
Subject: Fwd: [predict] [predict-outbreak] Fwd: FAO Rapid Risk Assessment H5N8 HPAI Uganda
From: Jonna Mazet <jkmazet@ucdavis.edu>
To: Billy Karesh <karesh@ecohealthalliance.org>
Cc: predict-outbreak@ucdavis.edu, Benard Ssebide <[redacted]>, Mike Cranfield <[redacted]>, Kirsten Gilardi <kvgilardi@ucdavis.edu>

ATT00001.htm
H5N8 Uganda RRA.xlsx
RA- H5N8 Draft 1Uganda_Jan 31.docx
ATT00002.htm

Thanks, Billy,
Just checking is this an FYI for P-2 or are they asking for Benard's or our team's input?
Just let us know,
J

On Tue, Jan 31, 2017 at 9:34 AM, William B. Karesh <karesh@ecohealthalliance.org> wrote:

FYI, please share with Lisa Kramer, her email isn't pooping up on my phone.

Sent from my iPhone
William B. Karesh, D.V.M
Executive Vice President for Health and Policy

EcoHealth Alliance
460 West 34th Street - 17th Floor
New York, NY 10001 USA

+1.212.380.4463 (direct)
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www.ecohealthalliance.org

President, OIE Working Group on Wildlife

Co-chair, IUCN Species Survival Commission - Wildlife Health Specialist Group

EPT Liaison - USAID Emerging Pandemic Threats - PREDICT 2 program

EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

Begin forwarded message:

From: "Kreindel, Silvia (AGAH)" <[redacted]>
Subject: FAO Rapid Risk Assessment H5N8 HPAI Uganda

Dear colleagues,

Within the FAO mandate, we are monitoring this year detection of H5N8 HPAI in Uganda. We are conducting a rapid risk assessment (RRA) in order to answer the following risk questions: (1) What is the likelihood of H5N8 spread from Uganda to another countries in the regions, (2) What is the likelihood of further spread of the virus within Uganda?, and (3) What will be the consequences of the spread of H5N8 in the Uganda's commercial and backyard poultry production system within the next 6 months?

Attached you find a draft document (work in progress) describing the available information and the reporting the of the risk questions we would like to submit for your evaluation. We are kindly asking for your availability on answering to our risk questions (excel file). Considering the urgency of the matter we are asking you to provide your answers by sending back the completed excel file by Thursday February 2. The time required for answering to our risk questions would not be more than 10 minutes.

Your comments and participation will be acknowledged in the final RRA report.

I apologize for the urgency. Sincerely we hope you could participate in this risk assessment exercise, providing your valuable expertise and contribution.

Please do not hesitate to contact us for any question or doubt.

Best regards,

Claudia Pittiglio, Paolo Calistri, and Silvia Kreindel

Dr Silvia Kreindel

Epidemiologist / Risk Analyst

US/UN Mission - USDA

Animal Health Division

REDACTED

Office Phone: REDACTED

Cell: REDACTED

Avian influenza in Uganda: A Rapid Qualitative risk assessment

Background

a. Global picture

Several Highly Pathogenic avian influenza (HPAI) serotypes and clades are actively circulating around the world. An important wave of the latest HPAI incursions is currently associated to the presence of H5N8 linked to wild birds migration. This wave relates to the detection of H5N8 HPAI strain in June, 2016 in Southern Russia. Since then, it has been spreading globally, following wild birds' migratory routes, and detected in over 30 countries in Asia, Europe and Africa. As of today, no human cases of avian influenza H5N8 have been reported in relation to the current circulating virus or other viruses of this subtype. Other circulating strains include the detection of H5N6 HPAI in Japan and Republic of Korea, and the presence of several H5N1 HPAI clades circulating endemically in Egypt, Indonesia and Nigeria. (India also?)

Co-circulation and multiple infections of avian influenza viruses in poultry or wild birds provide opportunities for recombination of viruses of different origins. Figure 1. Shows the global distribution of HPAI events in domestic birds, wild birds, and humans.

HPAI events, global, domestic/wild birds, human, by onset date 01 June 2016 – 31 January 2017

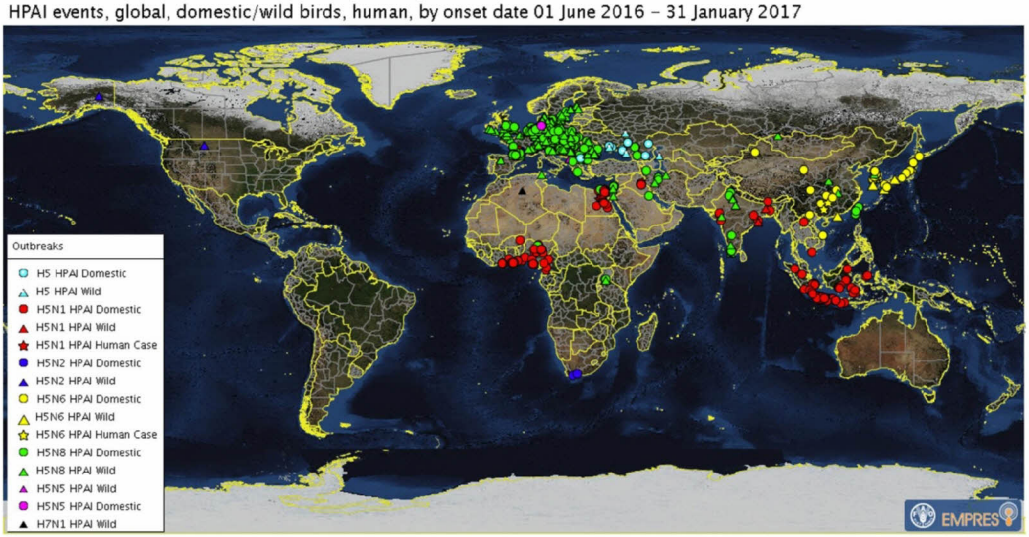
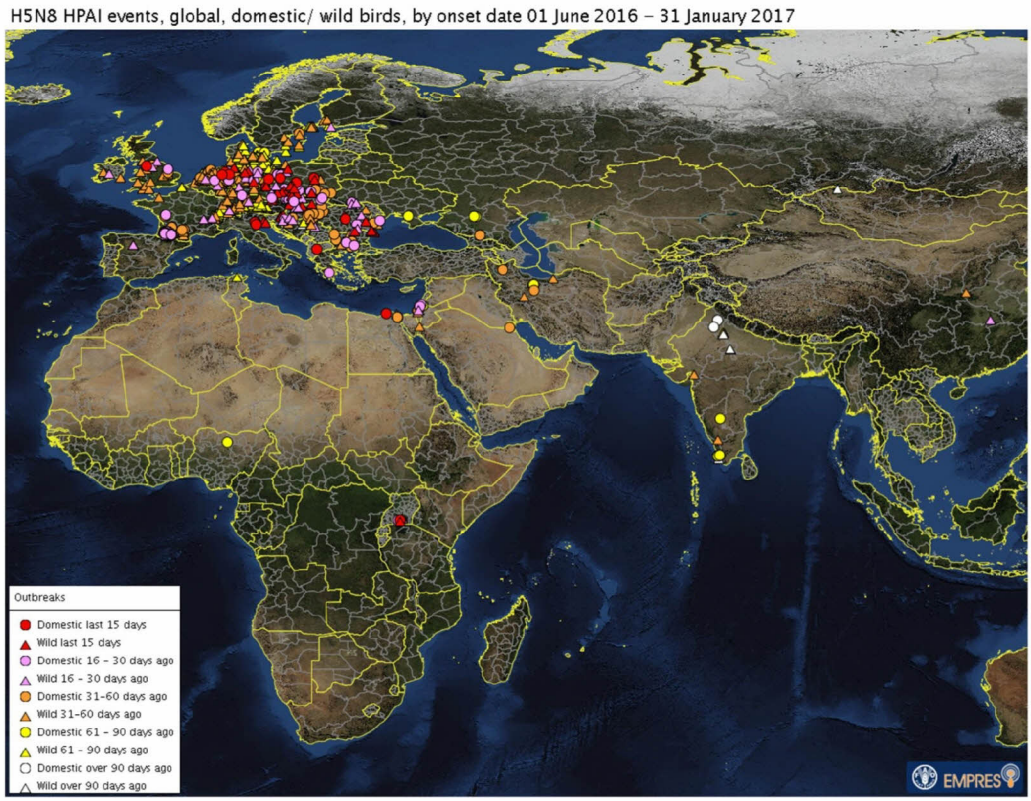


Figure 1. Global distribution of HPAI events in domestic birds, wild birds, and humans from 1 June 2016 to January 31, 2017 while Figure 2 shows the H5N8 HPAI events during the same time period



As shown on Figure 3, outbreaks of H5N8 in wild birds since June, 2016 appear to precede the ones on domestic birds.

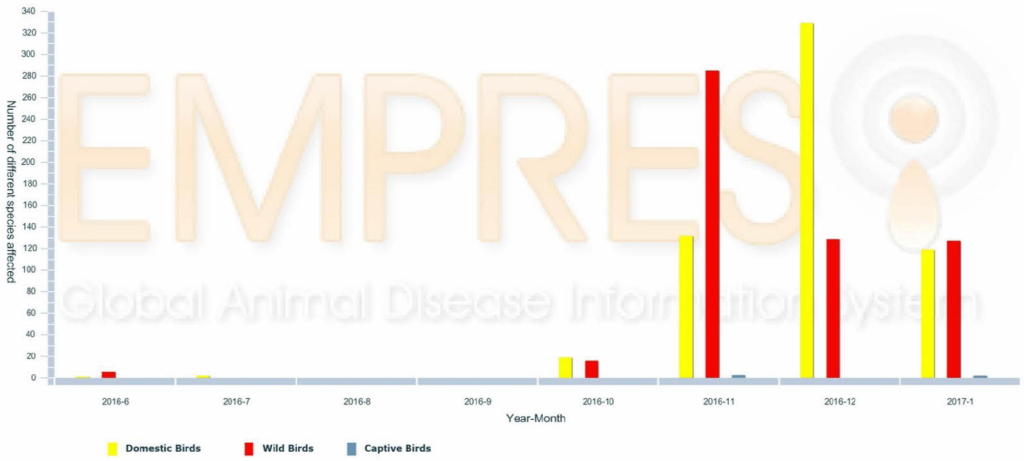


Figure 3. Outbreaks of H5N8 in birds (domestic, wild, and captive) from June 2016 until January 31, 2017

b. Situation in the region .

Situation in Uganda

On January 2, 2017, massive mortality in wild birds (white-winged terns, *Chlidonias leucopterus*) was reported in Uganda. The incident started in mid-December, 2016 along the shores of Lake Victoria in Lutembe bay (Wakiso District), and in Kachanga village in Masaka district (1,200 deaths over an estimated population of 2000 animals, mortality rate of 60%). On January 13, the Uganda Virus Research Institute confirmed the presence of H5 HPAI. In addition, H5 HPAI virus spillover from wild to domestic birds was detected in Kachanka village; 20 birds showed clinical signs, 7 died out of a population of 30000 birds. In addition, unconfirmed deaths of birds were reported in Kalangala district.

On January 25, the virus was characterized as H5N8 HPAI. Disease remains restricted along the shores of Lake Victoria, specifically in Mazinga, Bubeke, Kyamuswa,Bufumira, Bujumba and Mugoye sub counties in Kalangala district where 221 wild birds, 2918 domestic ducks and 1200 chicken died. Additional sub counties (i.e. Kyesiga) in Masaka district have estimated a loss about 1250 domestic birds and 150 wild birds from 5 landing sites. On January 18, 2017 media articles reported that the governments of Kenya and Rwanda banned the imports of poultry/poultry products from Uganda (https://www.yahoo.com/news/kenya-rwanda-ban-poultry-uganda-over-bird-flu-171730526.html).

Figure 4 shows the distribution of backyard flocks in relation of the two HPAI outbreaks detected this year. As shown on the figure, the region under consideration has a large density of chickens.

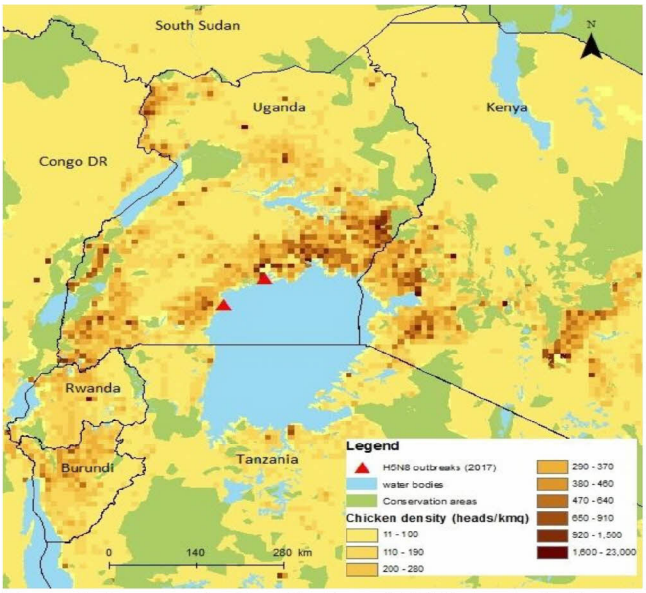


Figure 4. Geographical localization of H5N8 events in Uganda and chicken density (heads/km^2) in the region.

Interestingly, the 2017 finding does not represent the first detection of H5 in Uganda. In 2010, in fact, a study performed in Uganda detected H5 subtype at a prevalence of 1.2% (11/929 samples, 95% C.I. 0.7%-2.1%) of fresh fecal swabs taken from roosting sites of free-living waterfowl (Kirunda et al., 2014).

The 2017 finding of HPAI in Uganda raises concerns because the country has a combination of factors that could contribute to further spread of the disease including, among the others, a population of over forty million domestic poultry; a combination of a variety of informal trade of domestic poultry within the region, the presence of the disease in an area considered seasonal shelter of migratory birds that are reservoir of AI virus; the existence of numerous live bird market; and a large number of backyard poultry producers. This episode constitutes the first report of HPAI in the sub-Saharan region since XXXXX.

This document discusses the release of H5N8 in Uganda taken into consideration the (1) wild and domestic bird population in the area, (2) migration patterns of wild bird, (3) ecological characteristics of the region as they relate to the likelihood of spreading the disease, (4) veterinary infrastructure, (5) AI detection, and (6) trade and practices that could contribute to the spread of the disease into other countries in the region. The following in Risk Questions are addressed:

1. What is the likelihood of H5N8 spread from Uganda to another countries in the regions
2. What is the likelihood of further spread of the virus within Uganda?
3. What will be the consequences of the spread of H5N8 in the Uganda's commercial and backyard poultry production system within the next 6 months?

Hazard identification

Disease situation / epidemiology in Uganda

a. The hazard: the presence of H5N8 in Uganda

The Hazard Identified in this assessment is Highly Pathogenic Avian Influenza (HPAI) H5N8. For information regarding Avian Influenza, please refer to Appendix 1 (http://www.oie.int/fileadmin/Home/eng/Animal_Health_in_the_World/docs/pdf/Disease_cards/HPAI.pdf).

Outbreaks caused H5N8 HPAI viruses have been reported in Asia since 2010. In 2014/2015, outbreaks in H5N8 were reported in Europe (Germany, Hungary, Italy, the Netherlands, Sweden and the United Kingdom as well as in the US and Canada). Since the beginning of 2014, several outbreaks involving novel reassortant HPAI A (H5N8) viruses have been detected in poultry and wild bird species in South Korea as well as in China (ref) and Japan (Ref). The viruses have been detected in migratory birds and dead wild birds as well as in domestic chickens, geese and ducks. Since 2016, H5N8 has been detected in 30 European countries and in 30 wild bird species. As of Feruary 1, 2017 the reported chicken mortality has been around 1%. (ref).

Briefly, HPAI is a highly infectious viral disease that affects a wide range of bird species. AI viruses that cause HPAI are highly virulent, and mortality rates in infected domestic flocks often approach 90–100%. No human cases of avian of H5N8 have been reported in relation to the current circulating virus or other viruses of this subtype.

Release Assessment

1. **Profile of the Uganda Poultry Production System and Export Market**

The total domestic poultry population in Uganda in 2014 was reported as 44.5 million birds. This represents approximately 3% increase from 2013. (http://www.ubos.org/onlinefiles/uploads/ubos/statistical_abstracts/Statistical%20Abstract%202015.pdf). Figure 5 shows that the live poultry statistics for Uganda and neighboring countries, live poultry production has remained stable in 2013 and 2014.

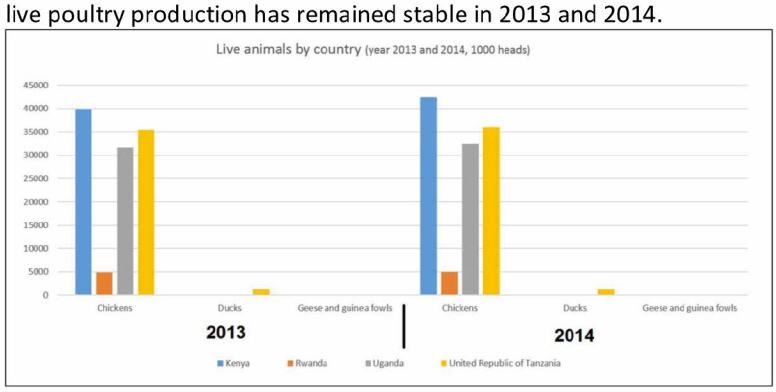


Figure 5. Live domestic live bird production in Uganda, Rwanda, Kenya, and Republic of Tanzania

Of the total Uganda poultry production, approximately 80% is comprised of free-ranged birds and 20% of intensive/commercial poultry production systems. Chicken form the main

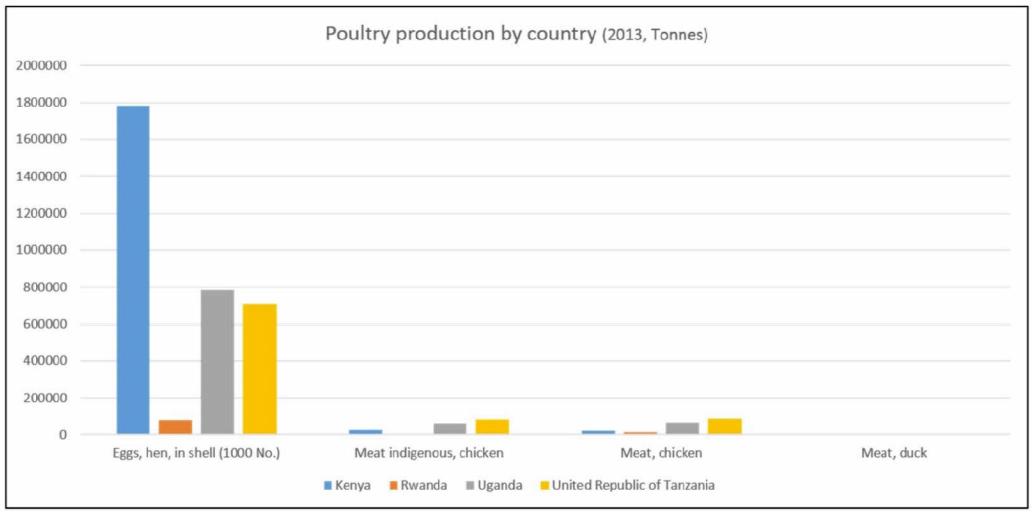
production type. There are wide variations in the number of birds, types, biosecurity depending on the management system. Commercial production is found in urban areas where there are markets for eggs and poultry meat. The eastern region is reported as having the highest numbers of free-range birds (representing approximately 40% of the population). Commercial producers are categorized into four groups:

(1) Small scale producers which are farms own by families (100-500 layers or broilers);
(2) Medium scale which are mainly own by individuals or farmers groups (500 -5,000 layers or broilers);
(3) Large breeding units (over 5,000 birds) representing a small group of farms; and
(4) large hatcheries whose national capacity has been estimated to be 510,00 eggs per week.

In some regions, small producers market chickens to hawkers or middlemen who subsequently assemble and transport the birds to urban traders (Okot 1990). Middlemen contribute to fifty percent of the chicken market, while the rest of the birds are marketed directly from rural farm households. Chicken trade is considered the major source of household income to the vast majority of the chicken traders. The demand for chickens is the highest in the festive months of December and April; and lowest in February and March. Organized marketing of free-range rural poultry is difficult because of small size of the output per household generated at irregular intervals (Chandraschka 1998). In 2009, the majority of the traders (52.9%) reported to obtain local chickens from Eastern Uganda and transport them to markets in passenger vehicles, on motorcycles, and on lorry trucks.

There is very little information regarding the marketing of local chickens, but is known that it is not streamline. Available market information is mainly informal (http://www.lrrd.org/lrrd22/4/emur22076.htm). Live bird markets (LBM) are very important for the marketing of poultry in Uganda. Information regarding the number of LBM is not available, but a study published in 2014 reported the presence of 108 LBM in the 37 districts. The study reference to the lack of consistent management practices in the marketing of domestic birds, leading to poor biosecurity and an increase risk of disease spread (ref.).

Regarding the export market, as shown in figure 6, in 2015 the main market of poultry/poultry commodities were countries in the region, specifically, for live chickens were Democratic Republic of Congo and Tanzania, while for bird eggs, fresh, preserved or cook were the Democratic Republic of Congo, Sudan, and Rwanda, and other eggs not in shell and yolks were exported to South Sudan.



Figures 7 shows the list of supply markets for poultry imported by Uganda and the exported markets for poultry products respectively.

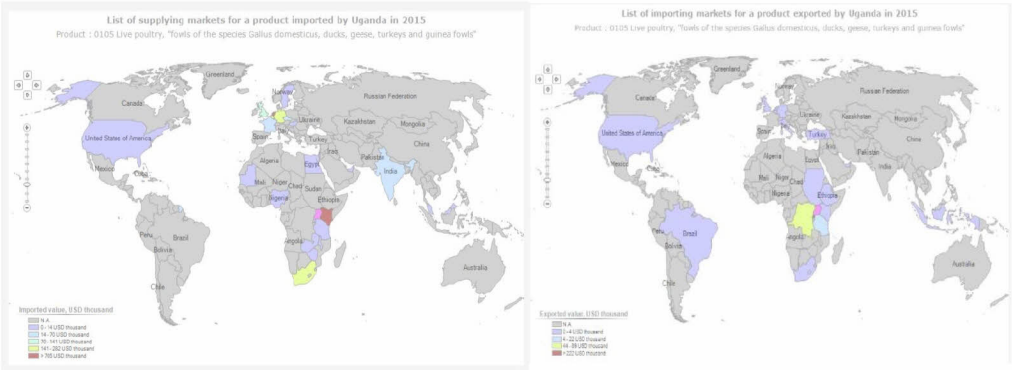


Figure 7. List of Supply Markets for poultry products imported and exported from Uganda.

Regarding imports of birds, the hatcheries import their parent DOC from outside Uganda, as there are no grandparent stock farms in the country. Uganda imports from the Netherlands, Mauritius, Kenya, Zimbabwe, UK, USA, France and Germany. MAAIF periodically reviews the 16 Poultry sector review: Uganda Version of 1st December 2008 countries from which imports are allowed and issues import restrictions which are implemented through requirements for import permits of poultry or poultry products enforced by law.

2. Uganda AI Surveillance and Veterinary infrastructure

In October 2005, Uganda developed the first Preparedness and Response Plan for Avian and Pandemic Influenza (2005-2007) (MOH, 2006) following actions recommended by WHO, OIE and FAO.

Over the years, Uganda has received support to strengthen its veterinary infrastructure (including laboratory capacity and human resources), increase surveillance activities for AI, and capacity building (http://documents.worldbank.org/curated/en/660961475114036848/Uganda-Preparedness-And-Control-Of-Avian-Influenza). By the end of 2015, the following improvements were reported:

(1) Completed eight sero-prevalence surveys covering HPAI and implemented community based surveillance systems in two high risk districts (Busia and Tororo),
(2) Registered of ALL commercial poultry farms and breeders,
(3) All districts became linked to an incident command system established within the National Veterinary Services,
(4) Updated HPAI protocols, Standard Operating Procedures,
(5) Increase number of districts reporting promptly on veterinary services,
(6) Updated preparedness and response plans for HPAI implemented in most districts integrated to a District Reporting System, with operational reporting of HPAI suspected clinical signs.

In addition, Uganda reported improved biosecurity practices along the poultry supply chain, including acceptable biosecurity practices in live bird markets. At the same time, Uganda developed a compensation policy for HPAI that has not yet been fully implemented. (same reference as above). The latest reports contradict a recent study published in 2014, (Kirunda et al, XX) which concluded (after assessing the biosecurity of 108 LBM in 37 districts) that poor management practices in Uganda's LBM are a potential risk for the spread of AI to poultry and humans.

3. Uganda's Wild bird population

Uganda hosts important wild bird areas for breeding, wintering and passage birds, and is considered a major stop-over point along the East Asian-East African flyway (Fig. X2). The region where the outbreak was reported is considered a shelter of 240,000 birds including 100 migratory waterbirds of which 82 are Palearctic and 17 Afro-tropical migrants (ref.). Along the Ugandan shores of Victoria Lake, five Ramsar sites (wetlands listed under the Ramsar Convention) are present (figure 8), and one of them, Lutembe bay, holds counts of up to 50,000 birds in January, however the number of birds counted in 1999-2000 reached over 2,000,000 (similar numbers were counted in Northern Uganda). There have been fluctuations in the number of waterbird species and waterbirds following a season pattern with highest numbers of waterbirds count in the winter months (specifically from December to March). The largest number of birds are the Palearctic wintering Gulls, terns, and waders with white winged terns (*Chlidonias leucopterus*) representing 70% of the population (ref.). Among the regularly observed migratory birds in the region, eight are considered to a high risk species for the spread of influenza viruses. These include the tufted duck (*Aythya fuligula*), the long-tailed cormorant (*Microcarbo africanus*), northern shoveler (*Anas clypeata*), garganey (*Anas querquedula*), black-headed gull (*Chroicocephalus ridibundus*), and the Eurasian wigeon (*Anas Penelope*).

Figure 8. Wetland areas in Uganda along Lake Victoria Lakes

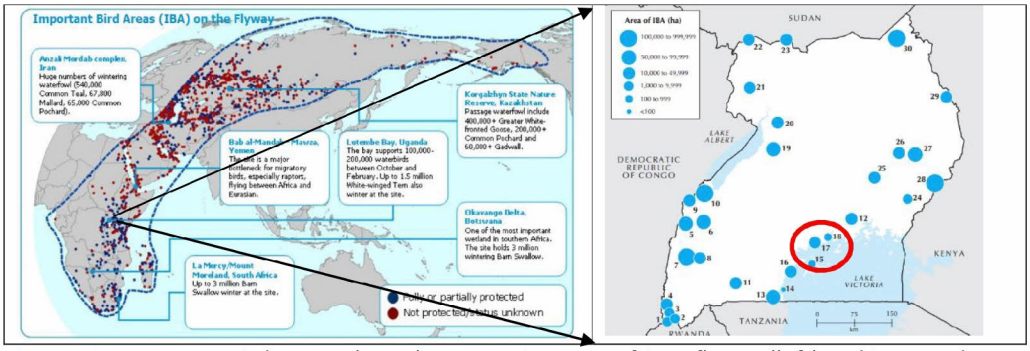


Figure 10. Important Bird Areas along the East Asian-East African flyway (left) and in Uganda (right). Source: BirdLife International.

Considering the migratory flyways of the white-winged terns (*Chlidonias leucopterus*), the breeding areas are largely overlapping the zones involved by H5N8 infection in the summer and autumn 2016 (Fig. 10), thus leading to the hypothesis of a possible role of this bird species in the recent introduction of H5N8 into Uganda.

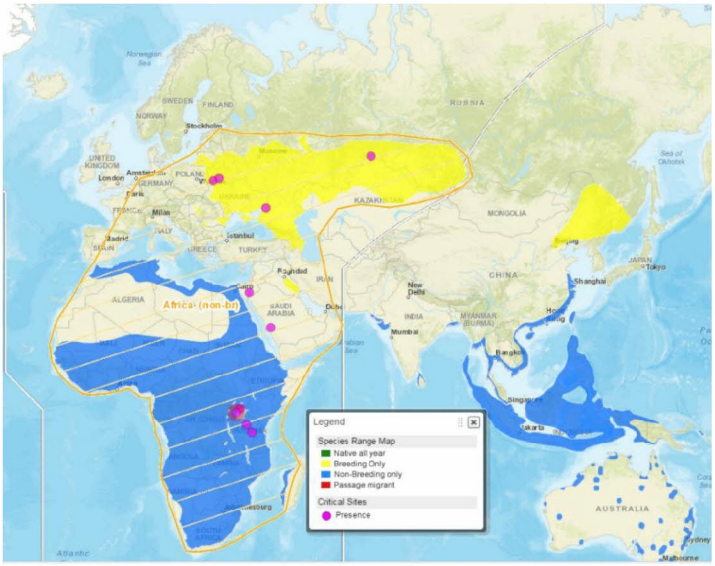


Figure 11 Breeding and Wintering areas.

4. **Wild bird migration and climate as factors contributing to the spread of AI in Uganda**

The climate in Uganda is characterized by two rainy seasons: from March to May and from September to December (UNMA 2016). The arrival of the wild bird migratory species in the Ugandan wintering areas, including waterfowl, occurs in October/November, during the rainy season, when the availability of food resources is higher. Here they mix with the resident species.

Since the last three/four months (September-October 2016), below-average and erratic rainfall has occurred over most of Uganda, Rwanda, Kenya, Tanzania and DR Congo resulting in strong moisture deficits, degraded ground conditions and droughts (Figure 12). These very dry conditions appear to be associated with the weak La Niña conditions over equatorial eastern Pacific Ocean that are predicted to persist during the early months of 2017. Rainfall anomalies influence phenology and forage availability for wildlife, thus affecting migration routes, wintering areas, and departure timing for the wild bird migratory species (Gaidet et al. 2008; Hurlbert and Liang 2012). As cold spells in temperate regions (Reperant et al. 2010), droughts in tropical areas may determine higher concentration of wild bird species in critical available hotspots, increasing competition for food and shelter and the risk of disease transmission. The current and persistent droughts around Lake Victoria could have determined a higher congregation of wild bird species at the critical bird resting areas where H5N8 has been reported, with increased risk of virus transmission among the animals. In addition droughts may have caused low availability of food thus increasing the vulnerability of the wild bird migratory and resident species to diseases.

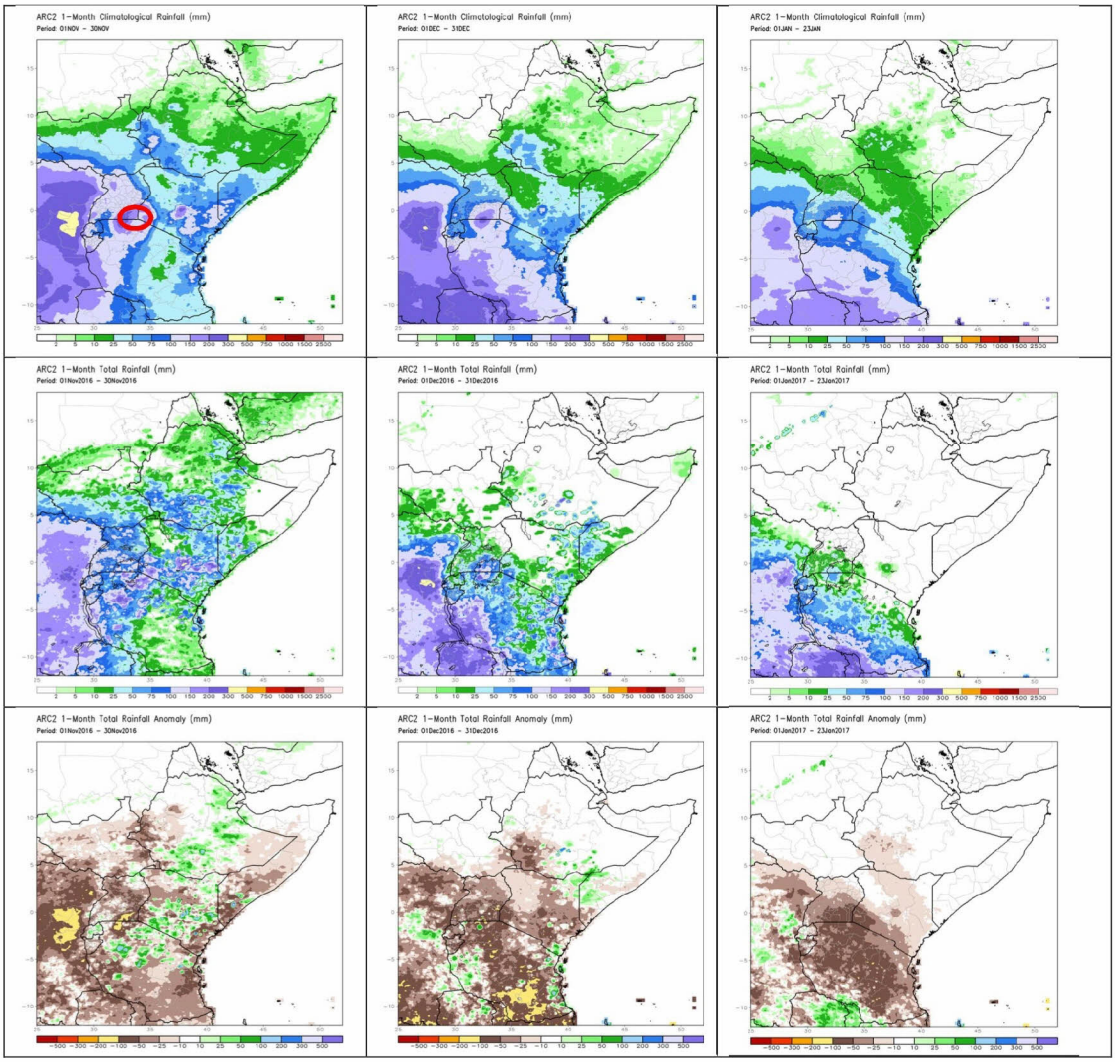


Figure 12. Rainfall in Uganda, Rwanda, Kenya, Tanzania and DR Congo (November 2016-January 2017)

There is evidence that infected birds can migrate long distances, and possibly carrying avian influenza viruses (Keawcharoen et al. 2008; Gaidet et al. 2008). A recent study showed that H5N1 could spread from central Siberia to Egypt and Sudan along the East Africa-West Asia flyway via Russia Federation, Iran, Iraq, Lebanon, Israel, West Bank and Gaza (Liang et al. 2010).

Environmental predictors: in temperate regions, cold spells, low temperature and low (both relative and absolute) humidity are considered main climatic determinants of avian influenza occurrences. In tropical areas, avian influenza outbreaks appear associated with rainfall and high humidity (ref.)

Nevertheless, in Uganda this may not be the case [low humidity due to drought).

Exposure Assessment

A. Exposure assessment

Addressing the risk questions:

-What is the likelihood of introduction of the virus into previously unaffected countries of the region?

- What is the likelihood of further spread of the virus within Uganda?

- What are the consequences for poultry health expected within the next 6 months?

B. Consequence assessment

Risk of further transmission and spread of avian influenza

Associated consequences for trade

Risk estimate

Risk management options

Advice and specific risk mitigation measures

Conclusions

REFERENCES

From: Kirsten Gilardi <kvgilardi@ucdavis.edu>
To: "William B. Karesh" <Karesh@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>
Cc: "predict-outbreak@ucdavis.edu" <predict-outbreak@ucdavis.edu>, "Benard Ssebide" [REDACTED], Mike Cranfield [REDACTED]
Subject: Re: [predict] [predict-outbreak] Fwd: FAO Rapid Risk Assessment H5N8 HPAI Uganda
Sent: Wed, 1 Feb 2017 06:04:31 +0000

Okay, thanks for the clarification, and for the share. -K

On Jan 31, 2017, at 6:44 PM, William B. Karesh <Karesh@ecohealthalliance.org> wrote:

Just FYI, FAO has sent it to the people they are asking for input

Sent from my iPhone
William B. Karesh, D.V.M
Executive Vice President for Health and Policy

EcoHealth Alliance
460 West 34th Street - 17th Floor
New York, NY 10001 USA

+1.212.380.4463 (direct)
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President, OIE Working Group on Wildlife

Co-chair, IUCN Species Survival Commission - Wildlife Health Specialist Group

EPT Liaison - USAID Emerging Pandemic Threats - PREDICT 2 program

EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

On Jan 31, 2017, at 12:41 PM, Jonna Mazet <jkmazet@ucdavis.edu> wrote:

Thanks, Billy,
Just checking is this an FYI for P-2 or are they asking for Benard's or our team's input?
Just let us know,
J

On Tue, Jan 31, 2017 at 9:34 AM, William B. Karesh <karesh@ecohealthalliance.org<mailto:karesh@ecohealthalliance.org>> wrote:
FYI, please share with Lisa Kramer, her email isn't pooping up on my phone.

Sent from my iPhone

William B. Karesh, D.V.M
Executive Vice President for Health and Policy

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President, OIE Working Group on Wildlife

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EPT Liaison - USAID Emerging Pandemic Threats - PREDICT 2 program

EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

Begin forwarded message:

From: "Kreindel, Silvia (AGAH)" <[redacted]>
Subject: FAO Rapid Risk Assessment H5N8 HPAI Uganda

Dear colleagues,

Within the FAO mandate, we are monitoring this year detection of H5N8 HPAI in Uganda. We are conducting a rapid risk assessment (RRA) in order to answer the following risk questions: (1) What is the likelihood of H5N8 spread from Uganda to another countries in the regions, (2) What is the likelihood of further spread of the virus within Uganda?, and (3) What will be the consequences of the spread of H5N8 in the Uganda's commercial and backyard poultry production system within the next 6 months?

Attached you find a draft document (work in progress) describing the available information and the reporting the of the risk questions we would like to submit for your evaluation. We are kindly asking for your availability on answering to our risk questions (excel file). Considering the urgency of the matter we are asking you to provide your answers by sending back the completed excel file by Thursday February 2. The time required for answering to our risk questions would not be more than 10 minutes.

Your comments and participation will be acknowledged in the final RRA report.

I apologize for the urgency. Sincerely we hope you could participate in this risk assessment exercise, providing your valuable expertise and contribution.

Please do not hesitate to contact us for any question or doubt.

Best regards,

Claudia Pittiglio, Paolo Calistri, and Silvia Kreindel

Dr Silvia Kreindel
Epidemiologist / Risk Analyst
US/UN Mission - USDA
Animal Health Division
REDACTED
Office Phone: + REDACTED
Cell: + REDACTED

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<H5N8 Uganda RRA.xlsx>

<RA- H5N8 Draft 1Uganda_Jan 31.docx>

From:	Amanda Fuchs <fuchs@ecohealthalliance.org>
To:	apereira@usaid.gov <apereira@usaid.gov>;aclements@usaid.gov <aclements@usaid.gov>;predict@ucdavis.edu <predict@ucdavis.edu>;William B. Karesh <karesh@ecohealthalliance.org>
Sent:	2/3/2017 12:54:49 PM
Subject:	[predict] Semi-Annual Meeting and Data Sharing Meeting

Good afternoon,

Billy and I spoke about scheduling the next Semi-Annual meeting as well as Data Sharing meeting for the last week in August or beginning of September. We are proposing to have both meetings over the course of one week. Please advise if there are preferred dates. Thank you and hope you have a great weekend!

Best,

Amanda Fuchs, LMSW

Administrative Assistant to the Executive Vice President for Health &Policy

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www.ecohealthalliance.org

Communications Coordinator, Future Earth oneHEALTH Project

EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

From: Elizabeth Leasure <ealeasure@ucdavis.edu>
To: Ryland Marbray <rmarbray@usaid.gov>
Cc: Andrew <aclements@usaid.gov>, Alisa Pereira <apereira@usaid.gov>, "Jonna Mazet" <jkmazet@ucdavis.edu>, David John Wolking <djwolking@ucdavis.edu>, Shana Gillette <sgillette@usaid.gov>
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)
Sent: Mon, 13 Feb 2017 17:51:48 +0000

Thank you!

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Ryland Marbray [mailto:rmarbray@usaid.gov]
Sent: Monday, February 13, 2017 9:51 AM
To: Elizabeth Leasure
Cc: Andrew; Alisa Pereira; Jonna Mazet; David John Wolking; Shana Gillette
Subject: Re: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi Elizabeth,

This action is on the top of my list and I hope to provide a response this week.

Best,

Ryland

On Mon, Feb 13, 2017 at 12:44 PM, Elizabeth Leasure <ealeasure@ucdavis.edu> wrote:
Hi everyone. Just wanted to follow up on the status of this request.

Thanks,
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Elizabeth Leasure
Sent: Tuesday, January 31, 2017 10:03 AM
To: Andrew; 'Ryland Marbray'
Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'Shana Gillette'
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi everyone. I just wanted to follow up on the status of this request. Any information you can provide would be most appreciated.

Thanks,
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Elizabeth Leasure
Sent: Wednesday, November 23, 2016 10:18 AM
To: 'August Pabst'; 'Deborah Adeola'
Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'aclements@usaid.gov'
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi Deborah. Just following up on this request, as well. This one was only submitted on 11/10 (so I'm not trying to rush you), but with the holiday and your upcoming vacation usage in December, I want to make sure this is on your radar and on course for the requested 12/15 start date.

Thanks!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Elizabeth Leasure
Sent: Thursday, November 10, 2016 10:49 AM
To: August Pabst; Deborah Adeola
Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'aclements@usaid.gov'
Subject: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi August and Deborah. Please find attached a request for a new subaward from the Center for Molecular Dynamics Nepal to Patan Academy of Health Sciences (PAHS) to facilitate PREDICT-2 activities in Nepal, which includes a subaward request letter, sole source memo, Excel budget, AOR checklist, and draft subaward document. **The requested POP start date is December 15, 2016**. PAHS is a foreign government parastatal.

Subaward ceiling: The ceiling of the initial subaward attached currently reflects the allocation of year 1 funding only ($11,286) and not the full 3-year estimated/requested ceiling ($41,972) for a number of reasons. Our current projected budget figures for future fiscal years (FY18, FY19) are estimates calculated using a 5% escalation factor as noted in the budget justification included in the subaward request letter. While these amounts are solid estimates based on the best information we have to date, the actual amounts to be allocated for PAHS each year are subject to AOR approval of annual project budgets and could potentially change based on the needs and shifting priorities of USAID. For this reason, we will allocate one year of funding at a time (meaning we will raise the subaward ceiling annually) once the annual project budget for that fiscal year is approved. Establishing the initial subaward with the full projected ceiling amount sets the expectation that the full amount will be funded, which could potentially sour relationships in-country and negatively impact implementation of activities if that full amount is not actually allocated. Furthermore, UC Davis generally does not establish subawards for more than one year at a time based on our internal policies and procedures. As such, the performance period for the Center for Molecular Dynamics Nepal's subaward currently only extends through 9/30/17. Because of this, they cannot issue a subaward to PAHS with an end date beyond 9/30/17.

Please let me know if you have any questions or need anything else.

Thanks!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

--

Ryland Marbray

Agreements/Contracting Officer

USAID Office of Acquisition & Assistance
M/OAA/E3
1300 Pennsylvania Ave., NW,
Rm. 567-B, SA-44
Washington, DC 20523

Phone: (202) 567-5328|rmarbray@usaid.gov

From: Elizabeth Leasure <ealeasure@ucdavis.edu>
To: Ryland Marbray <rmarbray@usaid.gov>
Cc: Andrew <aclements@usaid.gov>, Alisa Pereira <apereira@usaid.gov>, "Jonna Mazet" <jkmazet@ucdavis.edu>, David John Wolking <djwolking@ucdavis.edu>, Shana Gillette <sgillette@usaid.gov>
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)
Sent: Tue, 21 Feb 2017 17:54:05 +0000

Hi Ryland. I hope you enjoyed the long weekend. I just wanted to follow up regarding the status of this request. Any updates you can provide would be most appreciated.

Thank you!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
5 REDACTED 3 (cell)

From: Ryland Marbray [mailto:rmarbray@usaid.gov]
Sent: Monday, February 13, 2017 9:51 AM
To: Elizabeth Leasure
Cc: Andrew; Alisa Pereira; Jonna Mazet; David John Wolking; Shana Gillette
Subject: Re: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi Elizabeth,

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Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'aclements@usaid.gov'
Subject: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi August and Deborah. Please find attached a request for a new subaward from the Center for Molecular Dynamics Nepal to Patan Academy of Health Sciences (PAHS) to facilitate PREDICT-2 activities in Nepal, which includes a subaward request letter, sole source memo, Excel budget, AOR checklist, and draft subaward document. **The requested POP start date is December 15, 2016**. PAHS is a foreign government parastatal.

Subaward ceiling: The ceiling of the initial subaward attached currently reflects the allocation of year 1 funding only ($11,286) and not the full 3-year estimated/requested ceiling ($41,972) for a number of reasons. Our current projected budget figures for future fiscal years (FY18, FY19) are estimates calculated using a 5% escalation factor as noted in the budget justification included in the subaward request letter. While these amounts are solid estimates based on the best information we have to date, the actual amounts to be allocated for PAHS each year are subject to AOR approval of annual project budgets and could potentially change based on the needs and shifting priorities of USAID. For this reason, we will allocate one year of funding at a time (meaning we will raise the subaward ceiling annually) once the annual project budget for that fiscal year is approved. Establishing the initial subaward with the full projected ceiling amount sets the expectation that the full amount will be funded, which could potentially sour relationships in-country and negatively impact implementation of activities if that full amount is not actually allocated. Furthermore, UC Davis generally does not establish subawards for more than one year at a time based on our internal policies and procedures. As such, the performance period for the Center for Molecular Dynamics Nepal's subaward currently only extends through 9/30/17. Because of this, they cannot issue a subaward to PAHS with an end date beyond 9/30/17.

Please let me know if you have any questions or need anything else.

Thanks!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

--

Ryland Marbray
Agreements/Contracting Officer

USAID Office of Acquisition & Assistance
M/OAA/E3
1300 Pennsylvania Ave., NW,
Rm. 567-B, SA-44
Washington, DC 20523

Phone: (202) 567-5328|rmarbray@usaid.gov

From: Dennis Carroll <dcarroll@usaid.gov>
Sent: Wed, 22 Feb 2017 11:28:46 -0500
Subject: Re: FW: "The Future of Food and Agriculture: Trends and Challenges" Report
To: "Morzaria, Subhash (TCE)" [REDACTED]
Cc: "Lindsay Meade/PRP/Projects/DAI" <Lindsay_Meade@dai.com>, Lisa Kramer <lkramer@usaid.gov>, Carlos Zambrana-Torrelio <zambrana@ecohealthalliance.org>, "Moreland, Scott" <Scott.Moreland@thepalladiumgroup.com>, Andrew Clements <aclements@usaid.gov>, Peter Daszak <daszak@ecohealthalliance.org>, "William B. Karesh" <karesh@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>

Thanks Subhash. Curiously silent on the impact on zoonosis and AMR. we need to better cross-walk within FAO

d

On Wed, Feb 22, 2017 at 10:35 AM, Morzaria, Subhash (TCE) <[REDACTED] wrote:

Dear All,

FAO just launched a report titled "The future of food and agriculture: Trends and challenges". The report sheds some light on the nature of the challenges that agriculture and food systems are facing now and throughout the 21st century, and provides some insights as to what is at stake and what needs to be done. What emerges is that "business as usual" is no longer an option but calls for major transformations in agricultural systems, in rural economies and in how we manage our natural resources.

- PR associated: http://www.fao.org/news/story/en/item/471169/icode/
- Infographic: http://www.fao.org/3/a-i6887e.pdf
- Full report: http://www.fao.org/3/a-i6583e.pdf
- Summary: http://www.fao.org/3/a-i6881e.pdf
- Key findings: http://www.fao.org/3/a-i6644e.pdf

Best regards,

Subhash

--
Dr. Dennis Carroll
Director, Emerging Threats Program
Bureau for Global Health
U.S. Agency for International Development

Office: 202-712-5009
Mobile: [REDACTED]

From: Elizabeth Leasure <ealeasure@ucdavis.edu>
To: Ryland Marbray <rmarbray@usaid.gov>
Cc: Andrew <aclements@usaid.gov>, Alisa Pereira <apereira@usaid.gov>, "Jonna Mazet" <jkmazet@ucdavis.edu>, David John Wolking <djwolking@ucdavis.edu>, Shana Gillette <sgillette@usaid.gov>
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)
Sent: Wed, 22 Feb 2017 16:51:23 +0000

Hi Ryland. Thanks very much. I look forward to hearing from you later this week.

Cheers,
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Ryland Marbray [mailto:rmarbray@usaid.gov]
Sent: Wednesday, February 22, 2017 6:29 AM
To: Elizabeth Leasure
Cc: Andrew; Alisa Pereira; Jonna Mazet; David John Wolking; Shana Gillette
Subject: Re: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Good Morning Elizabeth,

I will be working on your request this week and will provide a response by Thursday.

Best,

Ryland

On Tue, Feb 21, 2017 at 12:54 PM, Elizabeth Leasure <ealeasure@ucdavis.edu> wrote:
Hi Ryland. I hope you enjoyed the long weekend. I just wanted to follow up regarding the status of this request. Any updates you can provide would be most appreciated.

Thank you!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Ryland Marbray [mailto:rmarbray@usaid.gov]
Sent: Monday, February 13, 2017 9:51 AM
To: Elizabeth Leasure
Cc: Andrew; Alisa Pereira; Jonna Mazet; David John Wolking; Shana Gillette
Subject: Re: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi Elizabeth,

This action is on the top of my list and I hope to provide a response this week.

Best,

Ryland

On Mon, Feb 13, 2017 at 12:44 PM, Elizabeth Leasure <ealeasure@ucdavis.edu> wrote:

Hi everyone. Just wanted to follow up on the status of this request.

Thanks,
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Elizabeth Leasure
Sent: Tuesday, January 31, 2017 10:03 AM
To: Andrew; 'Ryland Marbray'
Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'Shana Gillette'
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi everyone. I just wanted to follow up on the status of this request. Any information you can provide would be most appreciated.

Thanks,
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Elizabeth Leasure
Sent: Wednesday, November 23, 2016 10:18 AM
To: 'August Pabst'; 'Deborah Adeola'
Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'aclements@usaid.gov'
Subject: RE: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi Deborah. Just following up on this request, as well. This one was only submitted on 11/10 (so I'm not trying to rush you), but with the holiday and your upcoming vacation usage in December, I want to make sure this is on your radar and on course for the requested 12/15 start date.

Thanks!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

From: Elizabeth Leasure
Sent: Thursday, November 10, 2016 10:49 AM
To: August Pabst; Deborah Adeola
Cc: 'Alisa Pereira'; Jonna Mazet; David John Wolking; 'aclements@usaid.gov'
Subject: New PREDICT-2 subaward request for Patan Academy of Health Sciences (Nepal, POP start 12/15/16)

Hi August and Deborah. Please find attached a request for a new subaward from the Center for Molecular Dynamics Nepal to Patan Academy of Health Sciences (PAHS) to facilitate PREDICT-2 activities in Nepal, which includes a subaward request letter, sole source memo, Excel budget, AOR checklist, and draft subaward document. **The requested POP start date is December 15, 2016**. PAHS is a foreign government parastatal.

Subaward ceiling: The ceiling of the initial subaward attached currently reflects the allocation of year 1 funding only ($11,286) and not the full 3-year estimated/requested ceiling ($41,972) for a number of reasons. Our current projected budget figures for future fiscal years (FY18, FY19) are estimates calculated using a 5% escalation factor as noted in the budget justification included in the subaward request letter. While these amounts are solid estimates based on the best information we have to date, the actual amounts to be allocated for PAHS each year are subject to AOR approval of annual project budgets and could potentially change based on the needs and shifting priorities of USAID. For this reason, we will allocate one year of funding at a time (meaning we will raise the subaward ceiling annually) once the annual project budget for that fiscal year is approved. Establishing the initial subaward with the full projected ceiling amount sets the expectation that the full amount will be funded, which could potentially sour relationships in-country and negatively impact implementation of activities if that full amount is not actually allocated. Furthermore, UC Davis generally does not establish subawards for more than one year at a time based on our internal policies and procedures. As such, the performance period for the Center for Molecular Dynamics Nepal's subaward currently only extends through 9/30/17. Because of this, they cannot issue a subaward to PAHS with an end date beyond 9/30/17.

Please let me know if you have any questions or need anything else.

Thanks!
Liz

Elizabeth Leasure
One Health Institute
University of California, Davis
530-754-9034 (office)
REDACTED (cell)

--

Ryland Marbray
Agreements/Contracting Officer

USAID Office of Acquisition & Assistance
M/OAA/E3
1300 Pennsylvania Ave., NW,
Rm. 567-B, SA-44
Washington, DC 20523

Phone: (202) 567-5328|rmarbray@usaid.gov

--

Ryland Marbray
Agreements/Contracting Officer

USAID Office of Acquisition & Assistance
M/OAA/E3
1300 Pennsylvania Ave., NW,
Rm. 567-B, SA-44
Washington, DC 20523

Phone: (202) 567-5328|rmarbray@usaid.gov

From: Andrew Clements <aclements@usaid.gov>
Sent: Thu, 9 Mar 2017 13:19:50 +0100
Subject: SL results -- follow up
To: Jonna Mazet <jkmazet@ucdavis.edu>, David J Wolking <REDACTED> Tracey Goldstein <tgoldstein@ucdavis.edu>
Cc: Alisa Pereira <apereira@usaid.gov>, sgillette@usaid.gov

Just heard from the mission. Embassy and USAID senior leadership are supportive of ensuring that the Ministries are in the lead in informing the President of the findings. The mission believes that the meeting with the Minister of Health and the President may happen as soon as today.

Andrew P. Clements, Ph.D.
Senior Scientific Adviser
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

From:	Elizabeth S Chase <eschase@ucdavis.edu>
To:	(dcarroll@usaid.gov) <dcarroll@usaid.gov>;Jonna Mazet <jkmazet@ucdavis.edu>; (nwolfe@metabiota.com) <nwolfe@metabiota.com>;(erubin@metabiota.com) <erubin@metabiota.com>;daszak (daszak@ecohealthalliance.org) <daszak@ecohealthalliance.org>;Cara Chrisman <cchrisman@usaid.gov>; (watson@ecohealthalliance.org)" <watson@ecohealthalliance.org>
CC:	Cassandra Louis Duthil (clouisduthil@usaid.gov)" <clouisduthil@usaid.gov>;Rebecca Benmahdi <rbenmahdi@metabiota.com>;Elnicki Taylor (telnicki@metabiota.com) <telnicki@metabiota.com>;(andre@ecohealthalliance.org) <andre@ecohealthalliance.org>
Sent:	3/9/2017 3:57:02 PM
Subject:	RE: GVP Call Notes and Action Items_March 9

Resending with attachment. Please let me know if it is not attached.
Best, Liz

From: Elizabeth S Chase
Sent: Thursday, March 09, 2017 2:17 PM
To: (dcarroll@usaid.gov) ; Jonna Mazet (jkmazet@ucdavis.edu) ; (nwolfe@metabiota.com) ; (erubin@metabiota.com) ; daszak (daszak@ecohealthalliance.org) ; Cara Chrisman ; (watson@ecohealthalliance.org)
Cc: Cassandra Louis Duthil (clouisduthil@usaid.gov) ; Rebecca Benmahdi ; Elnicki Taylor (telnicki@metabiota.com) ; (andre@ecohealthalliance.org)
Subject: GVP Call Notes and Action Items_March 9

Hello Everyone,
Attached are notes from the GVP call March 9.
Additionally, remaining actions items from the March 2 call and new action items from today's call, March 9, are included in this email to make it easier to find them. Thank you Cara for making this recommendation.
Cheers,
Liz

3/9 Actions

- Peter & Nathan - Connect lawyers/non-profit advisors with Dennis (further discussions in SF and NYC)
- Peter/Brooke - Work with rest of EHA team to set up a post-May 1st webinar on modelling and possibly other S&T topics.
- Liz - Cancel March 13th mtg and find alternate date for Thematic co-lead call
- Nathan - Get in touch with Richard Wilcox and update
- Eddy - Set up meetings with Michael McCullough, Google Genomics, Steve Quake (Stanford BioHub), and possibly Lucy Paige/Page and Epic philanthropy arm.
- Dennis - Set up mtg with Larry Brilliant, send UCSF announcement to Eddy
- Peter - Update paper and share with other authors
- Dennis - Reach out to Ceci to encourage GVP as topic for Forum on MTs

Remaining 3/2 Actions

- Cara/Brooke to distribute Exec Summary
- All - Other key individuals to engage with the core group (Keiji, Steve, Kathleen, etc.) on particular topics
- Peter - Send modeling timeline to core group
- Dennis - Reach out to Richard Hatchett (CEPI)

Liz Chase
Executive Assistant to Dr. Jonna Mazet
One Health Institute
University of California, Davis

530-752-3630
eschase@ucdavis.edu

GVP Call March 9, 2017

Agenda

- GVP Non-profit
- Post-May 1st Webinar
- Thematic Leads Call
- SF/Seattle Trip
- Outreach - NAS, Paul Allen, Eddy presentations
- AOB

Notes

GVP as Non-profit:

- Dennis reports clear signals coming out of Washington that foreign assistance will be reduced by as much as 25 to 35 percent. It is clear that support for GVP may no longer be available. Dennis suggested the need to accelerate the process of GVP becoming an independent entity and explore establishing GVP as a nonprofit. What might this mean and what steps would be needed to bring to fruition.
- Peter outlined steps - get lawyer, apply, create board, president, treasure secretary, develop mission, fairly straight forward process. Timeframe can be quite fast. Need a good attorney.
    - Nathan suggested Pam Luca as good resource, as well as Non-Profit Suite for finances, etc.
    - Peter will talk to his governance lawyers and put them in touch with Dennis to get advice from them. Possibly set up a discussion during the March 22 modeling visit.

Post-May 1st Webinar out of EcoHealth for Modeling

- Dennis would like to record webinar and have it available for later viewing.
- Eco Health can run webinar and record and make available later playback
    - Need to set date/send doodle to find best date, likely first week of May

Modeling:

- Coming along well, some of this ready by March 22 visit and most ready by May 1st
- Looking at economic analysis re: optimum cost to generate the largest return

- Dennis thinking the percentage of virome is not the only goal, it is virome/risk. Such as 50% of virome but 75% of risk, Emergence Weighted Virome, may be the way we want to argue.

Thematic Lead Calls:

- Discussed having regular interactions with the thematic leads running up to the May 1 deadline with the goal as having a coordination mechanism between the Working Groups. So Working Group Leads should be in contact with Thematic Leads. Concern shared about forward movement on Working Groups.
- First Thematic Leads call scheduled for March 13, Peter not able to attend, will be traveling to Davis (neither is George). Since not everyone is available, reschedule call for end of March/April 1
- Should have at least on co-lead from each Thematic Area to make call productive.
- Delay meeting for a week or two so that Thematic leads can contact Working Group leads to ascertain progress.
    - Liz will reschedule

SF/Seattle Trip:

- Dennis will be in Seattle Thursday & meet with Richard Ragan. Nathan is in touch with Richard Wilcox
- Dennis speaking with Chris Elias from Gates Foundation, March 10.
- Dennis will also be in SF Thursday by 1:00 pm and can be available to stay in SF for outreach meetings on Monday if necessary
- Possible for SF visit
    - Michael McCullough possibly while Dennis is in SF - Eddy
    - David Glazer from Google Genomics - Eddy
    - Larry Brilliant - Dennis will contact Larry
    - Nathan mentioned Steve Quake who is at Stanford BioHub - Eddy
    - Eddy will also inquire about Lucy Page
        - Also CC Head of Merck Research Labs

Outreach

- NAS - Dennis reports a nice meeting with Victor Dzau at NAS and Julie Pavlin, Head of Board on Global Health. NAS may be an entry into larger scientific arena and GVP may present to Secretariat. Victor Dzau very interested in GVP.
- Also reached out to Oyewale Tomori for Nigerian Academy of Sciences

- One idea is to build on the interactions with the China Academy of Sciences and look to the international consortium of Academies of Sciences as a route to reach other countries.

AOB

- Peter discussed FMT and GVP presentation and FMT meeting
    - Dennis reach out to CeCi Mundaca-Shah-to request GVP for the December 2017 meeting
- Eddy submitted an abstract to Cold Spring but may not be able to present. Has abstract and slides for the audience if anyone from group wants to present but may have a personal conflict during the May 9-12 timeframe.
- Eddy presented to Genome Canada in Ottawa and plans to go back
- Dennis has meeting set with the Ambassador from Costa Rica March 24 and the Welcome Trust on March 23. Peter to join for that.
- Peter says reviewer's comments on the GVP paper have been addressed and he will send it around for review within a week.

From: Cassandra Louis Duthil <clouisduthil@usaid.gov>
Sent: Mon, 20 Mar 2017 16:44:12 -0400
Subject: Re: FW: CUGH Registration question
To: Elizabeth S Chase <eschase@ucdavis.edu>
Cc: "(dcarroll@usaid.gov)" <dcarroll@usaid.gov>, Jonna Mazet <jkmazet@ucdavis.edu>

Hello Liz,

Is there anything additional that needs to be done or is Dennis all set now?

Best,

Cassandra Louis Duthil
Program Assistant
Emerging Threats Division
U.S. Agency for International Development (USAID)
Telephone: 202-712-5583 Cell: REDACTED **clouisduthil@usaid.gov**

On Tue, Mar 14, 2017 at 3:55 PM, Cassandra Louis Duthil <clouisduthil@usaid.gov> wrote:

Hello Liz,

Please see the answers to your questions below:

Job Address - 1300 Pennsylvania Ave, NW, 3rd Floor, RRB

Washington, DC 20004

Work Phone - 202-712-5009

Best,

Cassandra Louis Duthil
Program Assistant
Emerging Threats Division
U.S. Agency for International Development (USAID)
Telephone: 202-712-5583 Cell: REDACTED **clouisduthil@usaid.gov**

On Fri, Mar 10, 2017 at 3:09 PM, Elizabeth S Chase <eschase@ucdavis.edu> wrote:

Hello Dennis,

We have worked out an arrangement with CUGH for your registration. Will you confirm/complete the following information and I will send it to them.

Best, Liz Chase

Email address-dcarroll@usaid.gov

First name-Dennis

Last name-Carroll

Job Title-Director, Global Health Security and Development Unit, USAID, USA

Job Address ??

Work Phone ??

From: CUGH [mailto:dsteinbach@cugh.org]
Sent: Friday, March 10, 2017 12:00 PM
To: Elizabeth S Chase <eschase@ucdavis.edu>
Cc: Jonna Mazet <jkmazet@ucdavis.edu>
Subject: Re: CUGH Registration question

Hi Liz,

Yes, I can do this. Please send me the complete information for Dennis Carroll (email, work address, job position) and I will make the change.

best,

Doris

On 10 Mar 2017, at 09:37, Elizabeth S Chase <eschase@ucdavis.edu> wrote:

Hello Doris,

I trust this finds you well. I am hoping you can assist with a CUGH registration issue. Dr. Jonna Mazet, who is a panel moderator, The Global Virome Project: A First Step Toward Ending the Pandemic Era (CS34), a panel guest (CS24) and a CUGH award recipient, registered for the CUGH conference before we knew any of these activities would be happening. (Reference number 20152540) We registered on October 21, 2016 and paid a $500.00 Registration Fee associated with High Income Countries.

Later, as an award recipient, she was offered a complimentary registration and she was registered again, not realizing the 1st registration had occurred. (2nd reference number 22133845) Currently there are two registrations associated with Dr. Mazet.

Subsequently we have learned that funding for a GVP panelist (CUGH panel CS34), Dr. Dennis Carroll, will not be approved. Dr. Carroll's participation on the Global Virome Project panel is integral and we are hoping that the original registration fee, associated with Dr. Mazet's first registration number, might be transferred to cover the registration for Dr. Dennis Carroll.

Please advise on how best to include Dr. Carroll and to remedy the dual registration for Dr. Mazet.

Very Sincerely Yours,

Liz Chase

Liz Chase

Executive Assistant to Dr. Jonna Mazet

One Health Institute

University of California, Davis

530-752-3630

eschase@ucdavis.edu

From: "William B. Karesh" <karesh@ecohealthalliance.org>
To: Tracey Goldstein <tgoldstein@ucdavis.edu>
Cc: "sja2127@cumc.columbia.edu" <sja2127@cumc.columbia.edu>, Chris Johnson <ckjohnson@ucdavis.edu>, Denise J Greig [redacted], "Wells, Heather L." <hlw2124@cumc.columbia.edu>, "Dr. Damien Joly" <djoly@metabiota.com>, Nathan Wolfe <nwolfe@metabiota.com>, Peter Daszak <daszak@ecohealthalliance.org>, Ian Lipkin <wil2001@columbia.edu>, "Dr. Steve Morse" <ssm20@columbia.edu>, Jonna Mazet <jkmazet@ucdavis.edu>, "xc2273@columbia.edu" <xc2273@columbia.edu>, [redacted], "sck2165@cumc.columbia.edu" <sck2165@cumc.columbia.edu>
Subject: Re: Abstract for WDA
Sent: Wed, 22 Mar 2017 18:32:59 +0000

Very nice !!
BK

William B. Karesh, D.V.M
Executive Vice President for Health and Policy

EcoHealth Alliance
460 West 34th Street - 17th Floor
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www.ecohealthalliance.org

President, OIE Working Group on Wildlife

Co-chair, IUCN Species Survival Commission - Wildlife Health Specialist Group

EPT Partners Liaison, USAID Emerging Pandemic Threats - PREDICT-2 Program

EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

On Mar 20, 2017, at 5:27 PM, Tracey Goldstein <tgoldstein@ucdavis.edu> wrote:

Dear All,

We were hoping to submit the abstract from our global coronavirus paper to present at the Wildlife Disease Association meeting this summer - please see the abstract below. As you are all co-authors on the paper I wanted to make sure you were happy for me to represent us on this work at the meeting - abstract is due April 1.

Please let me know if you questions, additions or concerns.

Best, Tracey

Global patterns in coronavirus diversity

Abstract:

Since the emergence of SARS-CoV and MERS-CoV it has become increasingly clear that bats are important reservoirs of CoVs. Despite this, only 16% of all CoV sequences in Genbank are from bats. The remaining 84% constitute sequences of known pathogens of public health or agricultural significance, indicating that current research effort is heavily biased towards describing known diseases rather than the 'pre-emergent' diversity in bats. Our study addresses this critical gap, and focuses on resource poor countries where the risk of zoonotic emergence is believed to be highest. We surveyed the diversity of CoVs in multiple host taxa from 20 countries to explore the factors driving viral diversity at a global scale. We identified sequences representing 100 discrete phylogenetic clusters, 91 of which were found in bats, and used ecological and epidemiologic analyses to show that patterns of CoV diversity correlate with those of bat diversity. This cements bats as the major evolutionary reservoirs and ecological drivers of CoV diversity. Co-phylogenetic reconciliation analysis was also used to show that host switching has contributed to CoV evolution, and a preliminary analysis suggests that regional variation exists in the dynamics of this process. Overall our study represents a model for exploring global viral diversity and advances our fundamental understanding of CoV biodiversity and the potential risk factors associated with zoonotic emergence.

--

Tracey Goldstein, PhD
One Health Institute
School of Veterinary Medicine
University of California
Davis, CA 95616
Phone: (530) 752-0412
Fax: (530) 752-3318
E-mail: tgoldstein@ucdavis.edu

From: Andrew Clements <aclements@usaid.gov>
Sent: Mon, 27 Mar 2017 15:42:01 +0200
Subject: MERS paper from Egypt (FAO and PREDICT)
To: ghsdunitmaillistusaid@usaid.gov, Akmal Elerian <aelerian@usaid.gov>, malkhateeb@usaid.gov, nkaufman@usaid.gov, Amy Kay <akay@usaid.gov>, "Daniel Schar (RDMA/OPH)" <dSchar@usaid.gov>, "Sudarat Damrongwatanapokin (RDMA/OPH)" <sDamrongwatanapokin@usaid.gov>, Christine Kreuder Johnson <ckjohnson@ucdavis.edu>, Jonna Mazet <jkmazet@ucdavis.edu>, William Karesh <Karesh@ecohealthalliance.org>, REDACTED Elizabeth Mumford <REDACTED>
Attachment
art22743.pdf

FYI

Andrew P. Clements, Ph.D.
Senior Scientific Adviser
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

Begin forwarded message:

From: "Makonnen, Yilma (FAOKE)" <REDACTED>
To: Dennis Carroll <dcarroll@usaid.gov>, Andrew Clements <aclements@usaid.gov>, Lisa Kramer <lkramer@usaid.gov>, Lindsay Parish <lparish@usaid.gov>
Subject: FW: art22743.pdf

Dear all
FYI
My best
Yilma

From: Makonnen, Yilma (FAOKE) REDACTED
Sent: 22 March 2017 19:41
To: Lubroth, Juan (AGAH) <REDACTED>; Dauphin, Gwenaelle (AGAH) <REDACTED>; Fasina, Folorunso (FAOKE) <REDACTED>; Mahrous, Heba (FAORNE) <REDACTED>; ElMasry, Ihab (FAOEGY) <REDACTED>; VonDobschuetz, Sophie (AGAH) <REDACTED>; Elsokary, Basma (FAORNE) <REDACTED>; Morzaria, Subhash (TCE) <REDACTED>
Cc: ECTAD-UG-List <REDACTED>; ECTAD-ETH-List <REDACTED>; ECTAD-KE-List <REDACTED> REDACTED>; TZ-ECTAD-List <REDACTED>
Subject: art22743.pdf

Dear all
Our 1st MERS-COV Publication is now available for international readership.
My best
Yilma

Sent from Samsung Mobile.

SURVEILLANCE AND OUTBREAK REPORT

Cross-sectional surveillance of Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels and other mammals in Egypt, August 2015 to January 2016

M Ali [1], R El-Shesheny [1], A Kandeil [1], M Shehata [1], B Elsokary [2], M Gomaa [1], N Hassan [2], A El Sayed [1], A El-Taweel [1], H Sobhy [3], FO Fasina [3,6], G Dauphin [5], I El Masry [3], AW Wolde [3], P Daszak [4], M Miller [4], S VonDobschuetz [5], E Gardner [5], S Morzaria [5], J Lubroth [5], YJ Makonnen [3]

1. National Research Center, Division of Environmental Research, Giza, Egypt
2. General Organizations of Veterinary Services, Ministry of Agriculture and Land reclamation (MoALR), Giza, Egypt
3. Food and Agriculture Organization of the United Nations, Emergency Center for Transboundary Animal Diseases (ECTAD), Egypt
4. EcoHealth Alliance, New York, New York, United States
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A cross-sectional study was conducted in Egypt to determine the prevalence of Middle East respiratory syndrome coronavirus (MERS-CoV) in imported and resident camels and bats, as well as to assess possible transmission of the virus to domestic ruminants and equines. A total of 1,031 sera, 1,078 nasal swabs, 13 rectal swabs, and 38 milk samples were collected from 1,078 camels in different types of sites. In addition, 145 domestic animals and 109 bats were sampled. Overall, of 1,031 serologically-tested camels, 871 (84.5%) had MERS-CoV neutralising antibodies. Seroprevalence was significantly higher in imported (614/692; 88.7%) than resident camels (257/339; 5.8%) ($p<0.05$). Camels from Sudan (543/594; 91.4%) had a higher seroprevalence than those from East Africa (71/98; 72.4%) ($p<0.05$). Sampling site and age were also associated with MERS-CoV seroprevalence ($p<0.05$). All tested samples from domestic animals and bats were negative for MERS-CoV antibodies except one sheep sample which showed a 1:640 titre. Of 1,078 camels, 41 (3.8%) were positive for MERS-CoV genetic material. Sequences obtained were not found to cluster with clade A or B MERS-CoV sequences and were genetically diverse. The presence of neutralising antibodies in one sheep apparently in contact with seropositive camels calls for further studies on domestic animals in contact with camels.

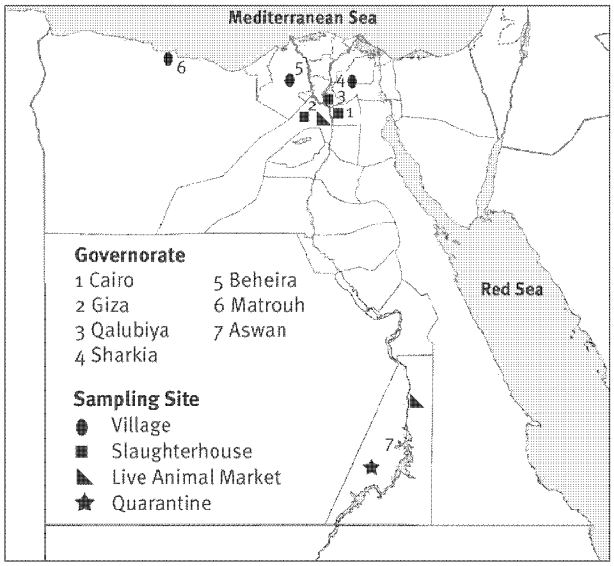
Introduction

Since the first human case of Middle East respiratory syndrome coronavirus (MERS-CoV) in Saudi Arabia, in 2012, the World Health Organization (WHO) was notified of 1,698 laboratory-confirmed human cases and at least 609 human deaths from 26 countries as of March 2016 [1]. Primary infections have originated from countries within the Arabian Peninsula, but travel-associated cases and some secondary and nosocomial transmissions have been reported in other countries. A recent study in 2016 found antibodies against MERS-CoV in human serum in Kenya [2]. Available data from serological and molecular studies suggest that the primary source of MERS-CoV infection for many in the Arabian Peninsula appears to be dromedary camels [3-5]. Bats are also incriminated in the origins of many known mammalian coronaviruses including severe acute respiratory syndrome (SARS) [6,7]. The close relationship of MERS-CoV genome sequences and sequences of bat coronaviruses suggests that bats may be a reservoir for MERS-CoV [8]. Moreover, bat cell lines display the MERS-CoV specific receptor, dipeptidyl peptidase 4 (DPP4), and can be infected under experimental conditions [9]. Previous epidemiological studies to investigate the presence of MERS-CoV in bats found a close relationship between characterised sequences generated from bat faecal samples, and previously characterised MERS-CoV sequences [10-12].

A retrospective serological study conducted on 189 archived dromedary camels sera originating from main camel-exporting countries, Sudan and Somalia, in the period from 1983 to 1997, showed the presence of MERS-CoV neutralising antibodies in 81% of total

FIGURE 1

Site map of the collected samples from dromedary camels and domestic animals in Egypt, August 2015–January 2016 (n =1,223 animals[a])



[a] In addition to 1,078 camels, a total of 145 domestic animals were sampled and included cattle (n=35), sheep (n=51), goats (n=36), donkeys (n=15), buffaloes (n = 4) and horses (n = 4).

samples suggesting long-term MERS-CoV circulation among camels [13]. Dromedaries from African countries (Egypt, Ethiopia, Kenya, Nigeria, Sudan, and Tunisia) and the Arabian Peninsula (Jordan, Oman, Qatar, Saudi Arabia, and United Arab Emirates) have high rates of MERS-CoV antibody seropositivity [14-20]. Dromedary camels are part of the culture of millions of people in Middle Eastern countries where camel milk and meat are consumed. Most dromedary camels traded in the Middle East are bred in East African countries, primarily in Ethiopia, Kenya, Somalia, and Sudan [21]. During the last 5 to 6 years (2010 to 2015), over 1.2 million camels were imported to Egypt, nearly 70% from Sudan and the rest from the African Horn, mainly Ethiopia [22].

Serological investigations carried out on camels in Egypt, revealed high levels of antibodies against MERS-CoV [17,23]. Furthermore, MERS-CoV was detected virologically in specimens collected from abattoirs in the country [23]. The objectives of this study were to determine the prevalence of MERS-CoV in imported and resident camels and investigate the prevalence of the virus among other domestic animals in Egypt.

Methods

Study animals and sampling strategy

A total of 1,176 sera and 1,223 nasal swabs, were collected from 1,223 animals including 1,078 dromedary camels (339 resident and 739 imported) and 145 other domestic animals (cattle, n=35; sheep, n=51; goats, n=36; donkeys, n=15; and buffalo and horses, n = 4 each) from different sampling sites (quarantine posts, live animal markets, slaughterhouses and villages) from seven governorates of Egypt (Figure 1) between August 2015 and January 2016.

Milk samples (3–5mL; n=38) and rectal swabs (in 1mL viral transport media; n=13) were also sampled from resident camels in a village located in the Matrouh governorate.

In addition, 109 throat swabs and 91 sera were collected from 24 fruit bats (*Rousettous aegyptiacus)* and 85 insectivorous bats (*Pipistrellus deserti*, n=28; *Nycteris thebaica*, n=30; *Taphozous perforates*, n=27) from Abo Rawash, Giza governorate, and included in the study.

A multistage sampling strategy involving a combination of simple stratified (for sex and age) and systematic sampling was employed to obtain samples from camels. Origin of camels was identified at the place of quarantine in Egypt, or from information obtained from the owners. Camels less than two years of age were considered young while those over two years-old were considered adult. Since the majority of the imported camels were adult male, purposive sampling was employed to include female adult camels particularly in the resident camels. Sampling procedures were approved by the Ethics Committee of the National Research Centre, Egypt.

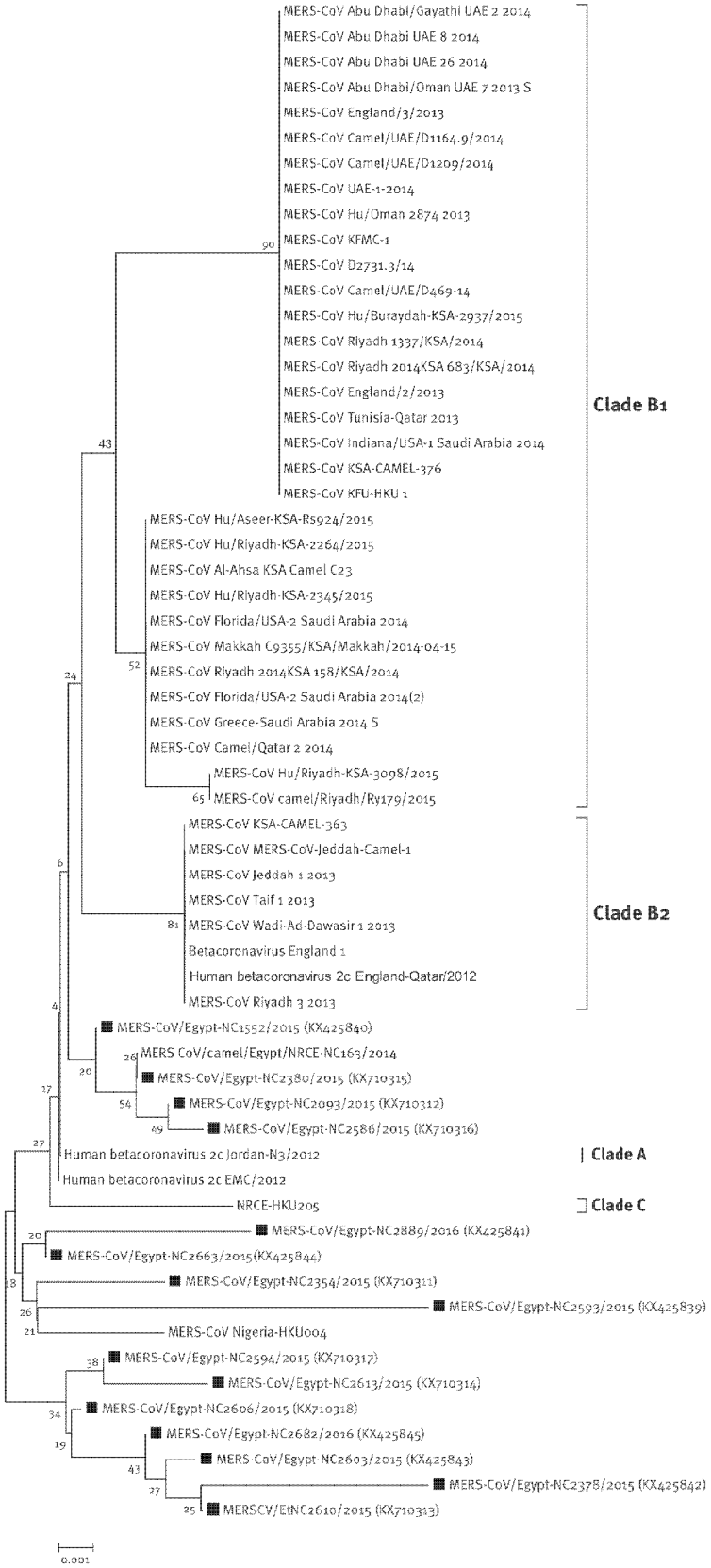
The nasal, throat, rectal swabs and milk were analysed using molecular virological techniques.

Serological testing

Serum microneutralisation assay was conducted as described [17], using Vero-E6 cell monolayers. Briefly, twofold serial dilutions of 200µL heat-inactivated sera (56 °C for 30 min) were made, starting with a dilution of 1:10. The serum dilutions were mixed with equal volumes of 200 tissue culture infectious dose (TCID50) of dromedary MERS-CoV Egypt NRCE-HKU270 (Egypt 270). After 1 hour of incubation at 37 °C, 35 µL of the virus–serum mixture were added in quadruplicate to Vero-E6 cell monolayers in 96-well microtitre plates. After 1 hour of adsorption, an additional 150 µL of culture medium were added to each well. The plates were then incubated for three more days at 37 °C in 5% CO2 in a humidified incubator. Virus back-titration was performed without immune serum to assess input virus dose. Cytopathic effect (CPE) was read at 3 days post infection. The highest serum dilution that completely protected the cells from CPE in half of the wells was taken as the neutralising antibody titre and was estimated using the Reed–Muench method. Positive cut off points was set at values greater or equal to 1:20 serum dilution points.

FIGURE 2

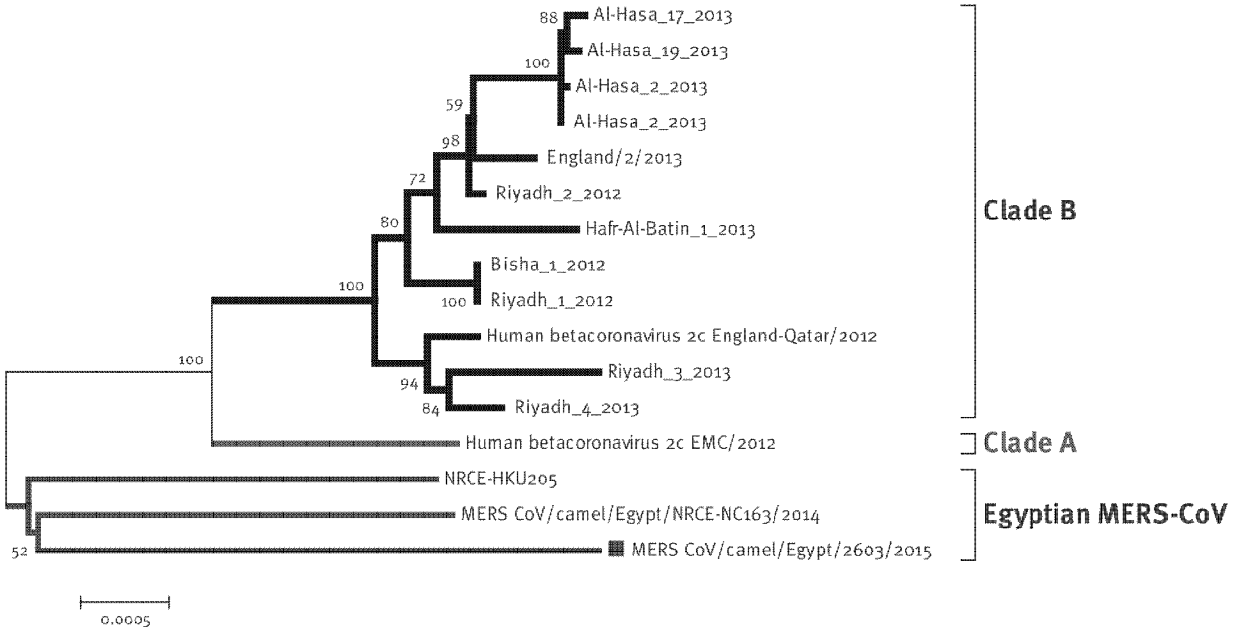
Phylogenic analysis of partial MERS-CoV spike sequences retrieved from dromedary camels residing in or imported to Egypt from Sudan between August 2015 and January 2016



Representative viruses from clades A, B and C are indicated and marked with vertical bar. Phylogenetic analysis was done using the neighbour-joining algorithm with the Kimura two-parameter model. The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The reliability of phylogenetic inference at each branch node was estimated by the bootstrap method with 1,000 replications; evolutionary analysis was conducted in MEGA 6.06. Viruses sequenced for this study are marked with red squares.

Figure 3

Phylogenic analysis of a full MERS-CoV genome sequence retrieved from an imported dromedary camel from Sudan between August 2015 and January 2016



Representative viruses from the two major MERS-CoVs clades (A and B) are indicated and marked with vertical bar. Phylogenetic analysis was done using the neighbour-joining algorithm with the Kimura two-parameter model. The reliability of phylogenetic inference at each branch node was estimated by the bootstrap method with 1,000 replications. The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. Evolutionary analysis was conducted in MEGA 6.06. The virus sequenced for this study is marked by a red square.

Real-time reverse transcription-PCR

Real-time reverse transcription-PCR (rtRT-PCR) targeting upstream of the envelope protein gene (UpE) of MERS-CoV was used for screening [24]. Confirmation was made using the open reading frame (ORF) 1a, RNA-dependent RNA polymerase (RdRp) or nucleocapsid protein (N) gene, based on the recommendation of World Health Organization for MERS-CoV diagnosis [25]. Briefly, 5 µL of extracted RNA was subjected to rtRT-PCR using UpE primers described elsewhere [24]. The rtRT-PCR was performed using a Verso One Step rtRT-PCR Kit according to the manufacturer's protocol. All positive samples by the UpE assay regardless of cycle threshold (Ct) value were then confirmed by one of ORF1a, RdRp, or N gene RT-PCR assay as described previously [24,26]. PCR products were analysed by sequencing using the protocol available on the web (on line Technical Appendix: http://wwwnc.cdc.gov/eid/article/20/6/14-0299-techapp1.pdf).

Reverse transcription-PCR for MERS-CoV genotyping

A partial 640 bp fragment of the spike gene was amplified using 50-Fwd (5'-CCAATTTA-CGCCAGGATGAT-3') and 50-Rev (5'-AATAGAGGCGG AAATAGCAC-3') primers in the first round using one step RT-PCR kit (QIAGEN) and a total reaction volume of 25 µL including 5 µL of 5X reaction buffer, 1 µL dNTPs, 1 µL enzyme mix, 1.5 µL (10 pmol) forward primer, 1.5 µL (10 pmol) reverse primer, 10 µL ddH2O and 5 µL of sample RNA. Subsequent to thirty min at 50 °C and 95 °C for 15 min, the RT-PCR also comprised 45 cycles of 94 °C for 15 s, 55 °C for 30 s and 72 °C for 60 s followed by a final step of 72 °C for 10 min. The PCR product was then submitted to a second PCR round using the same primers as in the first round and Phusion High Fidelity PCR Master Mix Kit (Thermo Scientific). The PCR had a 25 µL reaction volume, with 12.5 µL of 2 X phusion master mix, 1.5 µL (10 pmol) forward primer, 1.5 µL (10 pmol) reverse primer, 7.5 µL H2O and 2 µL of the first round PCR product. The PCR cycler conditions were 98 °C for 30 s then 45 cycles (98 °C for 10 s, 55 °C for 30 s, 72 °C for 60 s), then 72 °C for 10 min. The final PCR product was gel purified and subsequently sequenced with the same primers at the Macrogen sequencing facility (Macrogen, South Korea). One positive imported sample (NC2603/2015) from Sudan was subjected to whole genome sequencing according to a previously published procedure [27]. The phylogenetic tree was constructed using MEGA6 programme [28].

Data management and analysis

Data collected from the study animals were coded and entered in a Microsoft excel sheet. All statistical analyses were performed using SPSS version 16 for windows. The association between MERS-CoV prevalence in camels and the study variables (sampling site, origin, age

Table 1

MERS-CoV surveillance test results in camels based on origin, Egypt, August 2015–January 2016 (n = 1,078 camels[a])

Camel origin	Microneutralisation test						rtRT-PCR			
	Number tested	Number of camels positive	Per cent positive	CMLE OR[b] (95% CI)	P value (for OR)	P value (for hypothesis)	Number tested	Number of camels positive	Per cent positive	P value (for hypothesis)
East Africa	98	71	72.4%	0.84 (0.51–1.41)	0.50	p<0.001 x2=53.24	115	4	3.5%	p<0.001 x2=15.246
Sudan	594	543	91.4%	3.39 (2.24–4.98)	<0.0001		623	35	5.6%	
Egypt (resident)	339	257	75.8%	1.00	Ref.		340	2	0.6%	
Total	**1,031**	**871**	**84.5%**	**NA**	**NA**	**NA**	**1,078**	**41**	**NA**	**NA**

CI: confidence interval; CMLE: conditional maximum likelihood estimate; MERS-CoV: Middle East respiratory syndrome coronavirus; NA: not applicable; OR: odds ratio; ref.: reference; rtRT-PCR: real-time reverse transcription PCR.

[a] Of 1,078 camels, a subset of 1,031 underwent serum testing for MERS-CoV antibodies by microneutralisation assays, while all were sampled for rtRT-PCR testing.

[b] CMLE OR is the conditional maximum likelihood estimate of the odds ratio based on Mid-P exact confidence interval.

and sex) were analysed by Pearson chi-squared test of independence. Statistical significance was considered at p- value less than 0.05.

Results

Serological analysis

Of the 1,031 camels, which were serologically tested, 871 (84.5%) had MERS-CoV neutralising antibodies in their sera (Table 1).

The seroprevalence was significantly higher in imported (614/692; 88.7%) than in resident camels (75.8%; Table 1) ($p<0.05$). Based on the area of origin, seroprevalence varied significantly among camels originating from East Africa, Sudan, and Egypt and was 72.4%, 91.4%, and 75.8%, respectively ($p<0.05$). Camels sampled from live animal markets, quarantine facilities, slaughterhouses, and villages had seroprevalence of 94.5%, 95.7%, 77%, and 75% respectively and the differences was significant ($p<0.05$ Table 2). Overall, adult camels had significantly higher seroprevalence (87.3%) than young camels (51.8%) ($p<0.001$). A significantly higher seropositivity was observed for camels from the live animal markets (OR=5.52; $p<0.0001$) and quarantine facilities (OR=7.25; $p<0.0001$) as compared with those from villages and the slaughterhouses.

Both male and female camels had a comparable ($p>0.05$) level of seroprevalence (85.1% and 82.7% respectively), and risk of seropositivity (Table 2). Tested samples from 126 ruminants (cattle, sheep, goats, and buffaloes) and 19 equines (donkeys and horses) were negative for neutralising MERS-CoV antibodies but one serum sample from a sheep had 1:640 neutralising titre. None of the 91 tested bats was positive for MERS-CoV neutralising antibodies.

Virus genomic detection

Of the 1,078 nasal samples from camels, 41 (3.8%) were positive for MERS-CoV using MERS-CoV PCR tests indicating the presence of active or passive viral infection. Of the 41 positive camels, four originated from East Africa, 35 from Sudan and the other two from the study sites in Egypt (Table 1). The confirmed PCR-positive MERS-CoV cases was significantly higher in females than males ($p<0.001$). All the 38 milk samples and 13 rectal swabs were negative for MERS-CoV. Similarly, the 145 nasal swabs from domestic ruminants and equines were negative for MERS-CoV. Throat swabs collected from 109 bats were negative for MERS-CoV.

Sequence analysis

A phylogenetic tree was compiled based on partial spike nucleotide sequences obtained from 15 strongly positive samples. The sequences were derived from one camel residing in Egypt as well as from camels imported from Sudan, which had been sampled in a slaughterhouse (n = 9) and live animal markets (n = 5). The tree suggested that sequences from camels investigated in Egypt formed separate groups from previously published sequences of MERS-CoV (Figure 2). Moreover, a phylogenetic analysis of full genomes showed that sequences from camels sampled in Egypt were genetically diverse and clustered neither with clades A or B (Figure 3).

Discussion

The present study demonstrated that most of the camels that were imported to Egypt were seropositive for MERS-CoV (88.7%; 614/692) and virus genetic materials was detected in 5.3% (39/738) of the imported camels. The origins of the camels were Sudan and East Africa. Surprisingly, no human cases of MERS CoV infection has been recorded among camel traders from these countries. This may be due to the lack of diagnostic tools and experience for virus detection or

Table 2

MERS-CoV surveillance test result in camels based on sampling site, age and sex, Egypt, August 2015–January 2016 (n = 1,078 camels[a])

Category	Microneutralisation test						rRT-PCR			
	Number tested	Number positive	Per cent positive	CMLE OR[b] (95% CI)	P value (for odd ratio)	P value (for hypothesis)	Number tested	Number positive	Per cent positive	P value (for hypothesis)
Sampling site										
Live animal market	289	273	94.5%	5.52 (3.20–9.96)	<0.0001	p<0.001 x2=67.47	290	9	3.1%	p<0.001 x2=31.97
Village/Egypt	339	256	75.8%	1.00	Ref.		340	2	0.6%	
Quarantine	164	157	95.7%	7.25 (3.42–17.42)	<0.0001		164	4	2.4%	
Slaughterhouse	239	184	77%	1.09 (0.73–1.61)	0.69		284	26	9.2%	
Total	1,031	871	84.5%	NA	NA	NA	1,078	41	3.8%	NA
Age										
Young	81	42	51.8%	1.00	Ref.	p<0.001 x2=71.39	82	2	2.4%	p=0.77 x2=0.53
Adult	950	829	87.3%	6.34 (3.93–10.24)	<0.0001		996	39	3.9%	
Sex										
Male	765	651	85.1%	1.19 (0.82–1.73)	0.35	p=0.38 x2=0.86	798	21	2.6%	p<0.001 x2=13.07
Female	266	220	82.7%	1.00	Ref.		280	20	7.1%	

CI: confidence interval; CMLE: conditional maximum likelihood estimate; MERS-CoV: Middle East respiratory syndrome coronavirus; NA: not applicable; OR: odds ratio; ref.: reference; rtRT-PCR: real-time reverse transcription PCR.

[a] Of 1,078 camels, a subset of 1,031 underwent serum sampling for MERS-CoV antibodies by microneutralisation assays, while all were sampled for rtRT-PCR testing.

[b] CMLE OR: Conditional maximum likelihood estimate OR based on Mid-P exact confidence interval.

maybe due to the rarity of virus transmission from camels to humans.

Data from experimental camel infections suggest that MERS-CoV is a mild respiratory infection in camels [29] and although camels previously sampled at abattoirs shed the virus, they did not have overt clinical symptoms [23]. Egypt imports large numbers of live camels each year to meet its animal protein demand. According to the Ministry of Agriculture, almost 70% of the imported camels during the past five years originated from the Sudan and the rest from East Africa, mainly Ethiopia. These imported camels are quarantined usually for 2–3 days at the point of entry before they gain entry for sale at live animal markets. The animals often travel long distances by trucks and may be moved from one live animal market to another. Transport stress and close vicinity of camels during transport may precipitate disease dissemination, particularly in animals with latent infection and carrier animals, while transmission may be facilitated spatio-temporally in the different markets. The high MERS-CoV seroprevalence both in resident and imported camels and the presence of active viral infection circulating in the country were indications that the virus may have become ubiquitous in Egypt. Inter-market movement and transport stress may partially explain the higher seropositivity and molecular analysis results in samples obtained from the live animal markets, quarantine facilities, and the slaughterhouses.

Testing of archived dromedary sera has revealed that MERS-CoV has been circulating for at least three decades and is not a newly emerged virus, but rather a virus that has only recently been discovered [3,13,15]. Results of study in Egypt published in 2014 showed that 93.6% of camels originating from Sudan were seropositive for MERS-CoV, a finding is consistent with the present study where 91.4% of camels imported from that country were seropositive [23].

Analysis of the results based on age showed that adult camels had higher seroprevalence of MERS-CoV antibodies (87.3%) compared with young camels (51.8%) ($p<0.05$). The variation might be due to the small number of young camels tested or the higher likelihood of exposure of adult camels. In addition, young camels have been more acutely infected in past studies and may have died rather than seroconverted [18]. Similar studies elsewhere also indicated a higher seroprevalence in adult than in juvenile camels [30]. Although the number of seropositive samples was comparable in female and male camels, the number of confirmed PCR positive MERS-CoV animals was significantly higher in females than males ($p<0.05$). There was however no significant difference in rtRT-PCR positive cases between the age groups.

Nucleotide sequencing of the amplicons from 15 of 41 PCR-positive samples for MERS-CoV genetic material, followed by phylogenetic analysis showed that the sequences recovered in the current study in Egypt were distinct from those in clade A and B. This was also the case for previously identified MERS-CoV sequences derived from camels in Egypt (e.g. MERS CoV/camel/Egypt/NRCE-NC163/2014) [31] which were distinct from MERS-CoV EMC/2012 isolate [23].

All the 145 domestic animals (ruminants and equines) tested for MERS-CoV genetic materials were negative, in agreement with previous studies conducted in Jordan and Egypt [19]. Except one sheep, all domestic animals serologically tested were negative. Similarly, previous serological studies conducted on goats, sheep, and cows were all negative [19]. Also according to a prior report, 25 cows and eight buffalo from Egypt tested negative to MERS-CoV neutralising antibodies [17]. The seropositive sheep found in the current study was apparently in contact with seropositive camel herds in villages. This finding is significant and adds to the knowledge of host range of MERS-CoV. The DPP4 receptor for MERS-CoV has been found to be present in camel, goat, cow and sheep [32], and Reusken et al. [19] have earlier confirmed that six sheep reacted to MERS-CoV antigens but without neutralising antibodies [19]. Further and extensive studies on domestic animals especially in those in contact with camels are required to elucidate the possibility of MERS-CoV transmission from camels to such animals.

Whereas MERS CoV has been found in one bat sample in Saudi Arabia [5], all the 109 bats in the present study, were negative for MERS-CoV using both serology and molecular assays. Bats have been incriminated as the origin of many known mammalian coronaviruses including SARS [7]. A 190 nt RNA fragment of MERS-CoV was detected in a bat faecal sample [11]. However, since human–bat contact is limited, camels have been more implicated as a probable intermediate host [33].

In conclusion, the very high prevalence of MERS-CoV neutralising antibodies in both resident and imported camels indicates the widespread and ubiquitous presence of the virus in the country. A systematic longitudinal study, however, is needed to follow up imported camels from their country of origin until they reach the slaughterhouses to understand the epidemiology of the disease along the camel market chain. A separate study on resident camels is needed to understand the dynamics of infection in local camels as opposed to in imported camels. The very high seroprevalence detected in camels warrants the initiation of an active surveillance study on humans, particularly those that are at higher risks of exposure to MERS-CoV infections such as camel traders and abattoir workers.

*Authors' correction

The order of Dr Folorunso Oludayo Fasina's names was wrong in the authors' list, leading to abbreviation as FF Oludayo instead of FO Fasina. This was corrected on 17 March 2017 at the request of the author.

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Conflict of interest

None declared.

Authors' contributions

Mohamed Ali, Yilma Jobre and Abebe Wossene designed the study and wrote the article. Mahmoud Shehata, Ahmed El Sayed, Rabeh El-Shesheny, Ahmed Kandeil, Mokhtar Gomaa and Ahmed El-Taweel conducted the laboratory work. Basma Elsokary, Naglaa Hassan, Heba Sobhy and Ihab El Masry managed the field study. Juan Lubroth, Sophie VonDobschuetz, Emma Gardner and Subhash Morzaria funded the study and participated in study design. Gwenaelle Dauphin Fasina Folorunso Oludayo, Peter Daszak and Maureen Miller participated in the manuscript preparation and the analysis of data.

References

1. World Health Organization (WHO). Middle East respiratory syndrome coronavirus (MERS-CoV). Geneva: WHO; 2016. Available from: http://www.who.int/emergencies/mers-cov/en/
2. Liljander A, Meyer B, Jores J, Müller MA, Lattwein E, Njeru I, et al. MERS-CoV Antibodies in Humans, Africa, 2013-2014. Emerg Infect Dis. 2016;22(6):1086-9. DOI: 10.3201/eid2206.160064 PMID: 27071076
3. Alagaili AN, Briese T, Mishra N, Kapoor V, Sameroff SC, de Wit E, et al. Middle East respiratory syndrome coronavirus infection in dromedary camels in Saudi Arabia. MBio. 2014;5(2):e00884-14. DOI: 10.1128/mBio.00884-14 PMID: 24570370
4. Meyer B, Müller MA, Corman VM, Reusken CB, Ritz D, Godeke GJ, et al. Antibodies against MERS coronavirus in dromedary camels, United Arab Emirates, 2003 and 2013. Emerg Infect Dis. 2014;20(4):552-9. DOI: 10.3201/eid2004.131746 PMID: 24655412
5. Memish ZA, Cotten M, Meyer B, Watson SJ, Alsahafi AJ, Al Rabeeah AA, et al. Human infection with MERS coronavirus after exposure to infected camels, Saudi Arabia, 2013. Emerg Infect Dis. 2014;20(6):1012-5. DOI: 10.3201/eid2006.140402 PMID: 24857749
6. Pfefferle S, Oppong S, Drexler JF, Gloza-Rausch F, Ipsen A, Seebens A, et al. Distant relatives of severe acute respiratory syndrome coronavirus and close relatives of human coronavirus 229E in bats, Ghana. Emerg Infect Dis. 2009;15(9):1377-84. DOI: 10.3201/eid1509.090224 PMID: 19788804
7. Lau SK, Li KS, Tsang AK, Lam CS, Ahmed S, Chen H, et al. Genetic characterization of Betacoronavirus lineage C viruses in bats reveals marked sequence divergence in the spike protein of pipistrellus bat coronavirus HKU5 in Japanese pipistrelle: implications for the origin of the novel Middle East respiratory syndrome coronavirus. J Virol. 2013;87(15):8638-50. DOI: 10.1128/JVI.01055-13 PMID: 23720729
8. Corman VM, Ithete NL, Richards LR, Schoeman MC, Preiser W, Drosten C, et al. Rooting the phylogenetic tree of middle East respiratory syndrome coronavirus by characterization

of a conspecific virus from an African bat. J Virol. 2014;88(19):11297-303. DOI: 10.1128/JVI.01498-14 PMID: 25031349

9. Raj VS, Mou H, Smits SL, Dekkers DHW, Müller MA, Dijkman R, et al. Dipeptidyl peptidase 4 is a functional receptor for the emerging human coronavirus-EMC. Nature. 2013;495(7440):251-4. DOI: 10.1038/nature12005 PMID: 23486063
10. Annan A, Baldwin HJ, Corman VM, Klose SM, Owusu M, Nkrumah EE, et al. Human betacoronavirus 2c EMC/2012-related viruses in bats, Ghana and Europe. Emerg Infect Dis. 2013;19(3):456-9. DOI: 10.3201/eid1903.121503 PMID: 23622767
11. Memish ZA, Mishra N, Olival KJ, Fagbo SF, Kapoor V, Epstein JH, et al. Middle East respiratory syndrome coronavirus in bats, Saudi Arabia. Emerg Infect Dis. 2013;19(11):1819-23. DOI: 10.3201/eid1911.131172 PMID: 24206838
12. Ithete NL, Stoffberg S, Corman VM, Cottontail VM, Richards LR, Schoeman MC, et al. Close relative of human Middle East respiratory syndrome coronavirus in bat, South Africa. Emerg Infect Dis. 2013;19(10):1697-9. DOI: 10.3201/eid1910.130946 PMID: 24050621
13. Müller MA, Corman VM, Jores J, Meyer B, Younan M, Liljander A, et al. MERS coronavirus neutralizing antibodies in camels, Eastern Africa, 1983-1997. Emerg Infect Dis. 2014;20(12):2093-5. DOI: 10.3201/eid2012.141026 PMID: 25425139
14. Corman VM, Jores J, Meyer B, Younan M, Liljander A, Said MY, et al. Antibodies against MERS coronavirus in dromedary camels, Kenya, 1992-2013. Emerg Infect Dis. 2014;20(8):1319-22. DOI: 10.3201/eid2008.140596 PMID: 25075637
15. Hemida MG, Perera RA, Al Jassim RA, Kayali G, Siu LY, Wang P, et al. Seroepidemiology of Middle East respiratory syndrome (MERS) coronavirus in Saudi Arabia (1993) and Australia (2014) and characterisation of assay specificity. Euro Surveill. 2014;19(23):20828. DOI: 10.2807/1560-7917.ES2014.19.23.20828 PMID: 24957744
16. Hemida MG, Chu DK, Poon LL, Perera RA, Alhammadi MA, Ng HY, et al. MERS coronavirus in dromedary camel herd, Saudi Arabia. Emerg Infect Dis. 2014;20(7):1231-4. DOI: 10.3201/eid2007.140571 PMID: 24964193
17. Perera RA, Wang P, Gomaa MR, El-Shesheny R, Kandeil A, Bagato O, et al. Seroepidemiology for MERS coronavirus using microneutralisation and pseudoparticle virus neutralisation assays reveal a high prevalence of antibody in dromedary camels in Egypt, June 2013. Euro Surveill. 2013;18(36):20574. DOI: 10.2807/1560-7917.ES2013.18.36.20574 PMID: 24079378
18. Reusken C, Haagmans BL, Koopmans MP. Dromedaris en 'Middle East respiratory syndrome': MERS-coronavirus in het 'schip van de woestijn'. [Dromedary camels and Middle East respiratory syndrome: MERS coronavirus in the 'ship of the desert']. Ned Tijdschr Geneeskd. 2014;158:A7806.PMID: 25248734
19. Reusken CB, Ababneh M, Raj VS, Meyer B, Eljarah A, Abutarbush S, et al. Middle East Respiratory Syndrome coronavirus (MERS-CoV) serology in major livestock species in an affected region in Jordan, June to September 2013. Euro Surveill. 2013;18(50):20662. DOI: 10.2807/1560-7917.ES2013.18.50.20662 PMID: 24342516
20. Reusken CB, Haagmans BL, Müller MA, Gutierrez C, Godeke GJ, Meyer B, et al. Middle East respiratory syndrome coronavirus neutralising serum antibodies in dromedary camels: a comparative serological study. Lancet Infect Dis. 2013;13(10):859-66. DOI: 10.1016/S1473-3099(13)70164-6 PMID: 23933067
21. Food and Agriculture Organization of the United Nations (FAO). FAOSTAT. Live animals. Rome: FAO; 2014. Available from: http://faostat3.fao.org/browse/Q/QA/E
22. Central Administration of Veterinary Quarantine Offices. General Organization of Veterinary Services (GOVS) in Egypt; data untilSeptember30,2015.
23. Chu DK, Poon LL, Gomaa MM, Shehata MM, Perera RA, Abu Zeid D, et al. MERS coronaviruses in dromedary camels, Egypt. Emerg Infect Dis. 2014;20(6):1049-53. DOI: 10.3201/eid2006.140299 PMID: 24856660
24. Corman VM, Müller MA, Costabel U, Timm J, Binger T, Meyer B, et al. Assays for laboratory confirmation of novel human coronavirus (hCoV-EMC) infections. Euro Surveill. 2012;17(49):20334.PMID: 23231891
25. World Health Organization (WHO). Laboratory Testing for Middle East Respiratory Syndrome Coronavirus. Geneva: WHO; 2013,. Available from: www.who.int/csr/disease/coronavirus_infections/MERS_Lab_recos_16_Sept_2013.pdf?ua=1.
26. Corman VM, Eckerle I, Bleicker T, Zaki A, Landt O, Eschbach-Bludau M, et al. Detection of a novel human coronavirus by real-time reverse-transcription polymerase chain reaction. Euro Surveill. 2012;17(39):20285.PMID: 23041020
27. Graham R. 10 July 2014. MERS-CoV PCR/sequencing primers. Protocol Exchange. doi:.DOI: 10.1038/protex.2014.022 .
28. Tamura K, Stecher G, Peterson D, Filipski A, Kumar S. MEGA6: Molecular Evolutionary Genetics Analysis version 6.0.Mol Biol Evol. 2013;30(12):2725-9. DOI: 10.1093/molbev/mst197 PMID: 24132122
29. Adney DR, van Doremalen N, Brown VR, Bushmaker T, Scott D, de Wit E, et al. Replication and shedding of MERS-CoV in upper respiratory tract of inoculated dromedary camels. Emerg Infect Dis. 2014;20(12):1999-2005. DOI: 10.3201/eid2012.141280 PMID: 25418529
30. Hemida MG, Elmoslemany A, Al-Hizab F, Alnaeem A, Almathen F, Faye B, et al. Dromedary Camels and the Transmission of Middle East Respiratory Syndrome Coronavirus (MERS-CoV). Transbound Emerg Dis. 2017;64(2):344-53. DOI: 10.1111/tbed.12401 PMID: 26256102
31. Kandeil A, Shehata MM, El Shesheny R, Gomaa MR, Ali MA, Kayali G. Complete Genome Sequence of Middle East Respiratory Syndrome Coronavirus Isolated from a Dromedary Camel in Egypt.Genome Announc. 2016;4(2):e00309-16. DOI: 10.1128/genomeA.00309-16 PMID: 27125484
32. van Doremalen N, Miazgowicz KL, Milne-Price S, Bushmaker T, Robertson S, Scott D, et al. Host species restriction of Middle East respiratory syndrome coronavirus through its receptor, dipeptidyl peptidase 4. J Virol. 2014;88(16):9220-32. DOI: 10.1128/JVI.00676-14 PMID: 24899185
33. Sharif-Yakan A, Kanj SS. Emergence of MERS-CoV in the Middle East: origins, transmission, treatment, and perspectives. PLoS Pathog. 2014;10(12):e1004457. DOI: 10.1371/journal.ppat.1004457 PMID: 25474536

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From: Andrew Clements <aclements@usaid.gov>
Sent: Tue, 11 Apr 2017 23:18:27 +0200
To: Brian Bird <bhbird@ucdavis.edu>
Cc: PREDICTMGT <predictmgt@usaid.gov>, PREDICT-outbreak <predict-outbreak@ucdavis.edu>
Subject: [predict] [predict-outbreak] Re: Update on Crow-dieoff in Bangladesh

Thanks, Brian.

As scavengers, presumably the crows had access to some poultry that had died from a H5N1 infection. A lot of poultry, given more than 100 crows died.

I'll share this report with Ricardo and the mission.

Andrew

On Tue, Apr 11, 2017 at 10:39 PM, Brian Bird <bhbird@ucdavis.edu> wrote:

> Dear all,
>
> Official notification by GoB to OIE of H5 avian influenza activity. Confirmed by influenza specific testing by BLRI laboratory of animal specimens collected by PREDICT team.
>
> Link to official OIE report/notification can be found at bottom of PREDICT team report.
>
> I hope everyone is having a good day!
>
> -brian
>
> Brian H. Bird DVM, MSPH, PhD
>
> One Health Institute
>
> 1089 Veterinary Medicine Dr.
>
> School of Veterinary Medicine
>
> University of California, Davis
>
> bhbird@ucdavis.edu

--

Andrew Clements, Ph.D.
Senior Scientific Adviser
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: REDACTED
E-mail: aclements@usaid.gov

For more information on USAID's Emerging Pandemic Threats program, see: http://www.usaid.gov/ept2

From: William B. Karesh <karesh@ecohealthalliance.org>
To: Chris Johnson <ckjohnson@ucdavis.edu>
CC: Tracey Goldstein <tgoldstein@ucdavis.edu>;Simon Anthony <anthony@ecohealthalliance.org>;Amanda Fuchs <fuchs@ecohealthalliance.org>;predict@ucdavis.edu <predict@ucdavis.edu>;Megan M Doyle <mmdoyle@ucdavis.edu>
Sent: 4/25/2017 10:10:55 AM
Subject: [predict] Re: PREDICT Activity Tracker

That sounds great if you can help fill in.

I was thinking of the human questionnaire as the behavior qualitative work rather than the information collected when sampling people. So, let's change the heading on that column to reflect the behavior work.

BK

William B. Karesh, D.V.M
Executive Vice President for Health and Policy

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President, OIE Working Group on Wildlife

Co-chair, IUCN Species Survival Commission - Wildlife Health Specialist Group

EPT Partners Liaison, USAID Emerging Pandemic Threats - PREDICT-2 Program

EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

On Apr 25, 2017, at 12:57 PM, Christine Kreuder Johnson <ckjohnson@ucdavis.edu> wrote:

Nice looking tracker here.
Surveillance team is tracking the first 4 columns regularly and have last verified status with all partners about 2 weeks ago. If that's recent enough for you, we can easily reshape that info into this format (cc'ing Megan on that as she has the latest versions) – that way, we don't have to ask everyone again for the same information.
Other than the human questionnaire (which we do whenever we get samples from anyone so those 2 columns are the same at this level), I don't really see behavior in here – did you want to include our behavior qualitative research scope which I think is also relevant to info we'd present at One Health Platforms?
/ckj

From: Billy Karesh <karesh@ecohealthalliance.org>
Date: Tuesday, April 25, 2017 at 8:31 AM
To: Tracey Goldstein <tgoldstein@ucdavis.edu>, Simon Anthony <anthony@ecohealthalliance.org>, Christine Kreuder Johnson <ckjohnson@UCDAVIS.EDU>

Cc: Amanda Fuchs <fuchs@ecohealthalliance.org>, "predict@ucdavis.edu" <predict@ucdavis.edu>
Subject: Fwd: PREDICT Activity Tracker

Hi there,

Attached is the situation tracker that I mentioned on the EB call to let P&R know what information our country folks could present at National One Health Platform meetings that they are supposed to help organize. I tried to keep it as simple as possible and give them ideas of topics for discussion at local levels.

Leilani is going to make the first run on filling in the behavior column, Catherine will begin with the One Health Eval. and the group at EHA will fill in as much as they can for EHA countries.

We will send ours to all of you for review, but I thought you might want to get a head start on parts that you could fill in.

Just realized that I left out "training".

BK

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Executive Vice President for Health and Policy

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Begin forwarded message:

From: Amanda Andre <amanda.andre@ecohealthalliance.org>
Subject: PREDICT Activity Tracker
Date: April 24, 2017 at 4:57:51 PM EDT
To: "William B. Karesh" <karesh@ecohealthalliance.org>

Hi Billy,

Attached is the PREDICT Activity tracker with the updates you mentioned.

Amanda Andre
Administrative Assistant to the Executive Vice President for Health &Policy

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From:	Jonna Mazet <jkmazet@ucdavis.edu>
To:	Peter Daszak <daszak@ecohealthalliance.org>
CC:	David J Wolking <djwolking@ucdavis.edu>;Elizabeth Leasure <ealeasure@ucdavis.edu>;Alison Andre <andre@ecohealthalliance.org>;Evelyn Luciano <luciano@ecohealthalliance.org>
Sent:	5/9/2017 4:22:13 PM
Subject:	Re: 2 papers from Zhengli that I probably should cite PREDICT for..

Agree on both -- first using the Predict-adjacent wording with "benefitted from the ....of USAID PREDICT." Sounds like the other is a direct Predict acknowledgement. Are those viruses from P-1? If so, great. If P-2, I don't think they're cleared for release, so we'd need to handle that process ASAP before the pub comes out.
Congrats,
J

On Tue, May 9, 2017 at 9:49 AM, Peter Daszak <daszak@ecohealthalliance.org> wrote:

Hi Jonna,

Zhengli's cranking out great results again and has 2 drafts that I am editing right now. Either of these will make some news, and I want to be careful that we get ahead of the curve and have PREDICT acknowledged in the right way.

The first one is from sampling under the NIAID project, hummingbird IRB, and shows that 6/400 or so people have bat SARS-like CoV antibodies. Conclusion is that SL-CoVs from bats are spilling over into people in China, and therefore there is a risk of another SARS-like pandemic. The samples are not collected under PREDICT, but I'd like to acknowledge both NIAID and PREDICT as funding my involvement, e.g. the PREDICT funds could cover my helping draft the ms…

The second one shows that a pig CoV closely related to a known bat CoV is involved in pig die-offs in China. There are some PREDICT and NIAID samples from bats that were sequenced and used in the phylogeny of this pig virus. I think that makes it a direct PREDICT acknowledgement?

What do you think?

Cheers,

Peter

Peter Daszak

President

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Sent: Tue, 9 May 2017 16:48:00 -0700
Subject: Re: For next week -- specific details/ideas
From: Jonna Mazet <jkmazet@ucdavis.edu>
To: Peter Daszak <daszak@ecohealthalliance.org>
Cc: Alison Andre <andre@ecohealthalliance.org>, Jon Epstein <epstein@ecohealthalliance.org>, "Kevin Olival, PhD" <olival@ecohealthalliance.org>, Christine Kreuder Johnson <ckjohnson@ucdavis.edu>, Tracey Goldstein <tgoldstein@ucdavis.edu>, David J Wolking <djwolking@ucdavis.edu>, Elizabeth Leasure <ealeasure@ucdavis.edu>, Evelyn Luciano <luciano@ecohealthalliance.org>

Sounds good -- Mostly just aligning workplan with actual activities, communication structures among global contacts and from global to in-country staff, and planning moving forward for objectives and countries.
Thanks,
J

On Tue, May 9, 2017 at 9:14 AM, Peter Daszak <daszak@ecohealthalliance.org> wrote:

> No problem – look forward to that.
>
> We're getting ready over here with contract, staffing, workplan and other details for all countries. We'll have each country liaison POC available throughout the day by phone here at EHA and will have admin in the room (Molly) and on the phone (Evelyn and Ava).
>
> Anything else we need to think about ready for the meeting?
>
> Cheers,
>
> Peter
>
> **Peter Daszak**
>
> *President*
>
> EcoHealth Alliance
>
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EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.

From: [redacted] [mailto:[redacted]] **On Behalf Of** Jonna Mazet
Sent: Monday, May 8, 2017 4:06 PM
To: Peter Daszak; Alison Andre; Jon Epstein; Kevin Olival, PhD
Cc: Christine Kreuder Johnson; Tracey Goldstein; David J Wolking; Elizabeth Leasure
Subject: For next week -- specific details/ideas

Hi there,

As you prepare for our discussions next week, I'd like to specifically highlight that we are likely to propose changes in the human surveillance in China and Indonesia.

Just asking you to be prepared to discuss options going forward,.

Thanks,

Jonna

From: Andrew Clements <aclements@usaid.gov>
Sent: Fri, 23 Jun 2017 14:10:45 +0200
Subject: Fwd: WHO Global Action Plan on Antimicrobial Resistance newsletter no 27
To: Peter Black <REDACTED>, "Wantanee (FAORAP) Kalpravidh" <REDACTED>, "Subhash Morzaria (FAORAP)" <REDACTED>, William Karesh <Karesh@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>
Cc: Lindsay Parish <lparish@usaid.gov>, "Daniel Schar (RDMA/OPH)" <dSchar@usaid.gov>, "Sudarat Damrongwatanapokin (RDMA/OPH)" <sDamrongwatanapokin@usaid.gov>
Attachment
WHO GAP AMR Newsletter No.27 June 2017.pdf

FYI

Andrew P. Clements, Ph.D.
Senior Scientific Adviser
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

Begin forwarded message:

From: WHO AMR Secretariat <REDACTED>
Date: June 23, 2017 at 1:15:21 PM GMT+2
To: REDACTED
Subject: WHO Global Action Plan on Antimicrobial Resistance newsletter no 27
Reply-To: Development of a draft global action plan to address antimicrobial resistance <REDACTED>

Dear Colleagues

We are pleased to send you the 27th WHO Global Action Plan on Antimicrobial Resistance newsletter.

This newsletter will provide you with an update on work ongoing on AMR. It will also give you feedback on any significant meetings or events recently held and inform you about others upcoming on AMR that may be of interest and flag issues which you should be aware.

Feel free to share this newsletter with your colleagues if you think it will be of interest to them.

Best regards
Dr Marc Sprenger
Director, AMR Secretariat WHO

IMPLEMENTATION OF THE GLOBAL ACTION PLAN ON ANTIMICROBIAL RESISTANCE

Online Community of practice (CoP) update: New sub-community on Health Workforce AMR Education and Training.

Following the WHO expert consultation meeting on health workforce and AMR education held in Geneva 23 - 24 March 2017, a sub-community on Health Workforce AMR Education and Training has been established to provide a global platform that allows individuals and representatives of institutions to interact with the aim of strengthening health professional AMR education at the country level. Among others, it's objectives are to develop and maintain a repository of AMR-related products, tools and guidance documents for health professional education and training. If you are not already a member of the CoP, please click here to join. If you are a member and would like to join this sub-community, please contact the Moderator and request to be added to the sub-community.

A list of 91 tools on AMR education was identified for the March consultation and is available in the library of the sub-community. It is being categorized to make it more user-friendly. If you are aware of other useful AMR educational resources please send information about the programme, lead organization and the weblink/files to hickeyb@who.int and it will be added to the repository. The intention is to streamline the list to accommodate only the most useful/ relevant tools for stakeholders in Member States to use.

Monitoring of antimicrobial resistance: Outcome and goal indicators' meeting

On 8-9 June 2017, a group of technical experts from around the world came together at WHO Headquarters to discuss indicators for monitoring and evaluating country and global efforts to tackle antimicrobial resistance (AMR), as part of the Global Action Plan on AMR. The primary purpose of the meeting was to identify a set of indicators that can be used to track and communicate progress at country and global levels. Indicator discussions primarily focused on identifying outcome and goal measures, but also touched on process and outputs. Feedback from the meeting will be incorporated into the draft monitoring and evaluation framework, following which there will be a public, online consultation up to the end of September 2017. The report of the meeting will be made available here.

Essential Medicines List updated with new advice on antibiotics

New advice on which antibiotics to use for common infections and which to preserve for serious circumstances is among additions to the *WHO Model List of Essential Medicines* (EML) for 2017. Other additions include medicines for HIV, hepatitis C, tuberculosis, and leukaemia. The model list is used by many countries to increase access to medicines and guide decisions about which products they ensure are available for their populations.

In the biggest revision of the antibiotics section in the EML's 40-year history, WHO experts have grouped antibiotics into three categories – ACCESS, WATCH and RESERVE – with recommendations on when each category should be used. Initially, the new categories apply only to antibiotics used to treat 21 of the most common general infections. The change aims to ensure that antibiotics are available when needed, and that the right antibiotics are prescribed for the right infections. It should enhance treatment outcomes, reduce the development of drug-resistant bacteria, and preserve the effectiveness of "last resort" antibiotics that are needed when all others fail. More information here.

Supporting development of national action plans in the Europe region

In this interview, Dr Lars Blad talks about his experiences working with WHO in the Eastern European and Central Asia regions supporting countries in the development of their National Action Plans.

"To be able to provide the best support possible, it is crucial to, in dialogue, identify the relevant stakeholders to be involved. Of utmost importance is to get an early involvement of the Agricultural/ Veterinary sector – ensuring there is a One Health approach in the work and in the Plan from the outset". Read more here.

Network for Improving Quality of Care for Maternal, Newborn and Child Health

The "Network for Improving Quality of Care for Maternal, Newborn and Child Health" was launched in Lilongwe, Malawi in February 2017. The network is made up of nine countries: Bangladesh, Ethiopia, Ghana, India, Ivory Coast, Malawi, Nigeria, Tanzania and Uganda. A technical session on the links between quality of care (QoC) and water, sanitation and hygiene (WASH) in health care facilities was held to catalyse action and ensure that WASH in health care facilities is embedded with network countries' QoC action plans. Both WASH and QoC are critical to addressing AMR. A technical brief documenting the linkages between WASH and QoC can be read here.

First West African national action plan (NAP) workshop, Cameroon

The first West African multisectoral national action plan (NAP) workshop (and third in the WHO African region) took place in Douala, Cameroon 13-16 June and brought together 84 attendees from nine West African countries (Angola, Cameroon, Central African Republic, Chad, Comores, Congo, Equatorial Guinea, Madagascar and Sao Tomé et Principe). Representing the human health, veterinary, agriculture and environmental sectors, participants were trained and equipped with a series of tools and references to develop their NAPs. Students from 12 universities in Cameroon (undergoing studies in medicine, pharmacy, laboratory, nursing, midwifery, veterinary and environmental sectors) were invited to serve as scribes to also learn about AMR and, in time, to contribute to raising awareness of AMR in their respective areas. The workshop was covered by multiple media outlets - online, TV, newspapers and urban radio stations. The 2nd West African workshop will take place in Lome, Togo, 27-30 June.

Photo: Participants at the first West African NAP workshop, 13-16 June, Douala, Cameroon

British study itemises cost of superbug out-break at $1.2 milion- and outlines why investment in infection prevention strategies could save money in the long term

In 2015, five West London hospitals were afflicted with a 10-month outbreak in which 40 patients in renal and vascular wards were infected with a carbapenemase-producing strain of *Klebsiella pneumoniae*. Thirteen patients died. An investigative team from Imperial College London has now calculated the staggering cost of this antibiotic resistance outbreak at £980,000. The greatest cost (£296,000) turned up as lost revenue from planned surgical procedures that were cancelled due to the closure of four wards. Other major expenses were extra staff time (£193,000), extended patient length-of-stay (£140,000), and patient screening (£84,000). Twenty-four rooms required hydrogen peroxide vapour decontamination (£37,000). According to lead author, Alison Holmes, "This study highlights the cost to the British NHS and why a relatively small investment in infection prevention strategies could save money in the long term." More here.

Editor's Picks

One Health is the Approach for Uganda's Prevailing Health Challenges-Prime Minister

World Veterinary Day 2017, with the theme of 'Continuing Education with a One Health Focus', culminated at Makerere University, Uganda. The Ugandan Prime Minister presided over the day, noting on behalf of Ugandan President Museveni that the One Health approach is the right way to solve Uganda's current health challenges. The Minister of State for Agriculture, Animal Industry and Fisheries, Hon. Bright Rwamirama thanked the Ministry of Health for spearheading the formation of the One Health Country Taskforce which has enabled the government to manage several outbreaks. https://goo.gl/1fDSEU

How South Africa can reduce the risk of infections in hospitalized children

A study conducted in one of South Africa's leading children's hospitals found that just under 25% of children admitted over the course of a year acquired new infections while hospitalized. The infections collectively resulted in these children spending an extra 2,300 days in hospital and taking an additional 2,400 days of antibiotics. The cost of these largely preventable infections exceeded R60 million for the year.

The study also found that by combining laboratory surveillance and antibiotic prescription surveillance methods, it was possible to accurately identify 85% of children who had picked up an infection in hospital. This approach took 15 hrs per month compared to the traditional surveillance method of 120 hrs per month and needed far less expertise to implement. More information here.

Launch of White Paper on rapid diagnostic technologies to tackle AMR

The European Parliament Interest Group on Innovation in Health and Social Care has called on the European Commission to boost funding and innovation to foster the uptake of rapid diagnostic technologies. The paper was developed by Health First Europe in collaboration with the Alliance of Patients' Organizations and the World Alliance Against Antibiotic Resistance. Innovative diagnostic technologies can contribute – as part of a broader and coordinated plan – to reduce antibiotic misuse. Rapid diagnostic technologies are simple tools able to reduce unnecessary prescription, tailor treatment for bacterial infections and limit infection spread. More here.

Clean and Safe Health facility (CASH) initiative in Ethiopia

The Clean and Safe Health facility campaign (CASH) in Ethiopia was launched by the Ministry of Health in 2014. It aims to reduce health care infections and make hospitals safer through staff training on infection prevention and control and patient safety, safe and sufficient water supply and sanitation facilities and health care waste management along with implementing audits and supporting hospitals in developing and implementing charters for cleanliness, all of which will contribute to addressing AMR. CASH is being implemented in all hospitals in Ethiopia (approximately 150) and will be expanded to health centres. CASH includes (among others):

Attitude change on waste management and environmental hygiene

Sustained advocacy and communication on hospital cleanliness

Conducting regular cleanliness activities

Implemention of infection prevention and facility management standards

Assignment of an empowered ward master in each hospital

Conducting internal and external audits and recognizing hospitals

Ensuring hygiene, including environmental cleanliness, is high on everyone's agenda by having a cleaning service plan

More information here.

Global Antimicrobial Resistance Surveillance System (GLASS) update

Enrolment update: 51 countries have expressed interest in enrolling in GLASS, of which **40** are fully enrolled.

Resources

- For information regarding national action plans on antimicrobial resistance and supporting documents and tools, click here.
- Global Antimicrobial Resistance Surveillance System (GLASS) documents and tools.
- For information on infection prevention and control, click here.
- To access the WHO/UNICEF WASH in Health Care Facilities knowledge portal, click here.
- For information on antimicrobial resistance and the food chain, click here.
- For AMR activities at the Food and Agriculture Organization of the UN (FAO), click here.
- For AMR activities at the World Organisation for Animal Health (OIE), click here.

	UPCOMING MEETINGS/EVENTS	
June 29	Strategic Technical & Advisory Group meeting	Teleconference
June 27-30	2nd AMR National Focal Point workshop (10 West African countries)	Lome. Togo
June 30	Interagency Coordination Group (IACG) on AMR meeting	Teleconference
July 3-4	Consultative meeting on comprehensive AMR surveillance promotion in Iran	Ministry of Health & Medical Education, Tehran, Iran
July 5-6	Developing priorities for WHO activities on AMR and the environment.	Nieuwegein, Netherlands. WHO & KWR Watercycle Research Institute
July 11-12	EU-India seminar : Use of Veterinary Medicines and AMR	New Delhi, India
July 20	G20 Leaders' Summit	Hamburg, Germany
July 24-27	Sudan NAP workshop	Khartoum, Sudan
Aug 8-9 (TBC)	India National Consultation to Operationalise Action against AMR	New Delhi, India
Aug 22-24	3rd Workshop on Antimicrobial Consumption	Maputo, Mozambique
Sept 5-6	DRIVE-AB Final Conference. Further information here	Brussels, Belgium

Please let us know of your upcoming events for inclusion in the newsletter. We also welcome your suggestions and comments. For all communications, please contact the Secretariat at whoamrsecretariat@who.int. Responsibility for newsletter contenrests with the AMR Secretariat Director: Marc Sprenger.

Newsletter editor: Breeda Hickey.

From:	Kevin Olival, PhD <olival@ecohealthalliance.org>
To:	David J Wolking <djwolking@ucdavis.edu>;Chris Johnson <ckjohnson@ucdavis.edu>;Damien Joly <djoly@metabiota.com>;Dr. Jonna Mazet" <jkmazet@ucdavis.edu>
CC:	Peter Daszak <daszak@ecohealthalliance.org>;Anna Willoughby <willoughby@ecohealthalliance.org>;Evelyn Luciano <luciano@ecohealthalliance.org>;Ava Sullivan <sullivan@ecohealthalliance.org>;Molly Turner <turner@ecohealthalliance.org>;Leilani Francisco <francisco@ecohealthalliance.org>
Sent:	8/4/2017 1:21:31 PM
Subject:	Global workplan with M&A additions/edits

Dear David and all,

Attached are our edits to the Year 4 global workplan with additions from the M&A team. Most of the changes were relatively minor, as I think the bullets are written general enough to capture most of our current activities. Chris, Damien, and Jonna, please feel free to add or make additional suggested edits based on anything else we're doing across partners relevant to M&A. Sorry for not getting this out earlier before the deadline.

I went through and also changed the font color from blue to **black** for those items from Year 3 that I think are worth retaining in the plan.

Happy to answer any questions or concerns.

Thanks!
Kevin (and Peter)

YEAR 4 GLOBAL WORKPLAN INSTRUCTIONS

This Year 4 Global workplan template is designed to capture activities and expected outcomes at the global level.

What about the All-country plan and Country Briefs?
A draft of the Year 4 *All-country plan* will be shared with country teams separately to allow sufficient time for review and comment and to inform the development of country-specific plans (*Country Briefs*). Upon receipt of global-level content from operational leads, UC Davis will review and refine the draft *All-country workplan* and communicate any changes to country teams to facilitate county-level updates or revisions of the Briefs (if necessary).

Global workplan instructions:
As with last year's process, this template is based the Year 3 workplan describing Objectives and Activities. Also as in previous years, objectives and activities have been assigned to operational leads ***(highlighted in green)*** for content compilation.

Operational leads are responsible for coordination with consortium partners for completion. Workplan development is intended as a collaborative process, so please communicate with operational team members across consortium partners for content development.

Please update content with planned activities for Year 4 only. For quick reference, activities from the Year 3 workplan are included in blue font.

Do not mention your organization's name or acronym in the document unless absolutely essential for understanding a specific point. USAID considers all of us "PREDICT". Similarly, activities need not be attributed to individuals by name or title.

BE BRIEF AND CONCISE. Only list significant plans or items of specific interest for each objective and activity/sub-activity.

Timeline (reminders will be shared for all deadlines as they draw near):

- **Global workplan content from operational leads will be due to UC Davis HQ on Friday August 4th**
- Country Briefs (based on the draft All-country workplan) will also be due to HQ on August 4th
- GHSA Phase 1 workplan instructions will be shared separately along with the new and improved template; GHSA workplans will be due to HQ Friday August 11th with the week of August 14th reserved for HQ review and finalization.

PREDICT-2 GLOBAL Workplan (October 2017-September 2018)

USAID/PREDICT is supporting the Global Health Security Agenda (GHSA) by training and facilitating One Health teams to conduct zoonotic disease sampling and laboratory detection for known and novel viral threats and by working with in-country government partners to strengthen multi-sectoral partnerships and platforms that enable rapid detection and response to zoonotic pathogens spilling over from animals to people.

PREDICT's Global Workplan is a comprehensive list of activities and outcomes expected from collaborative efforts from PREDICT's extensive and unified (country-level and global) team. Specific country-level activities and additional details are provided in the companion GHSA country workplans (separate Excel template), the PREDICT All-country workplan, and the Country Briefs that follow. The Global and All-Country workplans are key requirements of PREDICT's Cooperative Agreement with USAID. These portions of the package also serve as guidance documents for all global and country activities to ensure the standardization of methods and resulting data for the cross-country and global analyses necessary to use the information most effectively to promote and protect global health.

GHSA Phase 1 countries are supported to complete most activities using Ebola funds. However, some important activities are supported through USAID core funds, as they may otherwise expand the overall scope of activities beyond current-year GHSA milestones. These are noted where appropriate.

Some global-level objectives and activities may not be fully achievable in 2017-2018, as activities will begin but take more than one year to complete. These activities are noted at the objective, activity, or sub-activity level as appropriate.

Objective 1: Characterizing Biological and Ecological Risk of Zoonotic Disease Threats

Identify the biological and ecological drivers and host-pathogen dynamics at high-risk interfaces in Asia and Africa.

Activity 1.1. Targeted sampling for zoonotic viruses with pandemic potential at specific high-risk interfaces

Conduct sampling for zoonotic viruses in collaboration with in-country and EPT partners (CDC, WHO, and FAO, etc.) at field sites most reflective of the processes underlying pathways for viral evolution, spillover, amplification, and spread.

Sub-activity 1.1.1. Identifying and characterizing pathways, epizones, and surveillance priorities for viruses with pandemic potential. . (Chris, Peter, Simon, Tracey)

- Continue to refine prioritization of wildlife and livestock host taxa for sampling and surveillance using species-level data on viral spillover risk, local information on human-animal interaction, and species occurrence at high-risk interfaces and disease emergence pathways.
- Optimize methods to investigate disease transmission among wildlife, livestock, and at-risk human populations and improve standardized protocols to collect data to assist in characterization of disease transmission interfaces and epizones.
- Together with EPT and country partners, continue to prioritize sampling activities, partnerships, and locations in areas of new engagement.
- Continue to explore animal movements, migrations, and value chains, in coordination with EPT and in-country partners, to refine targeted opportunities for surveillance and improve understanding of epizones for pathogens of significance.
- Refine spatial models to map geographic epizones for viral families of concern using data from host-virus associations to guide sampling and surveillance priorities and analytical approach.
- Use existing data to refine sampling strategies and prioritize potential zoonotic viral reservoirs, including potential ebolavirus hosts (see activity 1.6 below).

Expected Outcomes: Optimized sampling and surveillance priorities for identification and characterization of pathways for disease emergence and epizones; coordinated sampling activities with collaborative EPT partners, platforms, and networks.

Sub-Activity 1.1.2. Standardized, concurrent, and selectively longitudinal sampling of wildlife, livestock, and at-risk human populations with high levels of contact with animals. (Chris)

- Coordinate field activities across EPT countries through frequent meetings with regional and operational leads (behavior, laboratory, capacity building, information management, and modeling and analytics) for integration of expertise into sampling and surveillance design and implementation.
- Continue to develop, optimize, and amend protocols for the ethical conduct of research involving humans (IRB) and animals (IACUC).
- Ensure compliance with all permits and protocols, including locally approved protocols and permissions needed for sampling activities, site access, data collection, and diagnostic testing.
- Ensure adherence to national requirements for data and sample sharing and international standards and regulations for disease notification.

- Implement concurrent synchronized sampling of animals and humans using standardized field protocols, data collection tools, and diagnostic testing protocols across wildlife and at-risk human populations in high-risk communities to document sharing of viruses within and between species; identify high-risk interfaces and pathways for disease emergence; and enable standardized biological, behavioral, and ecological risk characterization.
- Implement syndromic surveillance among patients with undifferentiated or undiagnosed acute fevers of likely viral origin meeting standardized clinical case definitions in collaboration with clinics and hospitals in the catchment of high-risk communities targeted for concurrent surveillance.
- Continue to coordinate with FAO at global, regional, and country level to collaborate on concurrent synchronized sampling of livestock species at prioritized sites with respect to sample collection, sample and data handling, and viral detection and characterization protocols.

Expected Outcomes: Coordinated concurrent and effective sampling activities, including standardized data collection for wildlife, livestock, and at-risk human populations (where feasible) for monitoring of viral threats and investigation of viruses with pandemic potential at high-risk interfaces; known and novel pathogens associated with diseases of unknown origin, including severe acute respiratory infections, acute encephalitis, and influenza-like illnesses detected and identified.

Activity 1.2. Characterizing Risk
Collect standardized data at regular intervals on epidemiological and ecological factors identified as important drivers of pandemic risk, identify and characterize epizones for pandemic risk, and develop actionable surveillance improvements and risk mitigation strategies.

This activity is included for completeness, but some sub-activities may not be achievable in Year 4.

***Not a GHSA funded activity.*

Sub-Activity 1.2.1. Ranking of high-risk interfaces and identification of key processes influencing evolution, spillover, amplification, and spread of viral threats. (Chris)

- Continue to optimize sampling and data collection protocols and tools for standardized characterization of animal-human contact and high-risk interfaces that articulate human-animal contact and produce data on human activities and epidemiologic conditions associated with transmission of viruses between animals and humans at surveillance sites.
- Where feasible, use standardized questionnaires to collect quantitative data on human activities and behaviors underlying high-risk interfaces.

- **Develop methods to summarize PREDICT data as available and integrate with published data on known zoonotic viruses to identify high-risk interfaces, ecological conditions, and key epidemiological processes influencing evolution, spillover, amplification, and spread of viral threats to guide surveillance.
- **Characterize risk of viral spillover and spread for all PREDICT-detected viruses using associated virological, epidemiological, and ecological data.
- **As data on viruses in animal and human hosts become available (through the project and from other sources), develop methods to characterize virus host plasticity and cross-species disease transmission; rank high-risk interfaces; and model specific emergence, amplification, and spread for potential zoonotic and pandemic viral threats.

Expected Outcomes: Establishment of standardized epidemiologic approaches and protocols for characterizing and ranking high-risk viruses and interfaces to understand processes influencing viral evolution, spillover, amplification, and spread.

Sub-activity 1.2.2. Characterizing ecological risk and predicting spillover: advancing the knowledge of how ecological factors, demographic and other socioeconomic changes, agricultural and wildlife-use trends, host life history, viral diversity, and human behavior influence the likelihood of heightened viral evolution, spillover, amplification, and spread. (*Chris, Peter, Leilani*)

- **Integrate biological and behavioral surveillance data from PREDICT to-date into models on an ongoing basis and as appropriate.
- **Develop models to simulate the impact of various behavioral risk reduction interventions, specifically those aimed at preventing bat-human spillover.
- **As human questionnaire data become available, summarize behavior data with particular relevance to spillover (e.g., human-animal contact) and spread mechanisms (e.g., human movement patterns).
- **Continue to collaboratively develop, collate, and refine the methods, data sources/sets, and models (e.g., on land-use change; ecological, socioeconomic, and other demographic changes; agricultural trends; livestock production systems; value chains; climate variability; etc.) needed to characterize risk and predict spillover for each disease emergence pathway.
- **Continue to develop spatial analytical methods for mapping fine-scale spillover risk from wildlife to livestock for specific zoonotic viruses and hosts.
- **Continue to update all known mammalian virus-host associations using data available from published literature to date and combine with PREDICT data for comparative analyses.
- **Analyze PREDICT data to identify temporal trends (i.e. seasonality) in viral detections from wildlife.
- **Develop models to analyze projected changes to future EID hotspots with respect to recent trends and forecasts of known EID drivers.

- **Develop dynamic models to simulate risk of disease spread in livestock and human exposure under current conditions and FAO-provided future scenarios of changing livestock production systems for target countries, diseases, and livestock types under the African Sustainable Livestock 2050 project.
- **Develop spatial models to estimate new disease emergence risk and key drivers in target countries using current conditions and FAO-provided future scenarios of livestock production systems and land-use change under the African Sustainable Livestock 2050 project.
- **Continue analyses of global and local travel and risk of pandemic spread and validate models with data from past disease emergence events.
- **Identify epizones for high-risk priority viruses, based on modeled wildlife reservoir distributions and relevant EID drivers, building on previous PREDICT models for Ebola and MERS-CoV.
- **Develop and refine dynamic models (e.g. SIR models) for high-risk pathogens in animal reservoir populations and parameterize with field data; including simulation model of SADS-CoV outbreak on Chinese farms with estimation of R_0 and spread rates.
- **Model the zoonotic potential of viruses in high-priority viral families using a combination of viral traits and host and environmental associations.
- **Characterize and quantify risk pathways for Ebola virus disease emergence and spread.
- **Collate data on past antimicrobial resistance (AMR) emergence events globally and develop model to examine the spatial relationship with global antibiotic use in people and livestock.
- **Using antimicrobial resistance as a model for pathogen emergence, develop techniques that will assist in detecting emergence and spread and targeting potential policy interventions.

Expected Outcomes: Analysis of datasets needed to characterize ecological, demographic, and socio-economic factors to inform and prioritize surveillance activities; development of novel modeling and analytical approaches to forecast future changes in EID drivers, examine new socio-economic factors, and map the risk of pathogen emergence, including AMR; integration of human behavioral data into models; development and testing of models for characterizing ecological risk and predicting spillover of viruses from animals to humans; identification of epizones for key zoonotic viral groups; maps of national and international EID risk for spillover, amplification, and spread.

Sub-activity 1.2.3. Mapping viral diversity and evolution: analyzing global viral diversity and viral phylogeography to better understand the rules governing pandemic viral risk, how viruses evolve within emergence pathways, and which viral clades are more likely to spillover in which host species assemblages. (Peter, Chris, Tracey, and Simon)

- **Analyze PREDICT data to refine models to estimate viral diversity for each sampled mammal species and identify factors that influence viral diversity among species.
- **Continue co-evolutionary analyses of hosts and high-priority viruses to examine potential for cross-species transmission and human spillover, with focus on Coronavirus and Paramyxovirus datasets.
- **Continue to map viral sharing among host assemblages and evaluate viral diversity using network analysis to examine linkages among host taxa, emergence pathways, and epizones.

  Expected Outcomes: Novel approaches to map viral diversity and evolution and forecast disease emergence.

Sub-activity 1.2.4. Developing actionable surveillance improvements and risk mitigation strategies: *using modeling and other analytics to evaluate optimal surveillance strategies for biological and behavioral data collection. (Chris, Peter, Leilani)*

- **Evaluate data on shared viruses, including host traits, phylogeny, and recognized spillover and ecological risk characteristics, to prioritize animal taxa and identify important 'outlier taxa' for surveillance while maintaining consistency in standardized data collection.
- **Continue and refine cost-benefit analyses and scenario testing, as data become available, to evaluate different intervention strategies.
- **Analyze completed qualitative data from six countries to identify policy and intervention implications.
- **As surveillance, behavioral, and ecological data become available, identify specific risk mitigation and intervention strategies in target countries to prevent viral pathogen spillover at identified high-risk interfaces.
- **Collect baseline data on barriers to implementation of intervention strategies and evaluate risk mitigation models.

  Expected Outcomes: Iteratively optimized strategies and prioritization for surveillance and identification of potential targets for mitigation of spillover of viruses from animals to humans.

Activity 1.3. Potential pathogen detection and discovery and longitudinal monitoring of potential pathogens to track changes in geographic and host distribution, genetic sequences, transmissibility, infectivity, and evolution

This activity is included for completeness, but some sub-activities may not be achievable in Year 3.

***Not a GHSA funded activity.*

Sub-activity 1.3.1. Pathogen detection and discovery. (Tracey and Simon)

- Continue to implement strategy to test prioritized sample types to facilitate detection of viral sharing and/or spillover among humans and animals based on: i) evidence of direct or indirect contact between people, livestock, and wildlife; and ii) likely route of transmission, using data available to date and analyzed by viral family, transmission interface, and specimen type.
- Implement standardized testing of samples collected across interface, specimen type, host taxa, and region with laboratories ready to start testing priority viral families (influenza, paramyxovirus, coronavirus, filovirus, and flavivirus when feasible) and adding additional families (retrovirus, arenavirus, bunyavirus, reovirus, rhabdovirus, picornavirus, alphavirus) to reflect regional priorities and viral diversity based on data available to date.
- As data become available, coordinate with government partners and national and international reporting authorities to inform on the detection of viruses in animals and humans.

  Expected Outcomes: Implemented plan for standardized testing of samples collected across interfaces, specimen types, host taxa, and regions; detection of virus from prioritized specimens originating within specified pathways for emergence; and potential discovery of novel viruses from different hosts and sample types.

Sub-activity 1.3.2. Deploying serology to characterize exposure in human and animal populations and detect spillover. (Tracey and Simon)

- Identify appropriate viral targets for serologic assay development (e.g. ebolavirus serology).
- Continue working with partner laboratories to select appropriate platforms (e.g., serum neutralization, ELISA, Luminex) and to develop plans to perform assay development.
- Following their development, optimize and evaluate serologic assay(s) for the testing of field samples, including the generation or acquisition of appropriate positive/negative controls.
- Develop and implement ebolavirus serology to assist in identification of ebolavirus reservoirs and spillover hosts in Sierra Leone, Liberia and Guinea (see Activity 1.6).
- Develop a training and distribution plan to implement serologic assay(s) in participating in-country collaborating laboratories.

  Expected Outcomes: Appropriate viral targets identified for serologic assay development and appropriate platforms and laboratories selected for assay development, optimization, and testing.

Sub-Activity 1.3.3. Expanding characterization of viruses to better understand pandemic potential, geographic and host distribution, and genetic diversity. (Tracey, Simon, Chris, Jonna, Peter)

- Identify viruses for further characterization (e.g., full genome sequencing, virus isolation, identification of human receptor binding) and follow-up investigations into pathogenicity and host range.
- Continue to identify laboratories and identify and acquire samples for further characterization according to a reasonable timeline.
- **Complete coronavirus pilot project to develop a set of primers for full-genome characterization of any new coronavirus in-country by PCR as a first step towards developing the capacity to fully characterize viruses discovered with PREDICT protocols.
- Complete the genome sequencing of prioritized coronaviruses and compare the spike protein sequences and structure of receptor binding sites to better understand mechanisms facilitating host sharing of viruses.
- Complete full genome sequencing of the influenza viruses identified by PREDICT to date for comparison to other subtypes.
- Complete full genome sequencing of targeted paramyxoviruses identified in a subset of countries.
- **Develop reverse genetics system to further characterize detected paramyxoviruses.

Expected Outcomes: Refined plan to prioritize samples for follow-up virus characterization; full genome characterization of prioritized viruses.

Activity 1.4 Advancing pathogen characterization

Sub-activity 1.4.1. Tiered approach to detecting, characterizing, and identifying disease associations with bacterial pathogens. (Tracey and Simon)

- **Select appropriate, available assays for detection of bacterial genes.
- Pilot appropriate assays for limited antimicrobial resistance detection.
- Develop training plan to implement testing for bacterial pathogens in in-country collaborating laboratories.
- **Identify appropriate methods (e.g., pathology, in-situ hybridization, immunohistochemistry, serology) to link bacterial infections with illness to begin to evaluate causation.

Expected Outcomes: Appropriate optimized assays for bacterial gene detection and antimicrobial resistance; plan for training and implementation with in-country partners.

Sub-Activity 1.4.2. Mainstreaming testing protocols and comparing speed and cost-effectiveness of viral family screening approaches with standard methods. (Tracey, Simon, Billy)

- Continue to work with FAO to partner with national veterinary laboratories to test livestock samples with viral screening protocols.

- **Assess the utility and cost-effectiveness of PREDICT protocols to detect known and new viruses in livestock samples in FAO collaborating laboratories.
- Assess capacity to conduct PREDICT viral family testing in other national laboratories (e.g., public health laboratories) in collaboration with appropriate ministries, WHO, and CDC.

Expected Outcomes: Strategy for collaborative implementation and assessment of PREDICT viral family protocols for livestock and human samples to guide decision making and planning for wider implementation; comparable test result data across host taxa for targeted viral families.

Activity 1.5. Assisting host country partners in outbreaks

Sub-activity 1.5.1. Strengthening existing relationships with host country governments and building partnerships to increase synergies between national task force and response planners and project teams. *(Billy, Brian)*

- Continue to coordinate with ministries and EPT partners on technical recommendations that could be provided to national task forces, One Health platforms, and GHSA partners for optimizing outbreak response.
- Continue to evaluate broad categories of partners involved to date and to identify major areas where global and in-country partnerships might be strengthened in both the short-term and long-term.

Expected Outcomes: Expanded network of professionals available that can be utilized to support outbreak response capacity and collaborations across episodes.

Sub-activity 1.5.2. Training, equipping, and supplying project teams to ensure a constant state of preparedness for contributing technically and substantively to focused outbreak response. *(Woutrina, Brian)*

- Coordinate with technical partners (e.g., P&R, OHW, CDC, WHO, FAO) in preparation of scenario-based in-service training for outbreak response assistance.
- Pilot test and update training materials on an annual basis or as needed based on new outbreak developments.
- Utilize updated outbreak preparedness and response protocols (Outbreak Response Guidance, Human-Animal Survey Instruments, and Outbreak Report short forms) during in-service, scenario-based training and outbreak response activities.
- Participate in preparedness exercises and training events as relevant to create a locally-responsive and globally-networked health community.
- Coordinate with EPT and implementing partners in the equipping and supplying of teams involved with outbreak response events.

Expected Outcomes: Refined training materials; improved knowledge and preparedness to participate in transdisciplinary teams during focused scenario training and actual outbreak response efforts; improved communication and coordination across partners and agencies involved with disease detection and outbreak response.

Sub-activity 1.5.3. Outbreak response, targeted surveillance during and between disease outbreaks, and sharing of data to inform on new or modified policies and practices for outbreak preparedness and response. (Chris, Brian)

- Support in-country implementing partners by providing technical assistance and conducting investigations during outbreaks of undiagnosed illnesses in humans and animals at the request of host country governments through field investigations, human and animal contact surveys, biological surveillance of suspected animal hosts, and testing of animal and human specimens using targeted viral detection techniques to identify potential cause(s) of disease.
- Support in-country implementing partners in analyzing outbreak investigation data to understand epidemiological factors facilitating spillover and spread of disease during outbreaks and to identify targets for disease control and prevention.
- Support in-country implementing partners in targeting surveillance activities between outbreaks to monitor key epidemiological factors facilitating spillover, including biological and ecological characteristics of host species and human activities facilitating contact with host species.
- Support in-country implementing partners in reviewing data gained from targeted surveillance during and between disease outbreaks to inform on new or modified policies and practices for outbreak preparedness and response and share information across EPT partners.

Expected Outcomes: Improved outbreak investigations that inform and target surveillance activities; engagement of partners in outbreak response and sharing of results.

Activity 1.6. Identifying potential animal reservoir(s) and transmission hosts for Ebola virus in Guinea, Liberia, and Sierra Leone
Identify animals that may act as reservoir or transmission hosts for Ebola virus to develop and target prevention measures that reduce the risk of spillover from animals to people.

Sub-activity 1.6.1. Surveillance for Ebola and other filo viruses. (Brian, Chris)

- Optimize field-study data collection instruments and survey tools for ebola-specific data collection.

- Identify sampling sites with high levels of Ebola virus disease and high human-animal contact in varying ecological zones (forest, rural, semi-urban, urban).
- Establish sampling strategy to cover potential reservoir host taxa (wildlife) and potential spill-back hosts (livestock and domestic animals) that may have been exposed to human EVD cases.
- Establish repeated longitudinal sampling to capture seasonal variations at study sites to span relevant key environmental time-periods among key target animal taxa (i.e. dry-season, wet-season, breeding season).
- Identify and characterize high-risk interfaces, epizones, and surveillance priorities for Ebola virus transmission.
- Continue to explore animal value chains, in coordination with EPT and in-country partners, to refine targeted opportunities for surveillance and improve understanding of animal movements for Ebola virus emergence and spillover.

Expected Outcomes: Strengthened in-country capacities in West Africa for surveillance to detect Ebola and filo viruses; optimized surveillance priorities for identification and characterization of pathways for Ebola virus disease emergence and epizones.

Sub-activity 1.6.2. Develop and utilize testing technologies to detect EBOV and filovirus infection (molecular techniques) or evidence of previous infection (serology) in wildlife and livestock. (Brian, Tracey, Simon)

- Compare viral family PCR for filovirus with previously published EBOV-specific assays for use in wildlife and livestock samples.
- Identify appropriate assay(s) for technology transfer to in-country laboratories.
- Sequence genomes of all positive samples using high-throughput sequencing.
- Develop in collaboration or coordination with in-country and EPT partners (CDC, WHO, and FAO) reagents for serologic assays (antigens, positive control sera, secondary antibodies).
- Develop and optimize ELISA or other technology-based serologic assays for use in wildlife and livestock species.
- Determine feasibility of technology transfer of serologic assays to in-country laboratories where available.

Expected Outcomes: Optimized molecular and serologic assays for Ebola and other filo viruses in targeted animal taxa; sharing of protocols and reagents across EPT partners (CDC, WHO, FAO and others) as feasible.

Sub-activity 1.6.3. Site characterization and pilot human surveys at select high-risk animal-human interfaces to examine risk of Ebola virus transmission. (Brian, Chris, Leilani)

- Implement the human behavioral questionnaire with Ebola-specific questions alongside concurrent animal surveillance activities.
- Characterize human Ebola exposure and history of animal use to investigate animal-human interface transmission risk (data from questionnaire on treatment, time spent in an Ebola treatment center).

Expected Outcomes: Standardized data collection protocols with Ebola-specific questions added; pilot human behavioral surveys with concurrent animal surveillance activities.

Objective 2: Characterizing Behavioral Risk

Characterize contact among people, livestock, and potential wildlife reservoirs; investigate the correlations between human behavior and zoonotic disease risk to understand the behavioral mechanisms of high-risk pathways for disease emergence and spread; identify potential control points and behavior change options; and field pilot strategies to evaluate behavior change interventions that can be taken to scale.

Activity 2.1. Standardizing approaches to study human behavioral risk
Identify and monitor behaviors, attitudes, practices, and socio-cultural norms and conditions that facilitate animal-human and animal-animal contact and influence the spillover, amplification, and spread of zoonotic pathogens.

**Not a GHSA funded activity.

Sub-activity 2.1.1. Developing frameworks and standardizing approaches for behavioral risk data collection to understand human-animal interactions and their associated meaning and rationale. (Leilani, Karen)

- Continue developing and strengthening partnerships to coordinate activities for human behavioral risk data collection.
- Continue integrating human behavioral risk data collection with concurrent biological sampling along targeted pathways and epizones.
- Continue to support the submission and monitoring of IRB protocols for the ethical conduct of human subjects research for additional qualitative and quantitative behavioral studies.
- **Complete the analysis of Deep Forest Human Contact survey data to inform and refine the human behavioral questionnaire.

Expected Outcomes: Integrated partnerships for the coordination of concurrent behavioral risk data collection; refined and standardized data collection protocols and training materials for the human behavioral questionnaire and biological sample collection; finalized sampling and

recruitment strategies; IRB approvals solicited and/or acquired; human behavioral questionnaire implemented with concurrent surveillance activities.

Sub-activity 2.1.2. Conducting semi-structured, targeted ethnographic assessments in natural settings at prioritized biological and ecological surveillance sites to characterize behavioral risk along high-risk pathways for disease emergence and spread. (Leilani, Karen)

- Analyze qualitative data from focus groups, ethnographic interview transcripts, and field notes to better understand relationships among human-animal contact, the context of contact, and unusual disease experiences as perceived by individuals at high-risk of disease spillover.
- Expand ethnographic interview and focus group discussion data collection to include up to 10 additional countries.
- **Analyze qualitative data for actionable insights from six countries where data collection is complete: China, Indonesia, Cameroon, DRC, Bangladesh and Uganda.
- Evaluate qualitative data to identify any evident intervention strategies, as well as any barriers or opportunities to risk mitigation interventions.

Expected Outcomes: Qualitative data from prioritized sites collected and analyzed; novel findings and actionable insights from qualitative data analysis reported; qualitative data used to identify or develop policy recommendations and risk mitigation strategies.

Activity 2.2. Identifying potential intervention points
Develop and measure indicators and integrate data from biological surveillance, behavioral risk characterization, and economic and anthropologic studies to identify potential targets for intervention to reduce the risk of viral amplification and spread.

Sub-activity 2.2.1. Combine data collected from human behavioral questionnaire with biological and ecological surveillance data; develop and measure key indicators of high-risk contact among demographic groups to identify high-risk subpopulations and determine relationships between high-risk contact indicators and biological, ecological, and socio-behavioral data. (Leilani, Karen, Chris, Peter)

- Analyze qualitative data in conjunction with human behavioral questionnaire data to refine key indicators of high-risk contact.
- Analyze human behavioral questionnaire data with results from biological sampling to identify high-risk subpopulations and to potentially specify disease spillover mechanisms (e.g., eating raw wildlife, cuts and scratches acquired through slaughtering practices).
- Analyze human behavioral questionnaire data with biological sampling data, for evidence of viral sharing between animal reservoirs and humans.

- Analyze human behavioral questionnaire data with ecological data to determine if human high-risk indicator activity or prevalence is associated with ecological context data.

  Expected Outcomes: Key indicators of high-risk contact and high-risk context developed and refined; indicator data shared within project for incorporation into analytic modeling frameworks; integration of human and animal data for exploration of viral sharing and indicators of drivers for spillover.

Sub-activity 2.2.2. Target specific high-risk contact behaviors commonly reported and associated with increased risk for further in-depth study and to advise on suitable intervention approaches. (Leilani, Karen, Chris)

This activity is included for completeness, but some sub-activities may not be achievable in Year 4.

- Begin to prioritize high-risk contact behaviors conditional on context for further in-depth study.
- Develop and prioritize data-informed policy and intervention targets as data become available.
- Based on the development of suitable intervention and policy approaches, create additional qualitative data collection tools to assess opportunities and barriers to success of specific intervention approaches, as well as to solicit community input on possible alternative engagement strategies.

  Expected Outcomes: Identify targets for policy recommendations and intervention strategies; anticipate and solicit community-based alternatives to challenges posed by specific policies and strategies.

Objective 3: Improving Global Surveillance Networks

Strengthen internal data storage and sharing platforms to improve the ease of collection, synthesis, storage, access, and dissemination of relevant animal and human, spatially explicit epidemiological, and ecological data.

Activity 3.1. Standardizing data collection

**Not a GHSA funded activity.

Sub-activity 3.1.1. Standardizing human and animal data management: developing and optimizing tools for the collection of standardized data on human and animal hosts and pathogens; behaviors and risks of disease emergence; and drivers, ecological conditions, and transmission interfaces during standard surveillance and outbreak situations. (Damien, Chris, Leilani, Tracey, Simon)

- Develop and refine surveillance, behavior, and ecological data collection tools already developed, based on feedback from field testing.
- Develop a system for entering and linking ethnographic interview, focus group, and field note data to surveillance and ecological data.
- Develop and refine a data quality tool to enable review of submitted data for assurance of consistency and standardization (QA/QC).

Expected Outcomes: Improved tools for standardized surveillance and behavioral data collection with improved validation and data QA/QC workflow over previous tools.

Sub-activity 3.1.2. Enhancing digital surveillance and outbreak intelligence: collecting, filtering, geo-referencing, and integrating publicly available information on emerging diseases with human and animal field surveillance data. (Damien)

- **Continue to develop the system with HealthMap to provide near real-time digital disease detection intelligence (e.g., HealthMap alerts) to government and host country partners, including country-specific feeds and training materials on the use of HealthMap and ProMED.
- Field test outbreak response assistance tools, including streamlined communication and outbreak response methods and standardized data collection procedures.

Expected Outcomes: Improved tools for global and in-country intelligence on disease outbreaks.

Activity 3.2. Synthesizing global data
Build on and extend the Emerging Infectious Disease Information Technology Hub (EIDITH) to create a secure and internal globally accessible database to house aggregated human behavioral risk, biological surveillance, and outbreak information with novel analytic and visualization tools.

Sub-activity 3.2.1. Expanding EIDITH to provide the access and integration capabilities necessary for biological, ecological, and behavioral risk characterization and progress tracking for deliverables and annual data reviews. (Damien, Chris, Leilani, Tracey, Simon)

- Continuously adapt and refine the EIDITH database structure for efficient storage of surveillance, ecological, and behavioral data, including diagnostic test results for human and animals (expanding beyond current focus on animal data).
- Refine and maintain the EIDITH surveillance databases that include human surveillance and behavior data linked to animal surveillance data by geographic space and time.

- Continuously improve the EIDITH data query, extraction, and reporting tools for efficient and effective reporting of surveillance, ecological, and behavioral data for deliverable tracking and annual data reviews.
- Continue developing and refining database structure, import and export tools, and data access and management policies and procedures.
- Develop visual maps and charts within the data collection app to aid in the tracking the locations, interfaces, and taxa groups where sampling has occurred.

Expected Outcomes: Improved EIDITH performance and capacity to handle the expanded scope of activities; relational databases for human data developed and linkages tested; tools in use by global and in-country teams for tracking and reporting; a globally accessible database of known and potential pathogens.

Activity 3.3. Disseminating global data
Provide data on results for policy use, response, and meeting IHR and OIE reporting obligations; distribute data for public release using a globally accessible public portal; and incorporate processed risk-characterization data coupled with clearly documented, cross-cutting forecasting of risk resulting from the characterization process. (Damien, Chris, Billy, Tracey)

- Continue to determine key areas of overlap between data collection strategies and IHR and OIE reporting requirements to develop a strategy to best utilize data collected to facilitate in-country achievement of reporting obligations.
- Continue to refine and enhance the PREDICT public data access portal (http://data.predict.global), specifically providing enhancements to incorporate risk characterization data and risk forecasting, as well as other enhancements to facilitate multilateral reporting requirements.

Expected Outcomes: Improved sharing and release of data with host country governments, EPT partners, and the public.

Objective 4: Validating One Health Approaches

Conduct a systematic and dedicated effort to validate and evaluate the utility of One Health approaches using all available evidence.

**Not a GHSA funded activity.

****Activity 4.1. Promoting policies and practices that reduce the risk of viral evolution, spillover, amplification, and spread**
In collaboration with government, EPT/P&R project, and inter-agency partners, develop the evidence base to support the strategic application and institutionalization of policy approaches promoting transdisciplinary cooperation;

compile and create case studies for situations in which a One Health approach has been used; and support efforts to more effectively utilize One Health platforms. (Billy)

- Disseminate the One Health case study booklet ('One Health in Action', co-developed with P&R) to country and global partners.
- Develop a case study template to capture/promote quantitative data and begin compiling case studies for version two of the case study booklet, with emphasis on quantitative measures.
- As part of the One Health data collection tool, begin compiling information on results reporting to communities and any mitigation measures employed.
- Continue to track and interpret findings from literature searches (peer-reviewed, reports, pubs, etc.) to identify examples of One Health in practice and compile qualitative and quantitative information for One Health case studies.
- Continue to engage in-country government partners, as well as partners from other EPT-2 projects, FAO, WHO, CDC, World Bank, and other local, regional, and intergovernmental entities, in the prospective and retrospective assembly of information to validate the use of One Health approaches.
- Based collected data, coordinate with P&R to conduct an analysis on gender equality and integration to elucidate how comprehensive representation contributes to a more successful One Health approach, especially around risk mitigation and prevention strategies.
- Work with P&R to help determine and encourage best practices for overcoming gender bias in One Health efforts, as well as provide information to P&R, OHW, and other EPT partners on populations that could be further integrated into One Health approaches (e.g., economically, culturally, and occupationally).
- Continue to evaluate potential inter-agency partnerships to assess the viability and palatability of potential policies informed by One Health activities.
- Contribute to outreach tools (e.g. short topic videos, blogs, presentations/events) to support awareness and cross-sectoral relevance of policies and practices that reduce risk of emerging viral threats (involving P&R partners).

Expected Outcomes: Quantitative One Health case studies generated/compiled; One Health best practices library expanded, including community reporting as a component; identification of broad factors contributing to gender or other biases in disease risk or risk mitigation; guidance on populations that could be further integrated into One Health efforts, as well as measures identified that might be taken to integrate underrepresented populations; potential examples of policy changes that could or have resulted from demonstrated One Health successes.

****Activity 4.2. Improving cross-sectoral collaboration, capacity development, and coordination with EPT-2 partners**

Sub-activity 4.2.1. Improving cross-sectoral collaboration by promoting strong communication and data sharing opportunities that support One Health approaches and demonstrating the value of adopting One Health approaches for biological surveillance, capacity building, and outbreak response. (Billy)

- Continue to maintain communications with EPT-2 global partners, including through maintenance and sharing of the EPT-wide partner contact list.
- Building on Year 2 progress, conduct policy engagement with priority policy processes and policy-making institutions, including OFFLU, GHSA, international animal trade regulators, such as OIE, CITES, the WHO Expert Roster on Zoonoses, the European Food Safety Agenda, Toward a Safer World initiative, the WHO-CBD Joint Work Programme on Biodiversity and Human Health, and the UN Office for Disaster Risk Reduction.
- Work jointly with P&R to complete the final version of their Supplemental Guidance (Planning Tool) and the Audit Tool, promote their dissemination and uptake by the private sector and development project financers, and examine the mitigation measures proposed and review the existing literature to determine current cost-effective mitigation measures that should be recommended in different hot spot areas.
- In collaboration with P&R, develop suggested updates for the International Finance Corporation's Environmental, Health and Safety guidelines and supporting evidence summary.
- Support P&R at both the international and national levels to engage the private sector as stakeholders in the One Health approach to prevention, preparedness, and response by working jointly to help build the business case and develop materials on the value of private sector participation in One Health (via cost-effectiveness scenarios).
- Provide One Health input on the proposed indicators for the Sendai Framework for Disaster Risk Reduction.
- Through ongoing communication with EPT partners, continue to identify EPT One Health activities for which PREDICT could offer technical support.

Expected Outcomes: Efficient communication pathways with EPT-2 partners; policy engagement; development of data sharing plan.

Sub-activity 4.2.2. Support collaborative platforms and partnerships for longitudinal monitoring of viral threats and monitoring of the use of One Health approaches in surveillance and outbreak response situations for comparison with other contemporary (single-silo) outbreak responses. (Billy)

- Through ongoing coordination with partners, continue to identify opportunities to compare One Health approaches to contemporary surveillance and outbreak response approaches (potentially informed by

P&R's After-Action Reviews) to conduct and refine analyses, including on potential savings from prevention, early warning/detection, or other outcomes that will be calculated and shared with EPT-2 partners.
- Toward furthering implementation of prevention and preparedness measures, collaborate with the UN Office of Disaster Risk Reduction on their pilot project on integration of health emergencies (including outbreaks) into disaster risk loss data collection in Guinea, Liberia, and Sierra Leone.

Expected Outcomes: Components of wildlife disease surveillance needed for longitudinal monitoring of viral threats refined**;** comparative analysis of approaches and cost or cost savings analyses continued and methods/outreach optimized; recommendations developed with partners on targeted intervention options; policy-relevant global indictors for outbreak prevention, preparedness, and response effectiveness refined.

Sub-activity 4.2.3. Advancing socio-economic arguments by conducting global scale analyses of the economics of pandemic mitigation vs. adaptation policies directly applied to the World Bank/FAO One World, One Health capacity building plan. (Billy)

- Continue process planning and stakeholder engagement through calls and meetings with partners from the World Bank to promote integration/complementarity with the One Health capacity building plan.
- In partnership with the World Bank and in coordination with P&R, hold an expert workshop and high-level forum on One Health economic evaluation as a follow up to the 2012 'People, Pathogens and Our Planet' report to identify key policy-oriented information gaps and develop and disseminate a global strategy.
- Continue to assemble available data for the global-scale analysis of the economics of pandemic mitigation versus adaptation policies; based on the global strategy developed from the One Health economic evaluation workshop; implement a plan for conducting and refining analyses (potentially at a country level in collaboration with P&R).
- Continue to conduct economic analyses of specific intervention strategies enacted or proposed for recent outbreaks (e.g., Ebola, SARS), which can be used support EPT-2 partners in policy development and developing messages for outreach to the private sector.
- Continue to analyze the costs of emerging disease outbreaks of relevance to EPT.
- Share methodologies, best practices, and case examples and co-developed materials on One Health systematic evaluation and policy outreach with partners in the EU COST Network for the Evaluation of One Health, as well as in the development of the Checklist for the One Health Epidemiological Reporting of Evidence.

Expected Outcomes: Stakeholder engagement and data collection tools and evaluation framework developed; pilot analyses refined; baseline data generated and built upon; global One Health evaluation strategy developed and endorsed by high-level institutions (with targeted commitments to fill key data/policy gaps).

Sub-activity 4.2.4. Sharing lessons learned among EPT partners and projects for utilization in national preparedness plans for public health events, for proposed incorporation into curricula for the One Health Workforce (OHW) and for validating evidence-based strategies to share with the P&R program to inform best practices and implementation guidelines at national levels. (Billy)

- Continue to hold coordination calls and email communication with OHW and P&R project personnel, FAO, and CDC.
- Collaborate with P&R and external partners (e.g. CBD) to disseminate evidence-based strategies to support effective One Health platforms and One Health evaluation on priority areas (e.g. data for decision making, research coordination to inform policy, disease prioritization, and others)
- In collaboration with P&R (and its Learning Agenda) and in coordination with country stakeholders, identify priority regional, country, or community-level policy questions for application of One Health effectiveness evaluation and begin targeted data compilation and analysis with a strategy for stakeholder engagement.

Expected Outcomes: Frequent information sharing and collaboration with EPT partners; ongoing sharing of best practices with EPT partners; targeted One Health questions identified for addressing; engaged stakeholders.

Sub-activity 4.2.5. Support the training of the next generation of One Health professionals through coordinated activities with EPT and inter-agency partners. (Billy)

- Continue to conduct strategic planning and coordination with other EPT projects and partners to promote capacity development at the epizone scale.
- Identify promising candidates to participate in diverse training opportunities.
- Participate in meetings, conferences, and trainings/workshops to share best practices across EPT projects and inter-agency partners.
- Compile One Health capacity building tools with EPT partners (e.g. an optional training module)
- Strengthen relationships with key institutional partners to build sustainability.

Expected Outcomes: Dialogue and coordination across EPT projects and inter-agency partners; development of training opportunities that contribute to capacity strengthening; placement of key individuals to receive training; enhanced project sustainability through institutional partnerships.

Objective 5: Strengthening Capacity

Add depth and scope to transdisciplinary One Health platforms using a systems approach to classify and track biological surveillance and behavioral risk characterization advances, thereby strengthening surveillance system capacities.

**Not a GHSA funded activity.

Activity 5.1. Systems approach to capacity building for wildlife, livestock, and human surveillance

Develop materials, conduct trainings, and track progress to address all areas of project design and implementation that will improve infrastructure and capacity to perform surveillance-related activities; coordinate with OHW and P&R projects on training and capacity strengthening plans along with complementary activities.

Sub-activity 5.1.1. Strengthening biological sampling and behavioral risk characterization capacity. (Woutrina, Chris, Leilani)

- Continue to conduct capacity scoping and assessments along with evaluation of ongoing capacity strengthening activities in areas of new engagement.
- Plan strategic activities to build capacity for biological sampling and behavioral risk assessment and characterization along high-risk pathways for disease emergence.
- Develop and continue revising protocols and training tools that build and test technical knowledge and skills related to biosafety, biological sampling, laboratory protocols, surveillance, behavioral risk investigations, assistance during outbreaks, and information management.
- Distribute protocols and training materials to participating countries and partners to strengthen in-country capabilities.
- Conduct and participate in training events related to biological sampling and behavioral risk assessment and characterization to build capacity at the local, national, and international levels.
- Provide Collaborative Institutional Training Initiative (CITI) training for all partners implementing human surveillance and behavioral risk activities.
- Continue training local public health professionals and other partners in human behavioral data collection techniques and preliminary analyses.
- Continue to identify and facilitate training opportunities for project staff and to develop and pilot new technologies for training and knowledge transfer in One Health, surveillance, pathogen detection, and information management.
- Develop and launch a system for assuring trainings are conducted with and knowledge and skills attained by all relevant personnel prior to taking part in project activities.
- Track and monitor capacity strengthening progress on an annual basis using a standardized protocol across countries and epizones.

Expected Outcomes: Systematic capacity building plans to optimize project implementation strategies; updated protocols and training materials; increased awareness of the importance of biological surveillance and human risk behavior data in successfully addressing emerging infectious disease issues; trainings conducted for human behavioral questionnaire and specimen collection; improved communication among human and animal health partners in-country.

Sub-activity 5.1.2. Technical support for viral surveillance and strengthening of laboratory capacity. (Tracey and Simon)

- Continue to identify training needs for collaborating laboratories to improve sample handling, nucleic acid extraction, biosafety, and performance of cPCR.
- Revise protocols as needed and provide refresher and annual basic training to staff in collaborating laboratories.
- Continue to identify priority laboratories and training for in-person training to improve performance and capacity.
- Distribute reference panels to perform quality control and assessments of laboratory procedures for deployment to all in-country collaborating laboratories.
- Continue to strengthen communication networks of key PREDICT partner labs to provide peer support for technical troubleshooting and data analysis.
- Begin development of training modules for introductory training on basic sequence analysis and bioinformatics.
- Track training and progress on an annual basis using a standardized protocol across countries and epizones.

Expected Outcomes: Completed plan for basic and follow-up training to improve the quality of cPCR results and sequences for analysis; active communication among lab personnel to enhance quality assurance and capacity.

Sub-activity 5.1.3. Strengthening information management capacity. (Woutrina, Damien)

- Plan strategic activities to continue to improve information management capacity locally and globally.
- Continue to compile, revise, and distribute available protocols and training materials related to information management.
- Conduct training exercises relating to information management skills and technologies that build capacity at the local, national, and international levels.
- Track training and progress on an annual basis using a standardized protocol across countries and epizones.

Expected Outcomes: Development of information management training materials; disseminated knowledge and training materials to in-country personnel.

***Sub-activity 5.1.4. Strengthening risk management capacity though training on basic data analysis tools, spatial mapping, and disease modeling.* (Woutrina, Peter)

- Identify key gaps and opportunities for capacity building related to risk management at the local and national levels.
- Conduct and participate in regional or country-level training exercises relating to risk management skills and technologies, such as data analysis, spatial mapping, and disease modeling.
- Support in-country scientists through in-depth training and collaborative analyses to develop local capacity in risk modeling of EIDs.
- Track capacity strengthening progress on an annual basis using a standardized protocol across countries.

Expected Outcomes: Increased numbers of trained individuals able to utilize data analysis and modeling tools to inform risk management; development and refinement of new training materials; submission of annual capacity tracking progress report.

Objective 6: Assisting Organization of USAID EPT-2 Annual Data Review Meetings

**Not a GHSA funded activity.

****Activity 6. In close coordination with USAID and other EPT-2 projects and partners (including FAO, CDC, WHO, etc.), organize annual data reviews to optimize and refine ongoing and future activities.** **(Billy)**

- Review Year 2 data meeting structure, partner representation, and outcomes with USAID to identify refinements needed for Year 3 meeting
- Refine the draft data sharing plan with EPT-2 partners as needed.
- Plan the Year 3 global data meeting, including requesting, assembling, and collating agenda priorities from partners into a meeting agenda and identifying participants.
- Assess progress on and utility of proposed cross-project or comparable data sharing platforms.
- Use selected country-level discussions to strengthen One Health platforms and produce recommendations to be utilized by P&R around sustained cross-sectoral collaboration, including through data sharing.
- Continue to explore/refine the compilation of and potential improvements to global data sets of influenza and other respiratory pathogens, potentially

with input from external partners, e.g. OFFLU, Influenza Research Database, etc. (exploring optimized ways to link bio-surveillance data to response through "IT portals").
- In follow up to the global data review meeting, generate a list of action items to support the advancement of effective data sharing and compose recommendations for programmatic adjustments as needed.

Expected Outcomes: Identification of existing and pending available data sets; broad ideas and plans for longitudinal data sets; strengthened and efficient communication across partners; more direct and targeted lines of communication with global partners for data reporting; identification of needs/opportunities for more streamlined data outputs for more efficient integration into global reporting systems; identification of recommendations for programmatic adjustments, including more targeted data discussions for Year 4.

Objective 7. Managing and Coordinating Operations

Maintain collaborative and adaptive management of program operations and ensure compliance with agency policies and procedures. Activities in this objective are required for successful implementation of PREDICT's contributions to the GHSA. **(David)**

**Not a GHSA funded activity.

- Collaboratively develop work plans and project strategy.
- Execute and monitor award, sub-award agreements, sub-contracts, and service agreements and ensure compliance.
- Hold biweekly coordination meetings with Management Team and biweekly coordination meetings with Executive Board, with frequent communication and meetings for project planning between these meetings of leadership.
- Develop and compile semiannual technical reports, quarterly financial reports, GHSA technical and financial reports (monthly, quarterly, and annual), capacity strengthening tracking reports, and environmental management and mitigation reports; respond to other requests for information as needed.
- Continue to develop, refine, track, and report on monitoring and evaluation indicators and integrated plans with ministries and EPT partners to optimize program performance.
- Ensure frequent and regular communication with operational leads on activity plans, deliverables, and progress.
- **Provide management, administrative, and logistical support to the Global Virome Project.
- Coordinate and track travel among participants and facilitate travel approvals.

- Track and catalog all program communications and publications, including partner communications and reports for GHSA and government partners and USAID Missions.
- Continue to work with global and regional vendors to improve supply procurement and distribution of both field and laboratory supplies.

Expected Outcomes: Completion and implementation of workplans; ongoing refinement of systematic and collaborative implementation strategy; ensured compliance with USG policies and regulations and with host country policy and regulations; timely submission of all reports and response to data call requests; successful communications with EPT, GHSA, and interagency partners; cataloging and monitoring of all submitted updates and progress reports to host country partners; continued communications with vendors for improving supply chains; refined M&E indicators with EPT partners with data tracked and integrated into project reporting streams.

From: David J Wolking <djwolking@ucdavis.edu>
Sent: Wed, 30 Aug 2017 16:18:58 +0000
To: David J Wolking <djwolking@ucdavis.edu>, Molly Turner <turner@ecohealthalliance.org>
Cc: Alison Andre <andre@ecohealthalliance.org>, Amanda Andre <amanda.andre@ecohealthalliance.org>, Ava Sullivan <sullivan@ecohealthalliance.org>, Catherine Machalaba <Machalaba@ecohealthalliance.org>, Evelyn Luciano <luciano@ecohealthalliance.org>, Kevin Olival <Olival@ecohealthalliance.org>, Leilani Franciso <francisco@ecohealthalliance.org>, Peter Daszak <daszak@ecohealthalliance.org>, William Karesh <karesh@ecohealthalliance.org>, "predict@ucdavis.edu" <predict@ucdavis.edu>
Subject: [predict] Re: Updated agenda for NYC meeting and logistics

Great, thanks!

On Tue, Aug 29, 2017 at 14:12 Molly Turner <turner@ecohealthalliance.org> wrote:

> Hi David,
> We're working on a dinner reservation for Monday night and will let you know when those details are finalized.

In response to your other comment, Peter and Kevin would like to do the September 13th M&A team breakout in addition to the Monday evening meeting, as they would like to be able to review some slides as a group before Tuesday, but would also like to save some time on the 13th to collaborate with other teams and potentially address USAID feedback as a group. Kevin's sending around an email now to those who will be involved in the Monday evening breakout meeting.

We think that the event space is large enough for people to have breakout meetings without needing a separate room; I believe it will already be arranged as tables of 5-6 throughout the three days. There is also a common area that Amanda is confirming will be available if people would prefer a separate space. We're happy to inquire further though as to breakout room availability.

Best,
Molly

On Mon, Aug 28, 2017 at 7:25 PM, David J Wolking <djwolking@ucdavis.edu> wrote:

> Hi Amanda and EHA team,
> Just wanted to share an updated agenda for NYC. Jonna and I just worked through the schedule this afternoon and made some changes to all 3 days. There are a few questions on logistics for meeting space, follow-up on reservations for dinners, and breakout meeting times that we may need to discuss.

Let me know if you have any questions and happy to talk anytime, I'm pretty free tomorrow.

Apologies to Molly also, just seeing your request for a call to chat budgets today, I was booked from sunrise to happy hour, poor me. I'm sure things are no better on your coast :-(

Cheers,

David

--
Molly Turner
Federal Grants Coordinator

EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001

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1 REDACTED (cell)
www.ecohealthalliance.org

EcoHealth Alliance leads cutting-edge scientific research into the critical connections between human and wildlife health and delicate ecosystems. With this science, we develop solutions that prevent pandemics and promote conservation.

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Sent from Gmail Mobile

From: Corina Grigorescu Monagin <cgmonagin@ucdavis.edu>
To: Andrew Clements <aclements@usaid.gov>, Brian Bird <bhbird@ucdavis.edu>
Cc: "predict@ucdavis.edu" <predict@ucdavis.edu>
Sent: Wed, 13 Sep 2017 15:59:38 +0000
Subject: [predict] Re: Question about FAO lab work in Guinea and Sierra Leone

Thanks Andrew – that's really helpful to know and can be used to address the question of capacity to address priority zoonotic diseases.

Corina Monagin, MPH, DrPH
Project Scientist, PREDICT Project of USAID
One Health Institute
School of Veterinary Medicine
University of California Davis
1089 Veterinary Medicine Drive
Davis, CA 95616, USA

Mobile: +1.415.741.6996

From: Andrew Clements <aclements@usaid.gov>
Date: Wednesday, September 13, 2017 at 11:44 AM
To: Brian Bird <bhbird@ucdavis.edu>, Corina Grigorescu Monagin <cgmonagin@UCDAVIS.EDU>
Subject: Fwd: Question about FAO lab work in Guinea and Sierra Leone

See below.

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov
Begin forwarded message:

From: Lindsay Parish <lparish@usaid.gov>
Date: September 13, 2017 at 11:02:02 AM EDT
To: Andrew Clements <aclements@usaid.gov>
Cc: Kendra Chittenden <kchittenden@usaid.gov>
Subject: Re: Question about FAO lab work in Guinea and Sierra Leone

Hi Andrew,

From the FAO work plans, FAO will be providing training on how to do diagnostic tests for several of the priority zoonotic diseases in both SL and Guinea. I believe this would make use of the lab equipment that FAO is procuring.

Cheers,
Lindsay

On Wed, Sep 13, 2017 at 10:44 AM, Andrew Clements <aclements@usaid.gov> wrote:
Hi Lindsay and Kendra,

At today's Predict meeting, a question came up about what sort of follow up FAO is providing along with the equipment being procured for the vet lab in the two countries. Is it simply a lab-outfitting operation or is there training also in included?

Thanks!

Andrew

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

--

Lindsay Parish, PhD
Infectious Disease and Vaccine Advisor

Dual Appointment:
Emerging Threats Division, Office of Infectious Disease
USAID/Washington, Bureau for Global Health
Research Division, Office of Agriculture Research & Policy
USAID/Washington, Bureau for Food Security
Office: (202) 712-4838
Cell: REDACTED

From: Kama Garrison <kgarrison@usaid.gov>
Sent: Thu, 14 Sep 2017 21:10:48 -0400
Subject: Fwd: Agenda for tomorrow's call
To: Anna Helland <anna.helland@jhu.edu>
Cc: Kendra Chittenden <kchittenden@usaid.gov>, Shana Gillette <sgillette@usaid.gov>, Dorothy Peprah <dpeprah@usaid.gov>, Amalhin Shek <ashek@usaid.gov>, Andrew Clements <AClements@usaid.gov>, Cara Chrisman <cchrisman@usaid.gov>, David J Wolking <djwolking@ucdavis.edu>, Brian Bird <bhbird@ucdavis.edu>, Leilani Francisco <francisco@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>, Elizabeth Serlemitsos <eserlem1@jhu.edu>, Jane Brown <jane.brown@jhu.edu>, Alisa Pereira <apereira@usaid.gov>
SL BT P2 call.docx

cc-ing Anna Helland. The Breakthrough Action Field Director.

Thanks all
Kama

---------- Forwarded message ----------
From: **Kendra Chittenden** <kchittenden@usaid.gov>
Date: Thu, Sep 14, 2017 at 3:15 PM
Subject: Agenda for tomorrow's call
To: Alisa Pereira <apereira@usaid.gov>, Amalhin Shek <ashek@usaid.gov>, "Andrew Clements (GH/HIDN)" <aclements@usaid.gov>, Cara Chrisman <cchrisman@usaid.gov>, David J Wolking <djwolking@ucdavis.edu>, Dorothy Peprah <dpeprah@usaid.gov>, Kama Garrison <kgarrison@usaid.gov>, Leilani Francisco <francisco@ecohealthalliance.org>, Predict inbox <predict@ucdavis.edu>, Shana Gillette <sgillette@usaid.gov>, Brian Bird <bhbird@ucdavis.edu>, Elizabeth Serlemitsos <eserlem1@jhu.edu>, Jane Brown <jane.brown@jhu.edu>, Jonna Mazet <jkmazet@ucdavis.edu>

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Kendra Chittenden, Ph.D. | **Senior Infectious Disease Advisor| USAID** | mobile (703-209-5424) |KChittenden@usaid.gov

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Kama G. Garrison, MPH
Sr. Social Behavior Change Advisor
USAID/GH/MCHN/RPD
Ph: 571.551.7379
M: REDACTED

Call with USAID, Breakthrough Action, and PREDICT Sierra Leone teams
September 15, 2017, 10 am- 11am

Call in line: REDACTED International Dial-in number: REDACTED (toll charges apply)
Access code REDACTED

I. **Introductions** – Kendra
II. **Objectives of call** - Kendra
III. **USAID SL GHSA** - Dorothy
IV. **Goals for coming field visit** - Dorothy
V. **Wrap-up discussion & Next steps** for behavioral/communities joint activities-Shana

Notes (not for distribution):

I. Names and roles of all call participants - all

II. Objectives of call- Kendra
- Brief introduction the two projects
- to begin a productive ongoing dialogue on how BA & PREDICT will collaborate

III. USAID SL GHSA - Dorothy
- Brief overview of USAID SL GHSA projects and process
    - Key activities: One Health Platforms, CVL Renovation & zoonotic disease surveillance
    - Commitment to our GoSL relationship, collaboration & capacity building
    - Commitment to communication and collaboration among all USAID GHSA partners

IV. Scoping visit goals and actions - Dorothy
- BA connection with the HED
- Introduction to other USAID GHSA partners & community visit with PREDICT
- Map out focus areas for communication (topics/communities)

V. Wrap-up discussion & Next steps for behavioral/communities joint activities- Shana

From: Andrew Clements <aclements@usaid.gov>
Sent: Thu, 21 Sep 2017 10:25:54 +0200
Subject: Study shows co-circulating flu strains on Chinese pig farms
To: Dennis Carroll <dcarroll@usaid.gov>, Lindsay Parish <lparish@usaid.gov>, ajatapai@usaid.gov, "Daniel Schar (RDMA/OPH)" <dSchar@usaid.gov>, "Sudarat Damrongwatanapokin (RDMA/OPH)" <sDamrongwatanapokin@usaid.gov>, "Wantanee (FAORAP) Kalpravidh" <[redacted]>, Peter Black <[redacted]>, "Filip Claes (AGAH)" <[redacted]> William Karesh <Karesh@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>, Christine Kreuder Johnson <ckjohnson@ucdavis.edu>, daszak@ecohealthalliance.org, Gina Samaan <[redacted]>, Wenqing Zhang <[redacted]>

FYI

From CIDRAP News Scan for Sep 18, 2017

Study shows co-circulating flu strains on Chinese pig farms

A new study published in *Clinical Infectious Diseases* determined multiple strains of 2009 H1N1, swine-lineage H1N1, and swine-lineage H3N2 co-circulated and likely reassorted among people and animals on six Chinese swine farms monitored for 1 year.

Researchers from Duke University and the Beijing Institute of Microbiology and Epidemiology used a One Health approach, which takes into account human, animal, and environmental health, to survey flu strains on 299 swine workers and 100 controls, 9,000 pigs, and 6 pig farm environments from 2015 to 2016. Study subject samples were collected monthly and tested for influenza A viruses (IAV).

Between March 2015 and February 2016, 4,884 samples were screened for IAVs. Flu strains were detected in 11.6% of environmental samples, 7.1% of swine oral secretions, and 4.8% of fecal samples. Five of the 32 humans who reported influenza-like illness during the study period had nasal swabs test positive for IAV.

According to the authors, "Sequencing results showed that swine-lineage H1N1 and H3N2, and A(H1N1)pdm09 –like viruses were detected in pig oral secretion and environmental swabs."

China is home to some of the largest swine farms in the world, and the country has been implicated as the origin of the 1957 and 1968 flu epidemics. The authors concluded that enhanced biosecurity is needed on swine farms.

Sep 16 *Clin Infect Dis* study

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

From: Jonna Mazet <jkmazet@ucdavis.edu>
To: AOTR/Grant Manager Andrew Clements <AClements@usaid.gov>;Alisa Pereira <apereira@usaid.gov>;Dennis Carroll <DCarroll@usaid.gov>
Sent: 10/20/2017 8:33:02 PM
Subject: Ebola papers SL co-author

The attached are provided to illustrate that the appropriate GoSL co-author(s), both knowledgeable of the subject and publication rules, were selected for the current manuscript under discussion.
J

PLoS Currents
Rapid Sharing of Research in Progress

Version 1. PLoS Curr. 2015 April 20; 7:
ecurrents.outbreaks.9a6530ab7bb9096b34143230ab01cdef.
Published online 2015 April 20.
doi: 10.1371/currents.outbreaks.9a6530ab7bb9096b34143230ab01cdef
Research Article

PMCID: PMC4423925

Understanding the Emergence of Ebola Virus Disease in Sierra Leone: Stalking the Virus in the Threatening Wake of Emergence

Nadia Wauquier, James Bangura, Lina Moses, Sheik Humarr Khan, Moinya Coomber, Victor Lungay, Michael Gbakie, Mohammed S.K. Sesay, Ibrahim A.K. Gassama, James L.B. Massally, Aiah Gbakima, James Squire, Mohamed Lamin, Lansana Kanneh, Mohammed Yillah, Kandeh Kargbo, Willie Roberts, Mohammed Vandi, David Kargbo, Tom Vincent, Amara Jambai, Mary Guttieri, Joseph Fair, Marc Souris, and Jean Paul Gonzalez*

Nadia Wauquier, Sorbonne Université, UPMC, Paris, France;
Contributor Information.

Abstract

Since Ebola Virus Disease (EVD) was first identified in 1976 in what is now the Democratic Republic of Congo, and despite the numerous outbreaks recorded to date, rarely has an epidemic origin been identified. Indeed, among the twenty-one most documented EVD outbreaks in Africa, an index case has been identified four times, and hypothesized in only two other instances. The initial steps of emergence and spread of a virus are critical in the development of a potential outbreak and need to be thoroughly dissected and understood in order to improve on preventative strategies. In the current West African outbreak of EVD, a unique index case has been identified, pinpointing the geographical origin of the epidemic in Guinea. Herein, we provide an accounting of events that serve as the footprint of EVD emergence in Sierra Leone and a road map for risk mitigation fueled by lessons learned.

Keywords: Ebola Virus Disease, emergence, index case, Sierra Leone

Introduction

Ebola Virus Disease (EVD) was first medically recorded in 1976 when the virus emerged in what is now the Democratic Republic of Congo. The identification of this new disease, which presented similarly to that of Marburg Disease, led to the recognition of Viral Hemorrhagic Fevers (VHF) as a nosological entity. Despite the many studies conducted on EVD to date, rarely has the epidemic origin (the primary infectious event) been identified. Indeed, among the twenty-one most documented outbreaks of EVD in Africa, an index case was identified four times and hypothesized in two other instances[1, 2, 3, 4, 5, 6].

The difficulty of pinpointing the ports of viral entry into the human population mainly relies on the fact that these outbreaks often occur in remote regions that lack experienced epidemiologists which lead to delayed and unsuccessful investigations. Given the complexity of the task, it is remarkable that, in the current West African outbreak, a unique index case has been identified, defining with near certainty the geographic origin of the epidemic in Guinea. Identification of the first infected human was the result of

intensive forensic work performed by a multidisciplinary team, which acted quickly to address the emergency during the initial onset of the epidemic[2].

While apprehending the mechanisms of emergence of a zoonotic virus from an animal host to humans is critical to develop preventive strategies, a deep understanding of the immediate progression within the human population to the point of recognition by the local public health system is essential to improve on national surveillance and accelerate detection and thereby response to a nascent epidemic. Invaluable lessons can be drawn through thorough dissection of the early events, when an outbreak runs unnoticed by the health system. Ascertaining the initial spread of the virus from one human host to another is therefore critical to identify strategies to improve future outbreak response efforts.

Herein, we provide an accounting of events that serve as the footprint of EVD emergence in Sierra Leone.

Methods

Cases and Epidemiological Investigations

Patients that met the World Health Organization (WHO) case definitions for suspected or probable EVD[7] were investigated by District Health Medical Teams (DHMT) and investigation teams led by the Sierra Leone Ministry of Health and Sanitation (MOHS) and supported by international partners. Demographic, geographic, epidemiological, and clinical data were recorded on standard case investigation forms delivered by the WHO. Source of infection of each case was sought by tracing contacts retrospectively.

Sample Collection

Suspected or probable EVD cases were sampled, when possible, directly in the field by the DHMT or at various health-care and holding centers by clinical teams. Venous blood was drawn into collection tubes with or without EDTA, and oral swabs were collected on corpses and placed in viral transport medium (Σ-Virocult, Medical Wire). All samples were transported directly to the VHF laboratory (formerly Lassa fever Laboratory) located within the Kenema Government Hospital (KGH), for immediate testing.

Emergency Diagnostics

As part of the National Response Plan to the EVD outbreak in Sierra Leone[8], and with guidance from the Sierra Leone MOHS and the WHO, emergency diagnostics were performed at the VHF Laboratory. All blood samples collected from suspected and probable cases throughout Sierra Leone between March 22 and July 2 and most blood samples collected from July 2 to August 22, were tested by the VHF laboratory. Starting July 2, Public Health Agency Canada set up a mobile laboratory in Kailahun town, Kailahun District to further support diagnostic efforts. Eventually, in late August, a Centers for Disease Control and Prevention (CDC) mobile laboratory was set up at KGH, and took over EVD diagnostics as of 22nd August. All handling and testing of samples in the VHF laboratory was performed in full BSL3 level personnel protective equipment including face, eye and respiratory protection.

Quantitative Real-time RT-PCR

RNA was extracted from 140µl serum using RNAeasy kits from Qiagen (Venlo, Limburg) in a Class II Biosafety cabinet. Extracts were immediately tested for viral RNA using published and FDA-approved protocols and reagents from the Critical Reagents Program and a Roche (Basel, Switzerland) Lightcyler, software version 2.0. Capillaries contained 14.6µl Ebola Zaire Master Mix, 0.4 Taq polymerase, and 5µl sample. Cycling conditions were as follows: 50°C for 15 minutes (1 cycle), 95°C for 5 minutes (1 cycle), 95°C for 1 second and 60°C for 20 seconds with a single acquisition (45 cycles), 40°C for 30 seconds (1 cycle). Samples were tested in duplicate, including an Ebola Zaire HPLC RNA positive control and a negative (mastermix alone) control in each run.

Ethics

The need for written informed consent was waived by the MOHS, Sierra Leone, in the context of an emergency response to an ongoing EVD outbreak. The study performed here was approved by Western International Review Board (WIRB) and Sierra Leone Ethics and Scientific Review Committee.

Results

For centuries, Kissi people have lived in the Kissidougou region that extends across Guinea, Liberia, and Sierra Leone, which are divided by administrative borders inherited from colonial times. The Kissi inhabitants have historically travelled throughout this region, visiting community members to support their needs: attending births, marriages, and burial ceremonies. It is here, in the Kissidougou territory that the first EVD epidemic chains burst in Guinea. During this initial stage, the Kissi community followed their traditions in earnest, burying their dead, intimately supporting struggling families and patients, and seeking help from nearby traditional healers. In this context, a few kilometers away from the emerging epidemic in Guékédou (Guinea), infected individuals crossed the border to Sierra Leone (Figure S1, S2).

A traditional healer from the village of Kpondu, Kailahun District in Sierra Leone treated patients arriving from Guinea and Liberia that sought medical assistance. (Figure 1A,B). On April 28, the healer became extremely ill and died two days later. Several days later, in early May, two close relatives living in the same household as the healer (her husband and grandson) also died in Kpondu. Ultimately, most of those who attended her funeral ceremony became sick, each infected with the yet-to-be-identified Ebola virus.

Medical officers in the border chiefdoms of Sierra Leone had been undergoing preparedness training since the first cases occurred in Guinea and were aware of the risk of introduction of EVD into the country. It was in the small town of Koindu, five miles away and within walking distance of Kpondu (approximately three miles from the Guinean border), that the first suspected cases of EVD came to the attention of local health authorities. On May 24th, the Community Health Officer at Koindu Health Center notified the Kailahun District Health Management Team of three patients, who presented with fever, vomiting, and diarrhea. Each had attended the healer's funeral. The medical staff in charge at the Center managed the patients for gastroenteritis and, suspecting a resurgence of cholera, sent stool samples to Freetown for diagnostics. Taking into consideration the ongoing and nearby epidemic of EVD, the Community Health Officer also contacted the in-country lead of the Lassa Fever Project at the Kenema Government Hospital (KGH), the late Dr. Sheik Humarr Khan. Blood samples were sent immediately to Kenema for molecular testing at the VHF Laboratory. One of the initial three patients, a 42-year old housewife, became the first laboratory-confirmed case of EVD in Sierra Leone and later, the first Sierra Leonean to survive Ebola. Ultimately, fourteen individuals who attended the burial of the traditional healer contracted the disease.

The VHF Laboratory at KGH, a regional reference center for Lassa fever diagnostics in West Africa and a base of operations for collaborative research, was the only laboratory in Sierra Leone with the capacity to test for EVD. Beginning with the emergence of EVD in Guinea, samples from VHF-suspected cases throughout Sierra Leone were sent to this laboratory for testing. On the afternoon of May 25th, the laboratory received the first blood sample from Koindu. Using reagents provided by the US Critical Reagents Program (CRP) in coordination with the US Army Medical Research Institute of Infectious Diseases (USAMRIID), the sample was analyzed by real-time reverse transcription polymerase chain reaction (RT-PCR), along with a batch of other routine samples received that same day. Testing confirmed that the woman in Koindu was infected with Ebola virus, a finding that was immediately reported by Dr. Khan. Testing also confirmed that two other women were infected, both of whom were patients at KGH, one admitted on the Annex Ward and the other on the Maternity Ward. The latter patient had undergone a spontaneous abortion and later became the first Ebola survivor discharged from KGH. Both cases were confirmed positive the following day using an antigen-capture enzyme-linked immune-sorbent assay (ELISA) with USAMRIID reagents, and both were isolated on the Lassa ward. Subsequently, all KGH healthcare workers who had been in contact with these women were closely monitored.

On May 26th, the doctor in charge of the Lassa ward immediately sent an investigation team to Koindu and surrounding villages on the border of Guinea to inform local health authorities of the risk, determine the geographical origin of the laboratory-confirmed EVD cases, identify contacts, organize training for case management, isolate suspected cases, and investigate reported deaths. Together with Kailahun district health officials and surveillance officers, the outreach team initiated their investigation in Koindu, then rapidly expanded their efforts to include Kpondu, Kolorsu, Sasani, and Nyumondu, villages of the Kissi Tenge Chiefdom (Kailahun District) (Fig 1; Fig.S2; Fig.S3).

Through May 26th, of twelve suspected EVD cases investigated since the first case in Koindu, seven tested positive for EVD. By May 27th, it was clear that transmission chains had started in the nearby villages of Buedu, Nyumudu, and Kolorsu, while two other localities, Fokoma and Kpondu, reported their first laboratory-confirmed cases of EVD. In less than four weeks, five villages and the towns of Koindu and Buedu were found affected by EVD. During this early phase of disease transmission, great fear of increasing fatalities (case fatality rate of 1:2) combined with lack of communication and information in the most remote Kissi communities led to the development of social unrest. Ultimately, a few families forcefully retrieved their sick relatives from the health center, performed high-risk traditional burial ceremonies and denied access of the responding teams to affected villages.

One of the nurses who had tended to the infected patients at Koindu Health Center became ill on May 18th. She set out for KGH to seek treatment, traveling from Koindu to Daru via public transport. Too sick to continue, she stopped at the Daru Community Health Center (CHC) where she died on the 24th of May. Her corpse was handed over to the family for traditional burial in Njala village (Jawei Chiefdom), a few kilometers away. Three health workers who admitted and treated her at Daru CHC became ill and died, including the Community Health Officer in charge. Infected local health workers and their families in Daru, together with those who participated in the nurse's burial ceremony, sparked two new fast-growing epidemic chains in the surrounding villages of Njala and Bumbuhun. Meanwhile, the driver, who had taken the nurse from Koindu to Daru, returned to his residence in Kambia District, in the northwestern part of the country more than 500km from Koindu, first stopping in Masiaka of Port Loko District. On May 29th, he also developed symptoms and infected two relatives in Masiaka. Rapid response in Port Loko and Kambia led to the isolation of these three cases, and no further transmission events occurred.

At this point in time, 35 days after the death of the traditional healer, there were 30 confirmed cases from Kailahun District, five active epidemic chains, and sporadic cases were being identified in another district, Port Loko. Two weeks later, on June 17th, the first laboratory-confirmed case in Kenema district was identified: a 40-year old female health worker from the Kenema Township Burma II section, Nongowa Chiefdom. She had been in contact with a nurse from Golahun in Kailahun district who had participated in the funeral ceremony of the nurse in Njala. She became ill on June 7thand travelled from Kailahun to Kenema where she was admitted to the Female Ward at KGH. While on ward rounds, Dr. Khan identified her as an EVD-suspected case, and on June 10th, testing revealed she was infected. A male nurse, who had assisted in caring for her in Kenema, became sick and, on June 19th, also tested positive. Neither of these nurses survived (Fig. 2.).

Kenema District rapidly became the third epicenter of the expanding Ebola outbreak in Sierra Leone. From the case of the traditional healer, the disease spread within four days to eleven individuals in the same chiefdom and in less than a week, to twenty-five cases in the contiguous Jawei chiefdom. Twenty days after the index case in Sierra Leone, eight chiefdoms of the Kailahun district displayed active epidemic chains. Six weeks after EVD emergence in Koindu, three districts were severely affected by the EVD epidemic, including Kailahun, Kenema, and Port Loko. The exponential start of the Sierra Leone outbreak was insidious and rapid. Within less than six weeks, the national healthcare system was overwhelmed, and the virus continued to replicate amongst naïve populations.

Discussion

These events make up the beginning of the EVD outbreak in Sierra Leone, the third major step of the virus, after Guinea and Liberia, towards developing the largest EVD epidemic in history. The identification on May 25thof the first confirmed case of EVD in Sierra Leone prompted local health authorities to immediately conduct extensive investigations, searching for suspected cases and to inform and engage the international community such as the WHO or Medecins Sans Frontières (MSF) in all response activities. Despite previous in-country experience with Lassa fever, a rapid response by well-informed field teams, availability of timely and effective laboratory diagnostics, and immediate isolation of infected individuals, expansion of the outbreak did not relent (Fig. S4). Retrospective investigations show that the virus had been circulating for at least four weeks and had spread through traditional burials and traditional healthcare settings, activities that are well known amplifiers of EVD outbreaks. Furthermore, high mobility of the infected contacts led to a rapid geographic expansion within Sierra Leone, which divided the response forces on the ground. The resulting exponential increase in case numbers rapidly overwhelmed the limited number of healthcare workers and adequate health facilities. Collectively, these factors created what is publicly referenced as the perfect storm, allowing the virus to thrive and cross new borders.[7]

Investigations are continuing to improve our understanding of the onset of the outbreak in Sierra Leone and other factors explaining the sudden and rapid increase in case numbers have not been ruled out. The Ebola community is looking into the possible existence of transmission events, prior to the infection of the traditional healer, which would imply that the virus was circulating unnoticed in Sierra Leone for a longer period of time. Additionally, a potential second independent and simultaneous introduction of EVD is currently under investigation (personal communications between authors, March 2015). Indeed, reports of a probable case that had returned sick from Guinea and a subsequent epidemic chain that developed in early May originating in Manowa village, Kailahun District, are to be dissected.

The current outbreak confirms yet again the critical role of and risk incurred by healthcare workers. The death toll of West African physicians, nurses, community health officers and other supporting staff is immense. Very rapidly in the outbreak, Sierra Leone suffered the loss of the healthcare workers leading the response activities.[9] Protection of healthcare workers is ever more paramount as these individuals serve such a key role in ending the outbreak. Major efforts to distribute the appropriate skills and tools through infection prevention and control training and use of personnel protective equipment, need to be continued to ensure that healthcare personnel abide by the classic rules of sanitary security enforced by international responding agencies.[10] Adding to the disease burden, is insufficient medical coverage and access to healthcare in the low resource setting of West Africa. Health posts serve a role as sentinels for surveillance in the most remote areas of the country. Once more, education on how to recognize and report suspect cases in these particular locations is critical to ensure maximal response efficiency. The primary healthcare system must therefore work in close collaboration with the community, on the forefront of surveillance. Indeed, EVD emerges from its natural niche without any known precursor signs, and outbreaks have always surprised local communities. Continuous active surveillance is needed and must be organized by specialized centers joined in local, regional, and international networks. Surveillance centers must be connected to public health systems and also to research teams for increased understanding and awareness to permit identification and implementation of rapid intervention strategies.

As viruses do not heed borders, a global approach is absolutely necessary. The medical community has recognized this concept, one of linking an international coordinated approach to pathogen emergence.[11] Viruses easily transgress administrative borders via travelers who have yet to present with or recognize symptoms. Therefore, border regions must be permeable to both regional and international healthcare systems. The healthcare worker must be able to effectively intervene in a manner that is not constrained by administrative challenges between countries, fostering communication and exchange beyond the country's limits. Concurrently, sanitary control measures and surveillance must be particularly enforced at border

checkpoints to reduce the risk of infected persons crossing over. Indeed, these checkpoints are needed to screen individuals for signs and symptoms, while also providing opportunity to inform travelers of health risks.

Wide-scale communication to the public, community counseling, and social mobilization programs need to be enacted at the very beginning of a suspected epidemic. Often, insufficient communication and dissemination of inaccurate information are significant impediments to public health initiatives. Populations at risk in Sierra Leone, Guinea, and Liberia are extremely varied and include many different age groups, religious affiliations, as well as social and ethnic backgrounds. These factors must be considered collectively when tailoring communications for efficient dissemination of high-impact messages to targeted populations. The role of social and human sciences is ever more important to inform in real-time, to teach those at risk how to protect themselves, breaking the cycle of transmission through transformative understanding that uproots traditional practices for the betterment of the population.

Clearly a deep understanding and keen recognition of the early signs portending to an emerging outbreak are essential to rapidly identify and isolate cases and contacts and interrupt and quell the dynamic of exponential viral transmission. Vulnerable populations must be clearly identified and fully understood. Healthcare systems must be immediately alerted and communication through regional networks must be enacted in a manner that permits quick adaptation to the rapidly evolving situation. The current outbreak has defied borders and is now a matter of concern for the international community, increasing the complexity of transmission dynamics and disease management, risking socio-political destabilization. Sensationalistic communication fueling fear, coupled with ignorance, has galvanized an unprecedented "journey" of the Ebola virus from Monrovia to Lagos to Dallas. In the aftermath of the outbreak it will be of critical importance to carefully consider the gaps, the missteps, which have permitted this emergence and ultimately, through technological advancement and lessons learned, prevention and control will certainly improve.

Author Contributions

NW, SHK, MC, VL: Actively worked on generating clinical and field data and processed the data; JB, LM, MG, DK: Actively worked on generating field data and processing data in a common data base. JB, LM, MG, DK, MSKS, IAKG, JLBM, LK, KK, WR: Largely generated complex and complete field data, contact tracing and interviews patient and families on the field; AG, JS, ML, MY, MV, AJ, JF, MG: Coordinate all team from the laboratory, to the field epidemiology and clinics. NW, MS, JPG, TV, MG: developed the concept, did the data analysis, produce the figures and wrote the manuscript.

Competing Interests Statement

All of the authors listed read the present version of the manuscript and do not have any conflict of interest with respect to the manuscript.

Acknowledgments

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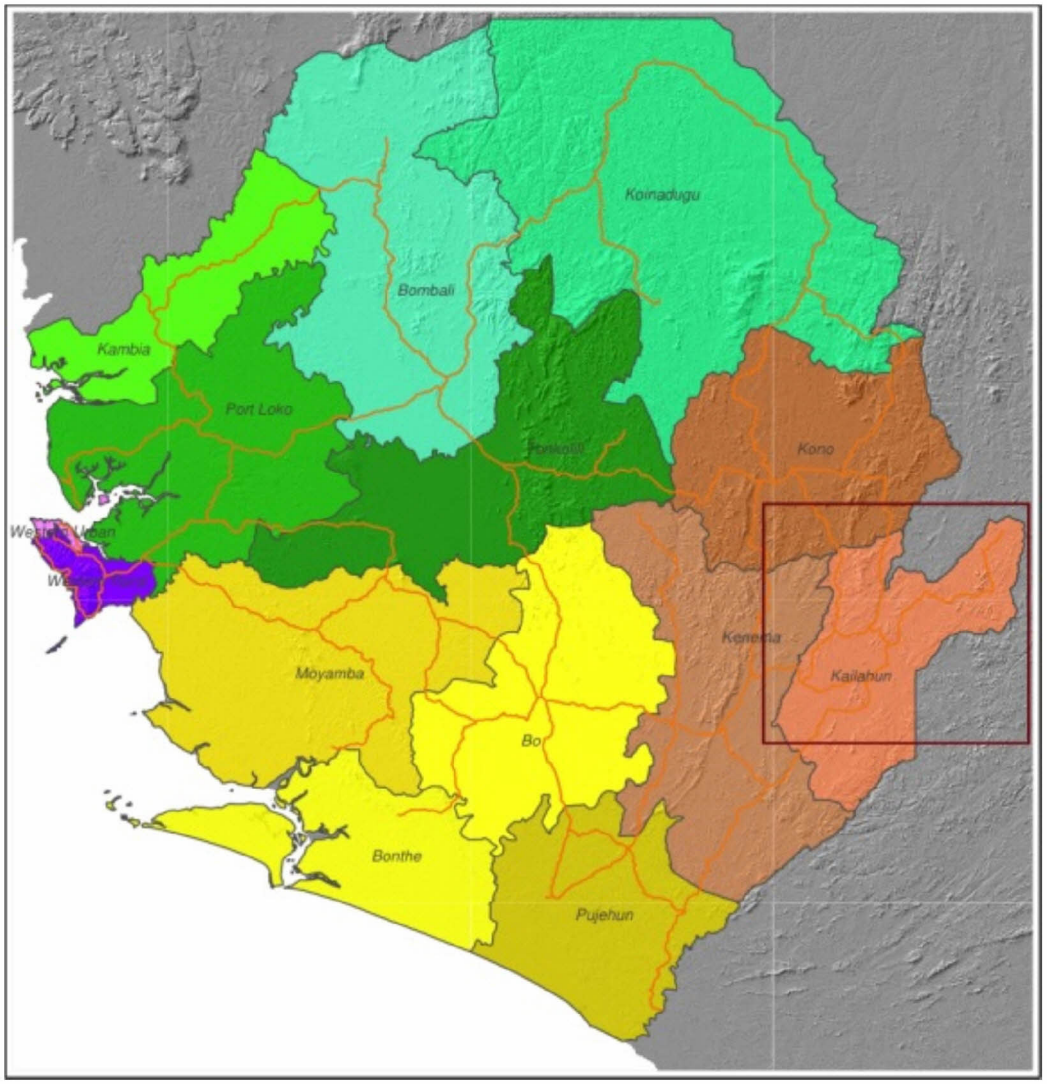
Biography

• Jean-Paul Gonzalez joined Metabiota Inc. as Senior Scientist on the 29th of April 2013 as expert on Emerging Diseases and Biosecurity. He graduated from the Medical School of Bordeaux in 1974 (France), completed his internship in French Guyana at the University Hospital Center of Antilles-Guyana (internal medicine and infectious diseases), and received his Ph.D. in viral ecology (Arenavirus molecular ecology) in 1984 from Clermont-Ferrand University (France). He went on to study zoology, marine biology and genetics at Bordeaux University Faculty of Sciences, and got his Master of Public Health & Tropical Medicine form the Medical School of Bordeaux (1975) As a medical researcher and formerly Research Director for the French Institute of Research for Development (IRD, Marseille, France), he has spent his career working in and for developing countries of South America, Africa and Asia (1979-2012). His main fields of interest encompass viral disease epidemiology, virus ecology, arboviruses and viral hemorrhagic fevers and understanding fundamentals of disease emergence. Since the late 70s, he has led international teams with partner institutions of developing countries as well as teams of virologists at the International Network of the Institut Pasteur (Dakar, Senegal; Bangui, Central African Republic). He worked for several years as a guest researcher at the Special Pathogen Branch of the Centers for Disease Control and Prevention (CDC) in Atlanta (Georgia, USA), visiting scientist at the Arbovirus branch of CDC in Fort Collins, and as a visiting professor of Epidemiology and Public Health at the Yale School of Medicine (New England, USA). He worked in high security laboratory practices and research (CDC, Yale) and on the early development of geographical information systems applied to Public Health and Infectious Diseases (Yale). From 1997 to 2007, he was invited as a visiting professor of Microbiology, Mahidol University (Thailand) where he founded the Research Center for Emerging Viral Diseases and developed a Technical Platform for the study of Emerging Vector Borne Diseases. He largely contributed to the development of tools and implemented strategies for the control and prevention of transmitted disease. He also developed several innovative concepts including the evolution of viruses on the geological time scale, the co-evolution as a general mode of evolution among others. Dr. Gonzalez has signed and produced books and chapters as well as more than two hundred scientific papers in peer-reviewed journals. For four years, Dr. Gonzalez, granted by IRD, was appointed project director by the French Ministry of Foreign and European Affairs (MAEE), and assigned by Presidential Decree of the Gabonese State, as Executive and Operating Director of the International Research Center for Medical Research of Franceville (Gabon). During that period he largely supported and enhanced several field of research including the Eco-epidemiology of emerging pathogen (virus and bacteria) and their natural reservoir and hosts in Central Africa, an appraisal of zoonotic risk and conservation medicine (e.g.: African non human primates), the understanding the diseases interconnection (e.g.: Sickle-cell diseases and infectious diseases), among others. His as a General Director of CIRMF Gabon, under the French MAEE ended on August 28, 2012 (, Technical Assistant of French MAEE: project manager in Gabon,). From 2012 to 2013, he returned for one year to his Institute of origin, IRD, appointed by the French Ministry of Research and Education as a scientific correspondent for Emerging Diseases and Biosecurity and based in Washington D.C. and hosted by Metabiota Inc. In 2013, he retired from the French government and joined Metabiota Inc. for implementing Tools & Strategies for Disease Emergence Assessment. He his presently actively participating in several projects as principal investigator or expert, including several: Filovirus Diversity, Animal Models for Viral Hemorrhagic Fevers, Remote Sensing of Lassa Fever, Viral Hemorrhagic Fevers of Unknown Origin (Biosecurity Engagement Program, BEP) ; training on Emerging Diseases (Academic Engagement Program, DoS AEP); Outbreak Preparedness and Response Training (DoS CBEP) among others.

Appendix 1

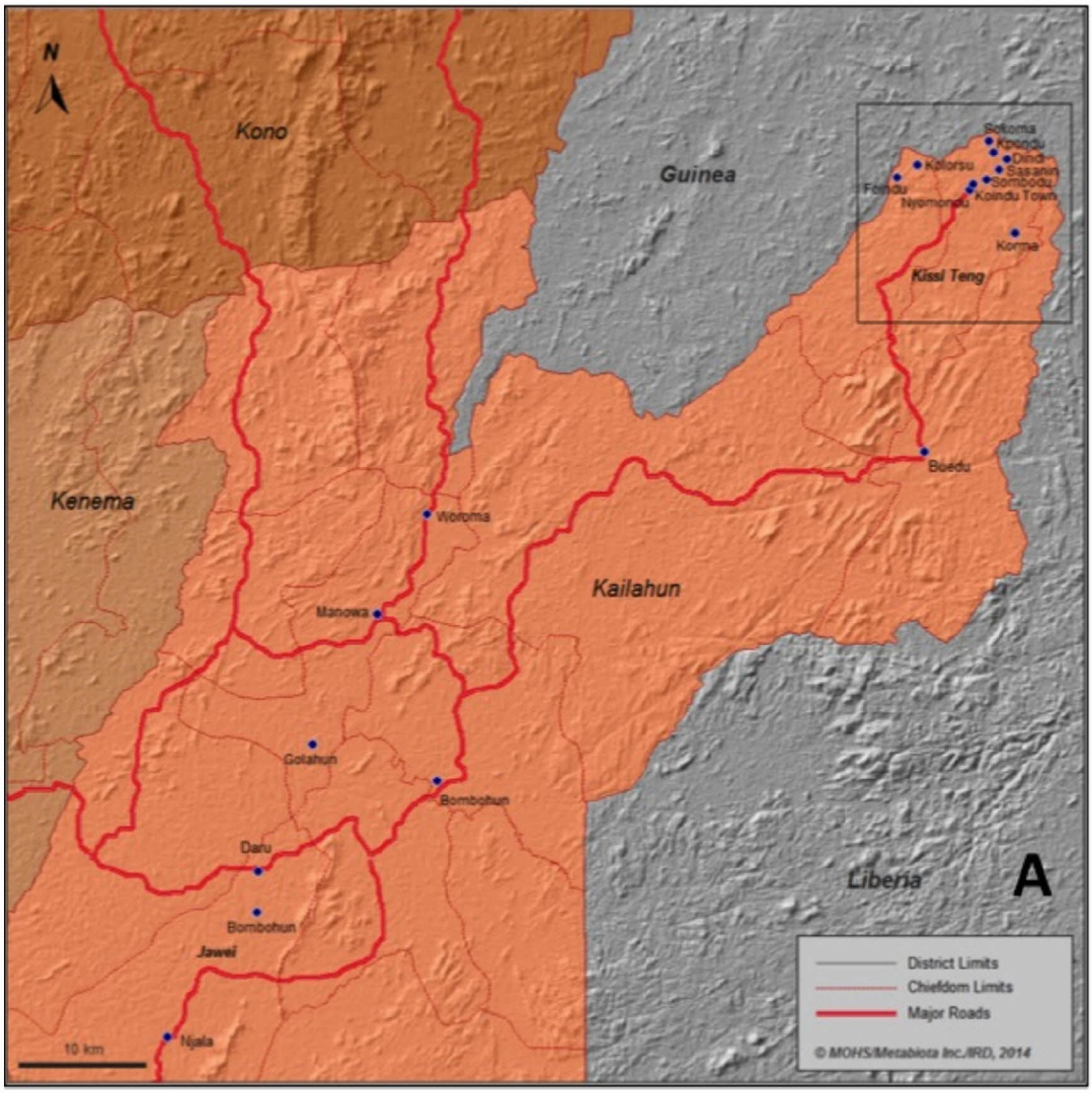
Figure S1. Administrative map of the Districts of Sierra Leone.



Green = Northern province districts (including Ebola Virus Disease epidemic districts of Port Loko and Kambia among others); Purple = Western areas districts; Yellow = Southern Province districts; Orange = Eastern province districts (including main Ebola Virus Disease epidemic of Kailahun and Kenema districts); Black line = district delineation; Orange line = main roads. Red square = Study area of Ebola Virus Disease emergence in country.

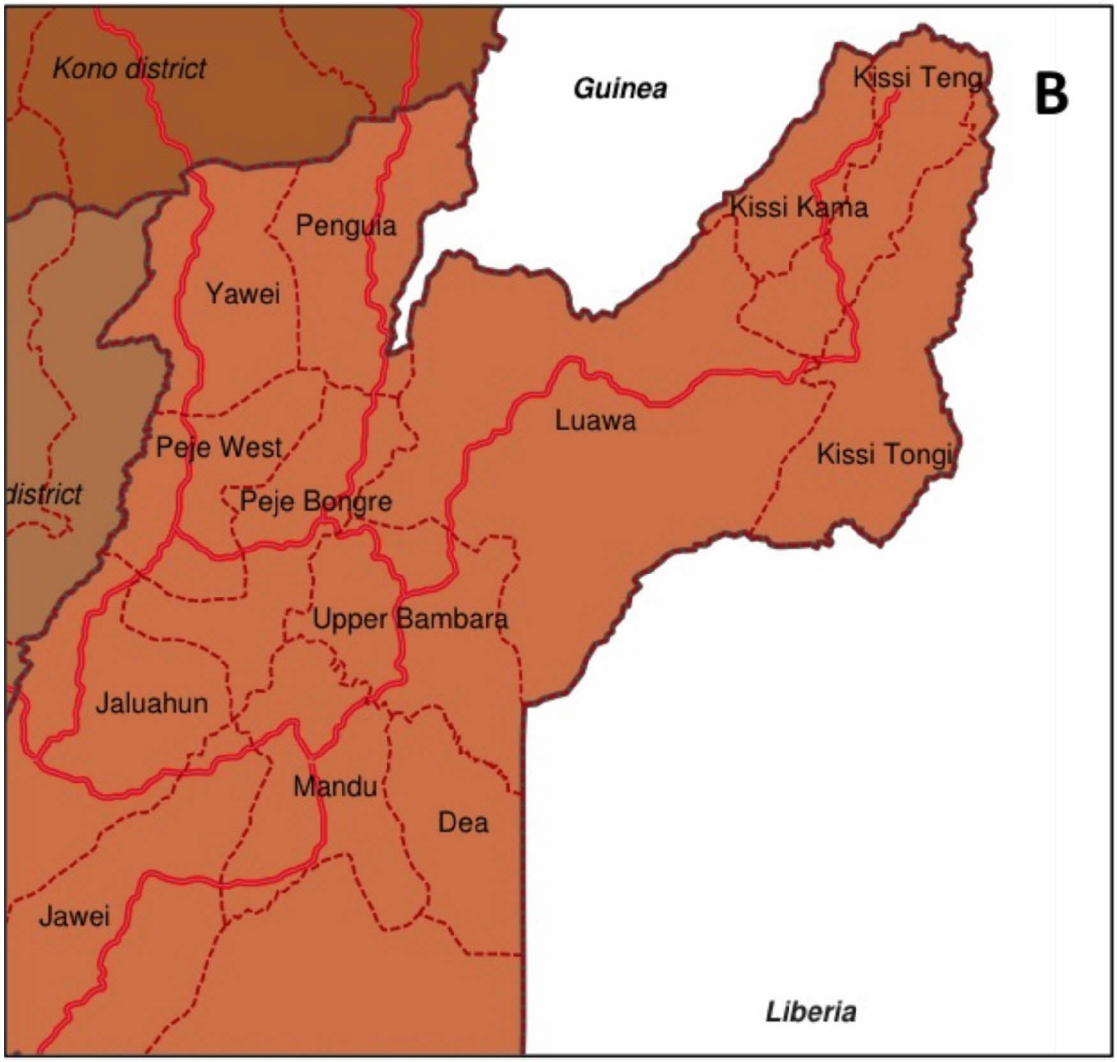
Appendix 2

Figure S2. Primary site of Ebola Virus Disease (EVD) emergence featuring the Kailahun District, Eastern Province of Sierra Leone.



Square = northern tip of Kailahun District were EVD emerged in country; Blue solid circle = Villages with laboratory confirmed case of EVD (i.e. epidemic chain) during the 3 week time period after the first EVD laboratory confirmed case in country.

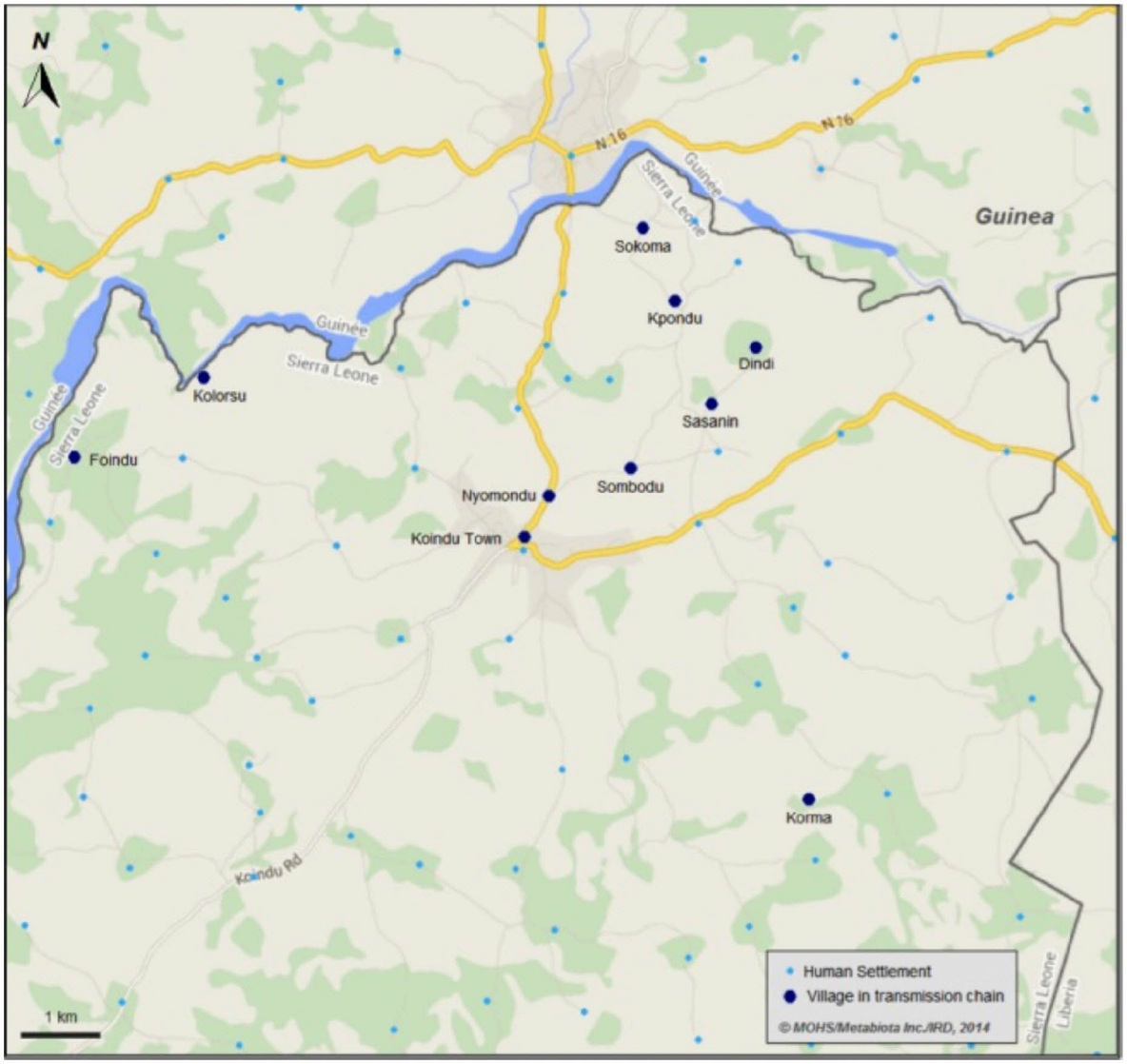
Figure S2B. Primary site of Ebola Virus Disease (EVD) emergence featuring the Kailahun District, Eastern Province of Sierra Leone.



Map of Northern Kailahun District featuring the chiefdoms and their border (red dotted line).

Appendix 3

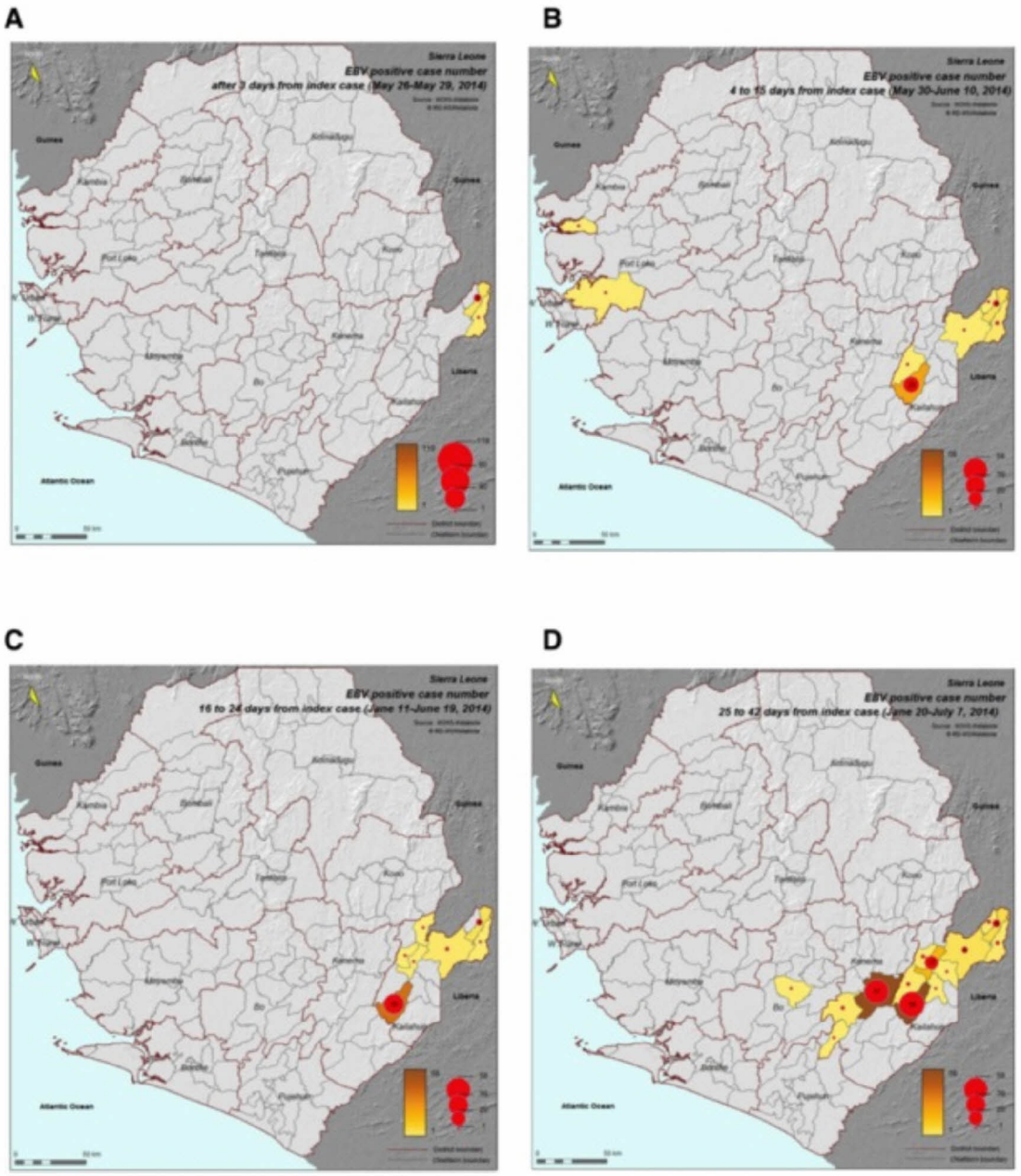
Figure S3. Northern Kailahun District (Eastern Province of Sierra Leone) where Ebola Virus Disease emerged in country on May 25, 2014.



Dark blue solid circle = Villages with epidemic chain of transmission during the 3 first week of EVD emergence in country (May to June 2014); Light blue solid circle = Villages without epidemic chain; Yellow line = main roads; Simple and double gray lines = secondary roads

Appendix 4

Figure S4. The spread of Ebola Virus Disease (EVD) during the first phase of its extension in Sierra Leone.



Laboratory cumulative confirmed EVD case by chiefdom for four consecutive period of time during the first phase of EVD epidemic in Sierra Leone (2014). Left to right, top to bottom: (A) May 26 to May 29; (B) May 30 to June 10. (C) June 11 to June 19. (D) June 20 to July 7.

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References

1. WHO. International Commission. "Ebola hemorrhagic fever in Zaire. Bulletin of the World Health Organization, 56, 271-293 (1976). [PMCID: PMC2395567]

2. D.L. Heymann, J.S. Weisfeld, P.A. Webb, J.M. Johnson, T. Cairns, et al. Ebola Hemorrhagic Fever: Tandala, Zaire, 1977-1978. Journal of Infectious Diseases. 142, 372-376 (1980).

3. A.J. Georges, E.M. Leroy, A.A. Renaut, C.T. Benissan, R.J. Nabias et al. Ebola Hemorrhagic Fever Outbreaks in Gabon, 1994-1997: Epidemiologic and Health Control Issues. Journal of Infectious Diseases. 17, S65-75 (1999).

4. A. Khan, F.K. Tshioko, D.L. Heymann, B. Le Guenno, P. Nabeth, et al. The Reemergence of Ebola Hemorrhagic Fever, Democratic Republic of the Congo, 1995. Journal of Infectious Diseases. 1999; 179, S76-S86 (1999).

5. E.M. Leroy, A. Epelboin, V. Mondonge, X. Pourrut, J.P. Gonzalez et al. Human Ebola outbreak resulting from direct exposure to fruit bats in Luebo, Democratic Republic of Congo, 2007. Vector Borne Zoonotic Diseases. 6, 723-8 (2009).

6. S. Baize, D. Pannetier, L. Oestereich, T. Rieger, L. Koivogui, et al. Emergence of Zaire Ebola Virus Disease in Guinea. N Engl J Med. 371,1418-1425 (2014).

7. WHO Ebola Response Team. Ebola Virus in West Africa - The First 9 Months of the Epidemic and Forward Projections. N Engl J Med 2014; 371: 1481-1495 (2014). [PMCID: PMC4235004]

8. Government of Sierra Leone Ministry of Health and Sanitation. Sierra Leone Accelerated Ebola Virus Disease Outbreak Response Plan, Annex 4. July-December 2014.

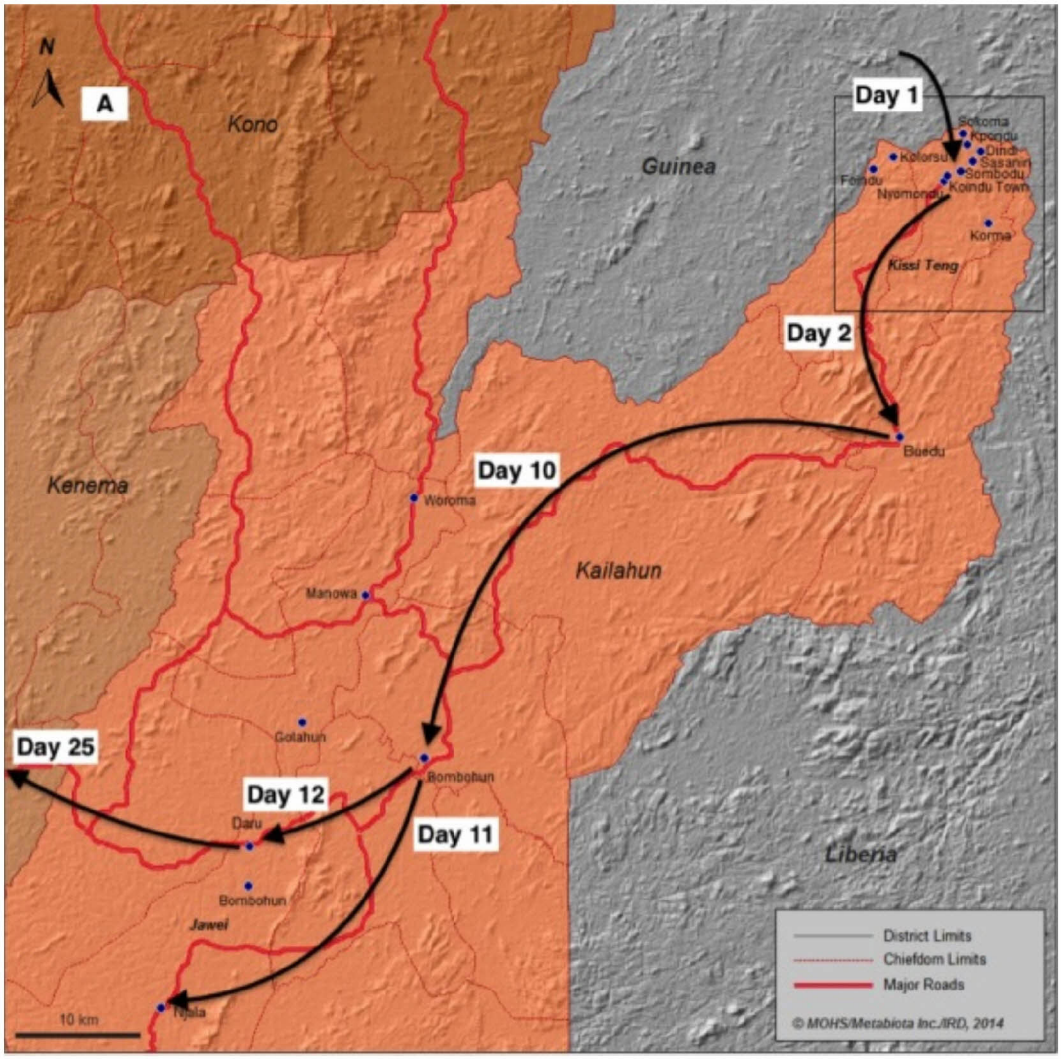
9. P.H. Kilmarx, K.R. Clarke, P.M. Dietz, et al. Ebola Virus Disease in Health Care Workers — Sierra Leone, 2014 MMWR 63(49);1168-1171 (2014). [PMCID: PMC4584541]

10. World Health Organization. Infection prevention and control guidance for care of patients in health-care settings, with focus on Ebola. Geneva, Switzerland: World Health Organization (2014).

11. Morse, S.S., Maze, J.A.K., Woolhouse, M., Parrish, C.R., Carroll, D., Karesh, W.B., Zambrana-Torrelio, C., Lipkin, W.I., Daszak, P. "Prediction and prevention of the next pandemic zoonosis." Lancet 380(9857): 1956-1965 (2012). [PMCID: PMC3712877]

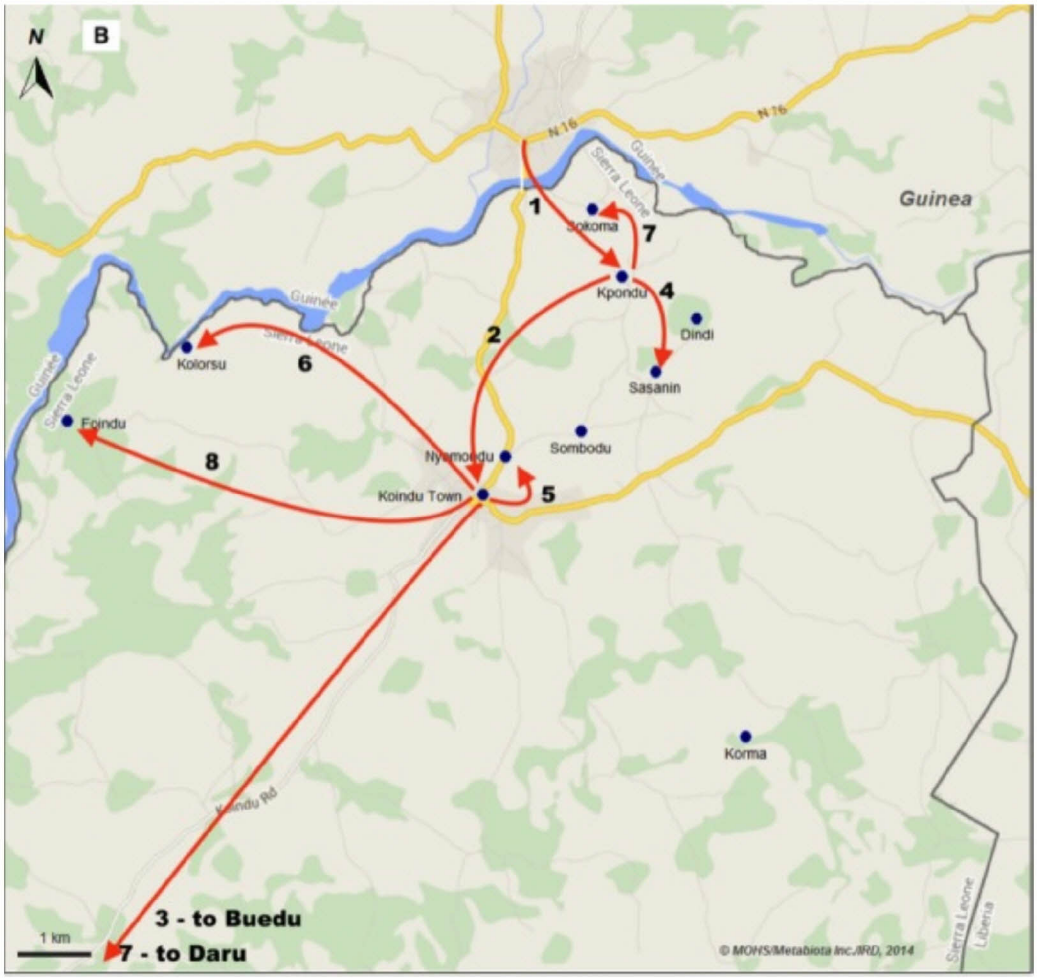
Figures and Tables

A. Ebola Virus Fever (EVD) emergence in Sierra Leone



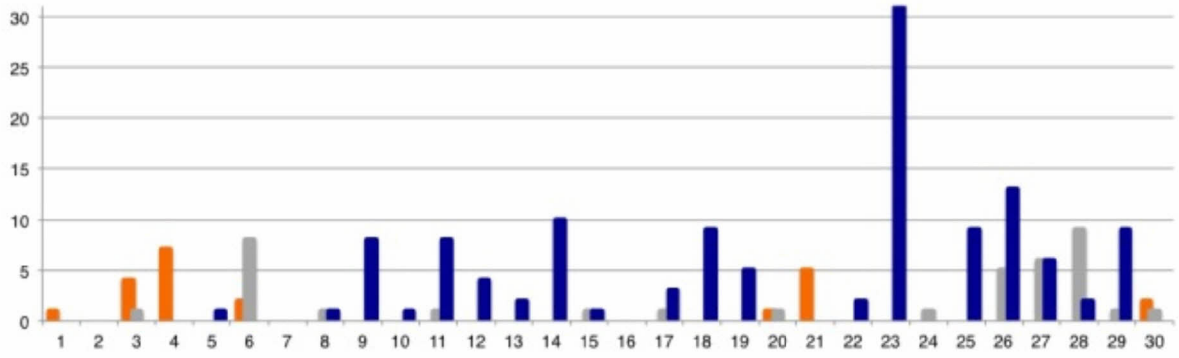
The Kailahun District (Orange) that has been the first one reporting confirmed cases of EVD in country. Villages and town reporting EVD laboratory confirmed cases: Blue point; main road = red line; administrative boundaries = grey line. Black arrow = Chronology and direction of the EVD spread. Top right square delineate the emergence zone (see 1B) where intense transmission occurred for day 1 to day 21 after confirmation of the index case.

Fig 1B. Ebola Virus Fever (EVD) emergence in Sierra Leone.



The first villages (blue points) form the North Eastern part of the Kailahun District that reported confirmed case of EVD and become EVD epidemic chain of transmission. Red arrow = form 1 to 8 showing the chronology (numbers) and direction (arrow) of the spread of the EVD during the two first week of the epidemic.

Ebola Virus Disease emergence in Sierra Leone, 2014: Main unprecedented epidemic chain by chiefdom, Kailahun District.



Ordinate = Number of case; abscise = Days; Bar = Three major epidemic chains that's sparked the outbreak in country (Kissi Tengue = orange bar; Nongowa = Black bar; Jawei = Dark blue bar). Starting on day 1 as for the 25th of Mai 2014 when the first EVD case was confirmed form Kissi Tengue chiefdom. For each chiefdom, one can clearly observed two waves of cases: the second wave constituted by secondary contacts from the first wave (i.e. emerging case in the chiefdom territory) with an estimated incubation period of 10+/- 5 days between the two waves.

VIRAL EVOLUTION

Genomic surveillance elucidates Ebola virus origin and transmission during the 2014 outbreak

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In its largest outbreak, Ebola virus disease is spreading through Guinea, Liberia, Sierra Leone, and Nigeria. We sequenced 99 Ebola virus genomes from 78 patients in Sierra Leone to ~2000× coverage. We observed a rapid accumulation of interhost and intrahost genetic variation, allowing us to characterize patterns of viral transmission over the initial weeks of the epidemic. This West African variant likely diverged from central African lineages around 2004, crossed from Guinea to Sierra Leone in May 2014, and has exhibited sustained human-to-human transmission subsequently, with no evidence of additional zoonotic sources. Because many of the mutations alter protein sequences and other biologically meaningful targets, they should be monitored for impact on diagnostics, vaccines, and therapies critical to outbreak response.

Ebola virus (EBOV; formerly Zaire ebolavirus), one of five ebolaviruses, is a lethal human pathogen, causing Ebola virus disease (EVD) with an average case fatality rate of 78% (*1*). Previous EVD outbreaks were confined to remote regions of central Africa; the largest, in 1976, had 318 cases (*2*) (Fig. 1A). The current outbreak started in February 2014 in Guinea, West Africa (*3*) and spread into Liberia in March, Sierra Leone in May, and Nigeria in late July. It is the largest known EVD outbreak and is expanding exponentially, with a doubling period of 34.8 days (Fig. 1B). As of 19 August 2014, 2240 cases and 1229 deaths have been documented (*4*, *5*). Its emergence in the major cities of Conakry (Guinea), Freetown (Sierra Leone), Monrovia (Liberia), and Lagos (Nigeria) raises the specter of increasing local and international dissemination.

In an ongoing public health crisis, where accurate and timely information is crucial, new genomic technologies can provide near–real-time insights into the pathogen's origin, transmission dynamics, and evolution. We used massively parallel viral sequencing to understand how and when EBOV entered human populations in the 2014 West African outbreak, whether the outbreak is continuing to be fed by new transmissions from its natural reservoir, and how the virus changed, both before and after its recent jump to humans.

In March 2014, Kenema Government Hospital (KGH) established EBOV surveillance in Kenema, Sierra Leone, near the origin of the 2014 outbreak (Fig. 1C and fig. S1) (*6*). Following standards for field-based tests in previous (*7*) and current (*3*) outbreaks, KGH performed conventional polymerase chain reaction (PCR)–based EBOV diagnostics (*8*) (fig. S2); all tests were negative through early May. On 25 May, KGH scientists confirmed the first case of EVD in Sierra Leone. Investigation by the Ministry of Health and Sanitation (MoHS) uncovered an epidemiological link between this case and the burial of a traditional healer who had treated EVD patients from Guinea. Tracing led to 13 additional cases—all females who attended the burial. We obtained ethical approval from MoHS, the Sierra Leone Ethics and Scientific Review Committee, and our U.S. institutions to sequence patient samples in the United States according to approved safety standards (*6*).

We evaluated four independent library preparation methods and two sequencing platforms

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‡Deceased. §These authors jointly supervised this work.

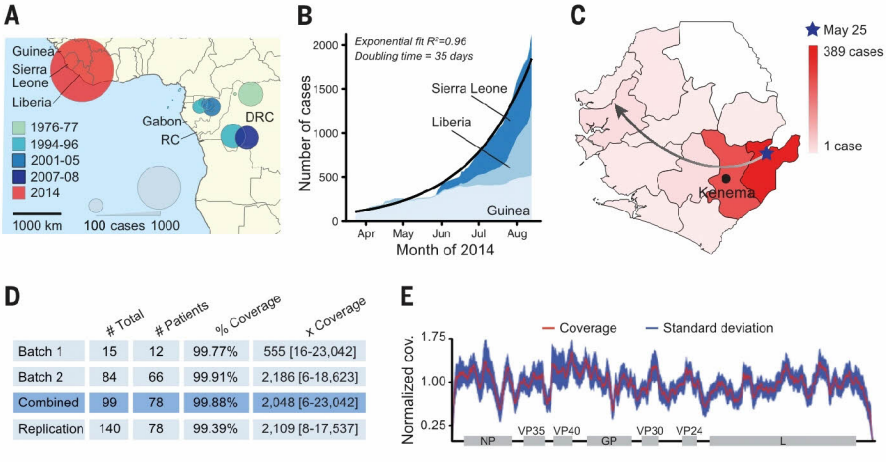

Fig. 1. Ebola outbreaks, historical and current. (**A**) Historical EVD outbreaks, colored by decade. Circle area represents total number of cases (RC = Republic of the Congo; DRC = Democratic Republic of Congo). (**B**) 2014 outbreak growth (confirmed, probable, and suspected cases). (**C**) Spread of EVD in Sierra Leone by district. The gradient denotes number of cases; the arrow depicts likely direction. (**D**) EBOV samples from 78 patients were sequenced in two batches, totaling 99 viral genomes [replication = technical replicates (*6*)]. Mean coverage and median depth of coverage with range are shown. (**E**) Combined coverage (normalized to the sample average) across sequenced EBOV genomes.

(*9*) (table S1) for our first batch of 15 inactivated EVD samples from 12 patients. Nextera library construction and Illumina sequencing provided the most complete genome assembly and reliable intrahost single-nucleotide variant (iSNV, frequency >0.5%) identification (*6*). We used this combination for a second batch of 84 samples from 66 additional patients, performing two independent replicates from each sample (Fig. 1D). We also sequenced 35 samples from suspected EVD cases that tested negative for EBOV; genomic analysis identified other known pathogens, including Lassa virus, HIV-1, enterovirus A, and malaria parasites (fig. S3).

In total, we generated 99 EBOV genome sequences from 78 confirmed EVD patients, representing more than 70% of the EVD patients diagnosed in Sierra Leone from late May to mid-June; we used multiple extraction methods or time points for 13 patients (table S2). Median coverage was >2000×, spanning more than 99.9% of EBOV coding regions (Fig. 1, D and E, and table S2).

We combined the 78 Sierra Leonean sequences with three published Guinean samples (*3*) [correcting 21 likely sequencing errors in the latter (*6*)] to obtain a data set of 81 sequences. They

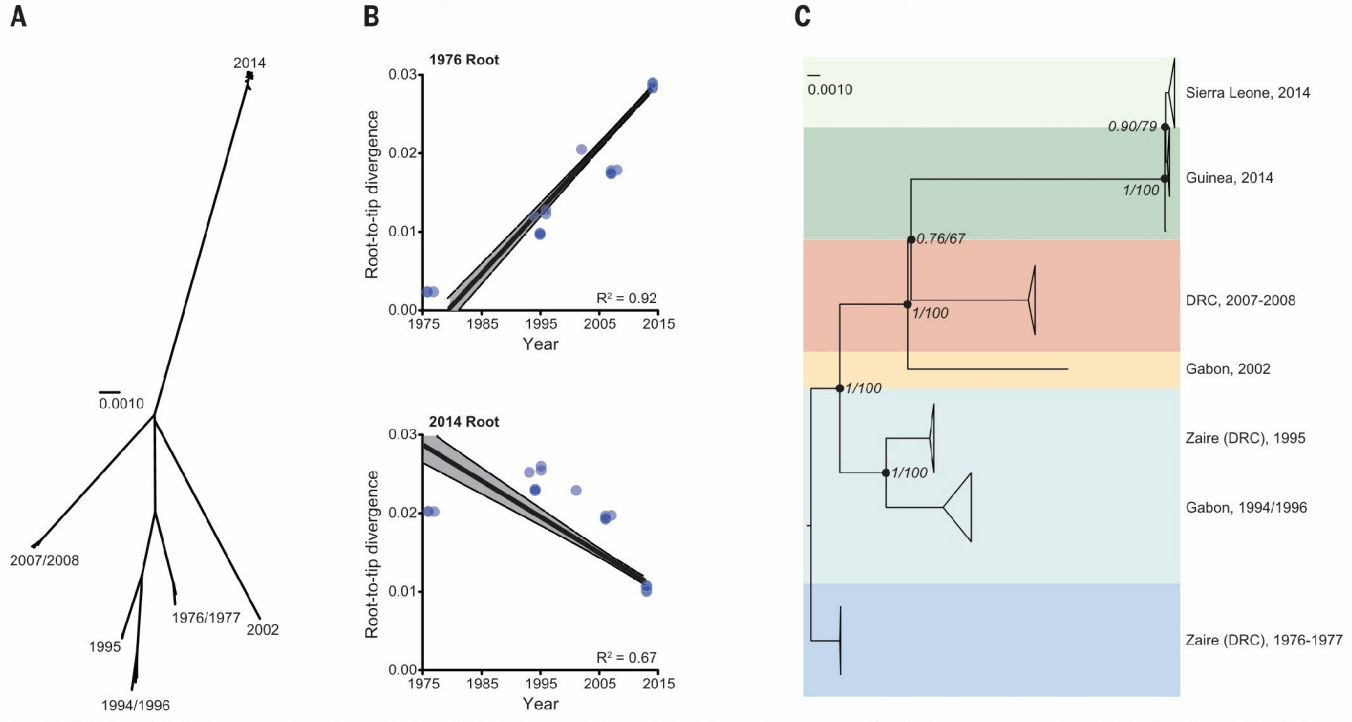

Fig. 2. Relationship between outbreaks. (**A**) Unrooted phylogenetic tree of EBOV samples; each major clade corresponds to a distinct outbreak (scale bar = nucleotide substitutions per site). (**B**) Root-to-tip distance correlates better with sample date when rooting on the 1976 branch (R^2 = 0.92, top) than on the 2014 branch (R^2 = 0.67, bottom). (**C**) Temporally rooted tree from (A).

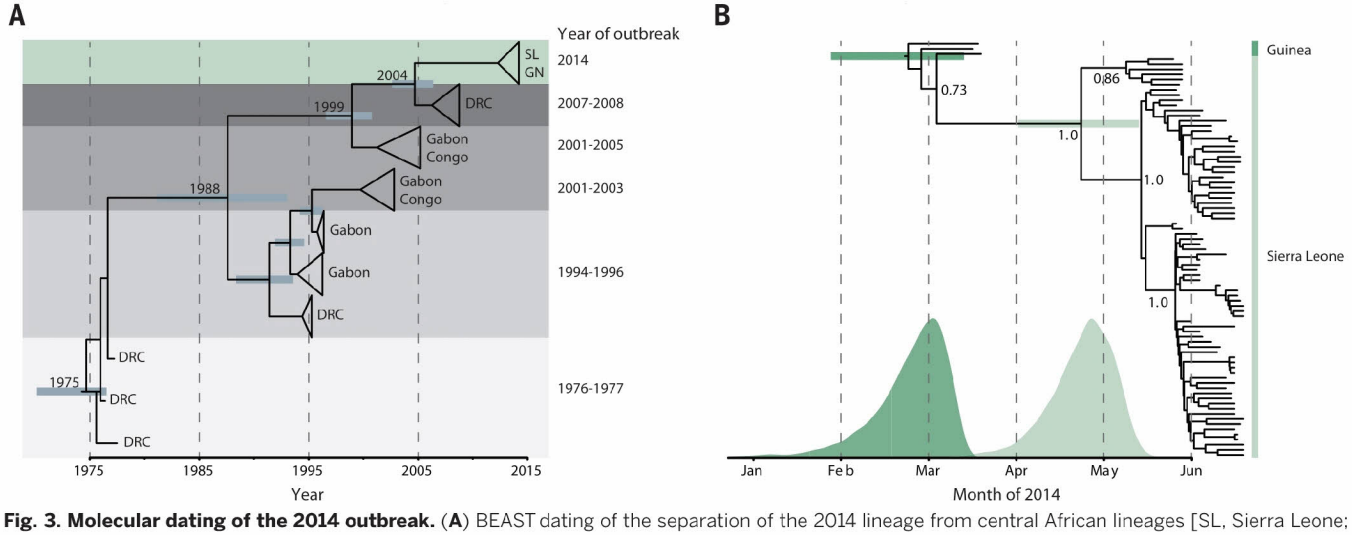

Fig. 3. Molecular dating of the 2014 outbreak. (**A**) BEAST dating of the separation of the 2014 lineage from central African lineages [SL, Sierra Leone; GN, Guinea; DRC, Democratic Republic of Congo; time of most recent common ancestor (tMRCA), September 2004; 95% highest posterior density (HPD), October 2002 to May 2006]. (**B**) BEAST dating of the tMRCA of the 2014 West African outbreak (23 February; 95% HPD, 27 January to 14 March) and the tMRCA of the Sierra Leone lineages (23 April; 95% HPD, 2 April to 13 May). Probability distributions for both 2014 divergence events are overlaid below. Posterior support for major nodes is shown.

reveal 341 fixed substitutions (35 nonsynonymous, 173 synonymous, and 133 noncoding) between the 2014 EBOV and all previously published EBOV sequences, with an additional 55 single-nucleotide polymorphisms (SNPs; 15 nonsynonymous, 25 synonymous, and 15 noncoding), fixed within individual patients, within the West African outbreak. Notably, the Sierra Leonean genomes differ from PCR probes for four separate assays used for EBOV and pan-filovirus diagnostics (table S3).

Deep-sequence coverage allowed identification of 263 iSNVs (73 nonsynonymous, 108 synonymous, 70 noncoding, and 12 frameshift) in the Sierra Leone patients (*6*). For all patients with multiple time points, consensus sequences were identical and iSNV frequencies remained stable (fig. S4). One notable intrahost variation is the RNA editing site of the glycoprotein (GP) gene (fig. S5A) (*10*–*12*), which we characterized in patients (*6*).

Phylogenetic comparison to all 20 genomes from earlier outbreaks suggests that the 2014 West African virus likely spread from central Africa within the past decade. Rooting the phylogeny using divergence from other ebolavirus genomes is problematic (Fig. 2A and fig. S6) (*6*, *13*).

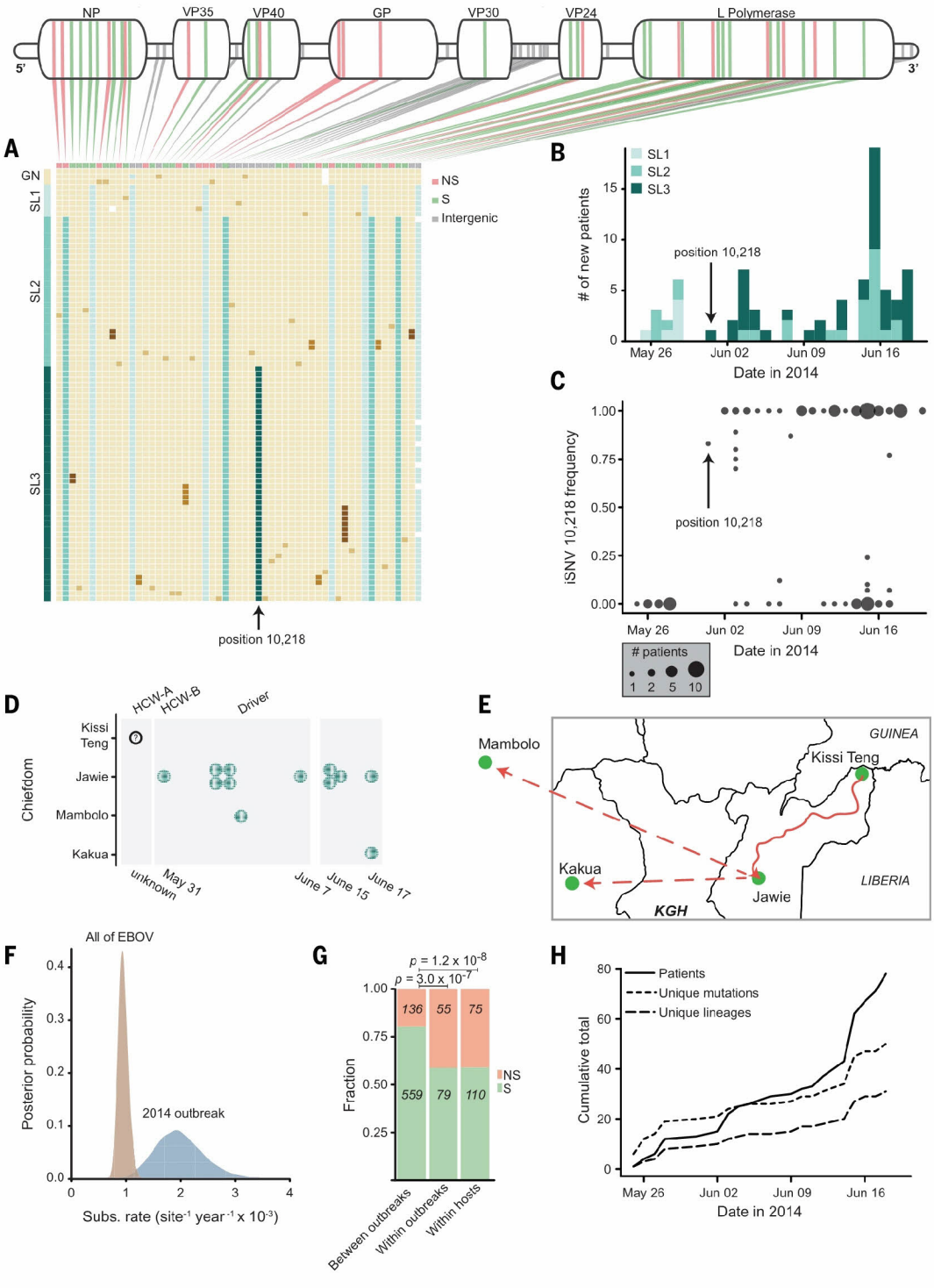

Fig. 4. Viral dynamics during the 2014 outbreak. (**A**) Mutations, one patient sample per row; beige blocks indicate identity with the Kissidougou Guinean sequence (GenBank accession KJ660346). The top row shows the type of mutation (green, synonymous; pink, nonsynonymous; gray, intergenic), with genomic locations indicated above. Cluster assignments are shown at the left. (**B**) Number of EVD-confirmed patients per day, colored by cluster. Arrow indicates the first appearance of the derived allele at position 10,218, distinguishing clusters 2 and 3. (**C**) Intrahost frequency of SNP 10,218 in all 78 patients (absent in 28 patients, polymorphic in 12, fixed in 38). (**D** and **E**) Twelve patients carrying iSNV 10,218 cluster geographically and temporally (HCW-A = unsequenced health care worker; Driver drove HCW-A from Kissi Teng to Jawie, then continued alone to Mambolo; HCW-B treated HCW-A). KGH = location of Kenema Government Hospital. (**F**) Substitution rates within the 2014 outbreak and between all EVD outbreaks. (**G**) Proportion of nonsynonymous changes observed on different time scales (green, synonymous; pink, nonsynonymous). (**H**) Acquisition of genetic variation over time. Fifty mutational events (short dashes) and 29 new viral lineages (long dashes) were observed (intrahost variants not included).

However, rooting the tree on the oldest outbreak reveals a strong correlation between sample date and root-to-tip distance, with a substitution rate of 8×10^{-4} per site per year (Fig. 2B and fig. S7) (*13*). This suggests that the lineages of the three most recent outbreaks all diverged from a common ancestor at roughly the same time, around 2004 (Fig. 2C and Fig. 3A), which supports the hypothesis that each outbreak represents an independent zoonotic event from the same genetically diverse viral population in its natural reservoir.

Genetic similarity across the sequenced 2014 samples suggests a single transmission from the natural reservoir, followed by human-to-human transmission during the outbreak. Molecular dating places the common ancestor of all sequenced Guinea and Sierra Leone lineages around late February 2014 (Fig. 3B), 3 months after the earliest suspected cases in Guinea (*3*); this coalescence would be unlikely had there been multiple transmissions from the natural reservoir. Thus, in contrast to some previous EVD outbreaks (*14*), continued human-reservoir exposure is unlikely to have contributed to the growth of this epidemic in areas represented by available sequence data.

Our data suggest that the Sierra Leone outbreak stemmed from the introduction of two genetically distinct viruses from Guinea around the same time. Samples from 12 of the first EVD patients in Sierra Leone, all believed to have attended the funeral of an EVD case from Guinea, fall into two distinct clusters (clusters 1 and 2) (Fig. 4A and fig. S8). Molecular dating places the divergence of these two lineages in late April (Fig. 3B), predating their co-appearance in Sierra Leone in late May (Fig. 4B); this finding suggests that the funeral attendees were most likely infected by two lineages then circulating in Guinea, possibly at the funeral (fig. S9). All subsequent diversity in Sierra Leone accumulated on the background of those two lineages (Fig. 4A), consistent with epidemiological information from tracing contacts.

Patterns in observed intrahost and interhost variation provide important insight about transmission and epidemiology. Groups of patients with identical viruses or with shared intrahost variation show temporal patterns suggesting transmission links (fig. S10). One iSNV (position 10,218) shared by 12 patients is later observed as fixed within 38 patients, becoming the majority allele in the population (Fig. 4C) and defining a third Sierra Leone cluster (Fig. 4, A and D, and fig. S8). Repeated propagation at intermediate frequency suggests that transmission of multiple viral haplotypes may be common. Geographic, temporal, and epidemiological metadata support the transmission clustering inferred from genetic data (Fig. 4, D and E, and fig. S11) (*6*).

The observed substitution rate is roughly twice as high within the 2014 outbreak as between outbreaks (Fig. 4F). Mutations are also more frequently nonsynonymous during the outbreak (Fig. 4G). Similar findings have been seen previously (*15*) and are consistent with expectations from incomplete purifying selection (*16*–*18*). Determining whether individual mutations are deleterious, or even adaptive, would require functional analysis; however, the rate of nonsynonymous mutations suggests that continued progression of this epidemic could afford an opportunity for viral adaptation (Fig. 4H), underscoring the need for rapid containment.

As in every EVD outbreak, the 2014 EBOV variant carries a number of genetic changes distinct to this lineage; our data do not address whether these differences are related to the severity of the outbreak. However, the catalog of 395 mutations, including 50 fixed nonsynonymous changes with 8 at positions with high levels of conservation across ebolaviruses, provides a starting point for such studies (table S4).

To aid in relief efforts and facilitate rapid global research, we have immediately released all sequence data as it is generated. Ongoing epidemiological and genomic surveillance is imperative to identify viral determinants of transmission dynamics, monitor viral changes and adaptation, ensure accurate diagnosis, guide research on therapeutic targets, and refine public health strategies. It is our hope that this work will aid the multidisciplinary international efforts to understand and contain this expanding epidemic.

In memoriam: Tragically, five co-authors, who contributed greatly to public health and research efforts in Sierra Leone, contracted EVD and lost their battle with the disease before this manuscript could be published: Mohamed Fullah, Mbalu Fonnie, Alex Moigboi, Alice Kovoma, and S. Humarr Khan. We wish to honor their memory.

REFERENCES AND NOTES

1. J. H. Kuhn *et al.*, *Biosecur. Bioterror.* **9**, 361–371 (2011).
2. J. Burke, *Bull. World Health Organ.* **56**, 271–293 (1978).
3. S. Baize *et al.*, *N. Engl. J. Med.* 10.1056/NEJMoa1404505 (2014).
4. WHO, (2014), www.who.int/csr/don/archive/disease/ebola/en/
5. O. Reynard, V. Volchkov, C. Peyrefitte, *Med. Sci.* **30**, 671–673 (2014).
6. See supplementary materials on *Science* Online.
7. J. S. Towner, T. K. Sealy, T. G. Ksiazek, S. T. Nichol, *J. Infect. Dis.* **196** (suppl. 2), S205–S212 (2007).
8. M. Panning *et al.*, *J. Infect. Dis.* **196** (suppl. 2), S199–S204 (2007).
9. C. M. Malboeuf *et al.*, *Nucleic Acids Res.* **41**, e13 (2013).
10. A. Sanchez, S. G. Trappier, B. W. Mahy, C. J. Peters, S. T. Nichol, *Proc. Natl. Acad. Sci. U.S.A.* **93**, 3602–3607 (1996).
11. V. E. Volchkov *et al.*, *Virology* **214**, 421–430 (1995).
12. V. A. Volchkova, O. Dolnik, M. J. Martinez, O. Reynard, V. E. Volchkov, *J. Infect. Dis.* **204** (suppl. 3), S941–S946 (2011).
13. G. Dudas, A. Rambaut, *PLOS Curr. Outbreaks* **6**, 10.1371/currents.outbreaks.84eefe5ce43ec9dc0bf0670f7b8b417d (2014).
14. J. Kuhn, C. H. Calisher, Eds., *Filoviruses: A Compendium of 40 Years of Epidemiological, Clinical, and Laboratory Studies* (Springer, New York, 2008).
15. M. J. Schreiber *et al.*, *J. Virol.* **83**, 4163–4173 (2009).
16. J. O. Wertheim, S. L. Kosakovsky Pond, *Mol. Biol. Evol.* **28**, 3355–3365 (2011).
17. S. Y. Ho, M. J. Phillips, A. Cooper, A. J. Drummond, *Mol. Biol. Evol.* **22**, 1561–1568 (2005).
18. E. C. Holmes, *J. Virol.* **77**, 11296–11298 (2003).

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SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/345/6202/1369/suppl/DC1
Materials and Methods
Supplementary Text
Figs. S1 to S11
Tables S1 to S4
Supplementary files S1 to S4
References (*19*–*44*)

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Science

Genomic surveillance elucidates Ebola virus origin and transmission during the 2014 outbreak

Stephen K. Gire, Augustine Goba, Kristian G. Andersen, Rachel S. G. Sealfon, Daniel J. Park, Lansana Kanneh, Simbirie Jalloh, Mambu Momoh, Mohamed Fullah, Gytis Dudas, Shirlee Wohl, Lina M. Moses, Nathan L. Yozwiak, Sarah Winnicki, Christian B. Matranga, Christine M. Malboeuf, James Qu, Adrianne D. Gladden, Stephen F. Schaffner, Xiao Yang, Pan-Pan Jiang, Mahan Nekoui, Andres Colubri, Moinya Ruth Coomber, Mbalu Fonnie, Alex Moigboi, Michael Gbakie, Fatima K. Kamara, Veronica Tucker, Edwin Konuwa, Sidiki Saffa, Josephine Sellu, Abdul Azziz Jalloh, Alice Kovoma, James Koninga, Ibrahim Mustapha, Kandeh Kargbo, Momoh Foday, Mohamed Yillah, Franklyn Kanneh, Willie Robert, James L. B. Massally, Sinéad B. Chapman, James Bochicchio, Cheryl Murphy, Chad Nusbaum, Sarah Young, Bruce W. Birren, Donald S. Grant, John S. Scheiffelin, Eric S. Lander, Christian Happi, Sahr M. Gevao, Andreas Gnirke, Andrew Rambaut, Robert F. Garry, S. Humarr Khan and Pardis C. Sabeti

Science **345** (6202), 1369-1372.
DOI: 10.1126/science.1259657originally published online August 28, 2014

Evolution of Ebola virus over time

The high rate of mortality in the current Ebola epidemic has made it difficult for researchers to collect samples of the virus and study its evolution. Gire *et al.* describe Ebola epidemiology on the basis of 99 whole-genome sequences, including samples from 78 affected individuals. The authors analyzed changes in the viral sequence and conclude that the current outbreak probably resulted from the spread of the virus from central Africa in the past decade. The outbreak started from a single transmission event from an unknown animal reservoir into the human population. Two viral lineages from Guinea then spread from person to person into Sierra Leone.

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Ebola Virus Disease--Sierra Leone and Guinea, August 2015.

Hersey S, Martel LD, Jambai A, Keita S, Yoti Z, Meyer E, Seeman S, Bennett S, Ratto J, Morgan O, Akyeampong MA, Sainvil S, Worrell MC, Fitter D, Arnold KE.

Abstract

The Ebola virus disease (Ebola) outbreak in West Africa began in late 2013 in Guinea (1) and spread unchecked during early 2014. By mid-2014, it had become the first Ebola epidemic ever documented. Transmission was occurring in multiple districts of Guinea, Liberia, and Sierra Leone, and for the first time, in capital cities (2). On August 8, 2014, the World Health Organization (WHO) declared the outbreak to be a Public Health Emergency of International Concern (3). Ministries of Health, with assistance from multinational collaborators, have reduced Ebola transmission, and the number of cases is now declining. While Liberia has not reported a case since July 12, 2015, transmission has continued in Guinea and Sierra Leone, although the numbers of cases reported are at the lowest point in a year. In August 2015, Guinea and Sierra Leone reported 10 and four confirmed cases, respectively, compared with a peak of 526 (Guinea) and 1,997 (Sierra Leone) in November 2014. This report details the current situation in Guinea and Sierra Leone, outlines strategies to interrupt transmission, and highlights the need to maintain public health response capacity and vigilance for new cases at this critical time to end the outbreak.

PMID: 26355422 DOI: 10.15585/mmwr.mm6435a6

[Indexed for MEDLINE] Free full text

Ebola Virus Disease in Health Care Workers — Sierra Leone, 2014

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(Author affiliations at end of text)

On December 9, 2014, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

Health care workers (HCWs) are at increased risk for infection in outbreaks of Ebola virus disease (Ebola) (*1*). To characterize Ebola in HCWs in Sierra Leone and guide prevention efforts, surveillance data from the national Viral Hemorrhagic Fever database were analyzed. In addition, site visits and interviews with HCWs and health facility administrators were conducted. As of October 31, 2014, a total of 199 (5.2%) of the total of 3,854 laboratory-confirmed Ebola cases reported from Sierra Leone were in HCWs, representing a much higher estimated cumulative incidence of confirmed Ebola in HCWs than in non-HCWs, based on national data on the number of HCW. The peak number of confirmed Ebola cases in HCWs was reported in August (65 cases), and the highest number and percentage of confirmed Ebola cases in HCWs was in Kenema District (65 cases, 12.9% of cases in Kenema), mostly from Kenema General Hospital. Confirmed Ebola cases in HCWs continued to be reported through October and were from 12 of 14 districts in Sierra Leone. A broad range of challenges were reported in implementing infection prevention and control measures. In response, the Ministry of Health and Sanitation and partners are developing standard operating procedures for multiple aspects of infection prevention, including patient isolation and safe burials; recruiting and training staff in infection prevention and control; procuring needed commodities and equipment, including personal protective equipment and vehicles for safe transport of Ebola patients and corpses; renovating and constructing Ebola care facilities designed to reduce risk for nosocomial transmission; monitoring and evaluating infection prevention and control practices; and investigating new cases of Ebola in HCWs as sentinel public health events to identify and address ongoing prevention failures.

For this report of Ebola in HCWs in Sierra Leone, data were analyzed on laboratory-confirmed cases in the national Viral Hemorrhagic Fever database, which was created to capture and analyze data from the 2014 Ebola outbreak. Surveillance officers used a standardized case investigation form to collect information from patients with suspected or probable Ebola (*2*) and their family members. Information collected included age, sex, address, occupation, date of onset of symptoms, and potential exposures to other Ebola patients. "Health care worker" was one of the choices listed under a patient's occupation and included clinicians such as doctors and nurses, as well as members of other cadres, including ambulance drivers, hospital cleaners, and burial team members. Vital status and laboratory information were entered into the patient's case record as results were reported to the surveillance team in each health district. District data were merged at the national level. Whole blood from live patients and oral swab specimens from corpses were sent to one of several laboratories in Sierra Leone. Reverse transcription–polymerase chain reaction assays were used to confirm *Ebolavirus* infection. Select characteristics of HCW and non-HCW cases were compared using chi-square tests. P-values <0.05 were considered significant. To inform infection prevention and control efforts and surveillance of Ebola in HCWs, unstructured interviews concerning HCW infections were conducted with HCWs and health facility administrators in the course of site visits to health care facilities in eight districts during August–October 2014.

During May 23 through October 31, 2014, there were 3,854 laboratory-confirmed cases of Ebola reported in Sierra Leone in the Viral Hemorrhagic Fever database, including 199 cases in HCWs (5.2%). Seven additional cases in HCWs and 949 cases in non-HCWs had dates of symptom onset that were missing or outside of May 23 (date of the first documented case) to October 31 and were excluded from analysis. According to the *National Health Strategic Plan 2010–2015*, published in 2009 (*3*), Sierra Leone had a total health workforce of 2,402 persons. Using this denominator, the cumulative confirmed Ebola incidence in HCWs was 8,285 per 100,000. This can be compared with the 2,806 confirmed Ebola cases in non-HCWs in a national population of 3.49 million persons aged ≥15 years, with a cumulative incidence in adult non-HCWs of 80.4 per 100,000 population. Therefore, the confirmed Ebola incidence was 103-fold higher in HCWs than that in the general population in Sierra Leone.

Among confirmed cases in HCWs, 54.8% were in males, compared with 48.2% in non-HCWs (p=0.09). Of 183 (92%) confirmed Ebola cases in HCWs with recorded age, two (1.1%) were reportedly in persons aged <15 years, 82.0% were in persons aged 15–49 years, and 16.9% were in persons aged ≥50 years. There were no confirmed Ebola cases in HCWs reported in May. The number peaked at 65 cases in August and declined to 36 in September and 42 in October (Figure 1). The highest percentage of confirmed Ebola patients that were

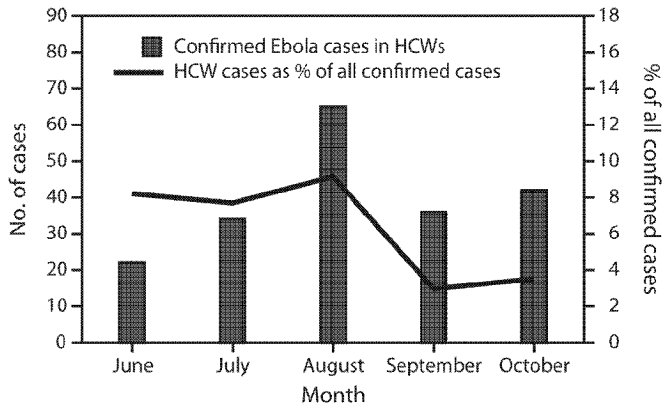
HCWs was in August (9.2%); this declined to 3.5% in October (Figure 1). The number of confirmed Ebola cases in HCW per district ranged from zero in two districts to 65 cases in Kenema District (Figure 2), which also had the highest percentage of all confirmed Ebola patients that were HCWs (12.9%). District of residence was missing in seven cases in HCWs (3.5%).

The surveillance form included questions on potential sources of infection, specifically attendance at a funeral or contact with a person with known or suspected Ebola, with an ill person, or with a corpse in the month before onset of symptoms. Among 159 (80%) confirmed HCW Ebola cases with data on funeral attendance, 13.8% had attended a funeral, compared with 32.3% in non-HCW ($p < 0.001$). Data on contact with a known or suspected Ebola patient or ill person or a corpse was available for 143 (72%) confirmed HCW Ebola cases; 18.2% were in persons who had contact with a person with known or suspected Ebola or an ill person, compared with 12.3% in non-HCWs ($p = 0.05$); 30.1% had contact with a corpse, compared with 34.3% in non-HCWs ($p=0.3$).

Among confirmed HCW Ebola patients, 12.1% were dead at the time of surveillance recording, compared with 15.0% among non-HCW patients ($p=0.3$); other data on vital status, including numbers with missing data at time of surveillance recording and final outcome, are not consistently available in the Viral Hemorrhagic Fever data.

Site visits and unstructured interviews with HCWs and health facility administrators revealed a broad range of circumstances potentially leading to Ebola in HCWs. These included a lack of standard operating procedures and clearly assigned responsibilities for infection prevention and control; overall staff shortages and lack of infection prevention specialists; limited availability of safe transport vehicles for patients and corpses; incorrect triage or recognition of potential Ebola in patients and corpses, including no reassessment of admitted patients to identify new symptoms of Ebola (especially children aged <5 years); delayed laboratory diagnosis of Ebola cases because of long turn-around time for specimen transport and reporting of results; inadequate control of Ebola patient or HCW movement within health facilities; and lack of delineation between high-risk and low-risk Ebola zones. Other findings included limited availability of appropriate personal protective equipment and hand washing facilities, including lack of water and sufficient chlorine supplies; no or inadequate training about and monitoring of personal protective equipment use and hand washing; lack of equipment and materials and no or inadequate training about and monitoring of decontamination of transport vehicles and care facility spaces; limited capacity and no or inadequate training about safe management of contaminated waste; and limited capacity and no or inadequate training about safe management and burial of corpses.

FIGURE 1. Number of laboratory-confirmed Ebola virus disease (Ebola) cases in health care workers (HCWs) and confirmed Ebola cases in HCWs as a percentage of all confirmed cases, by month — Sierra Leone, June–October 2014



Discussion

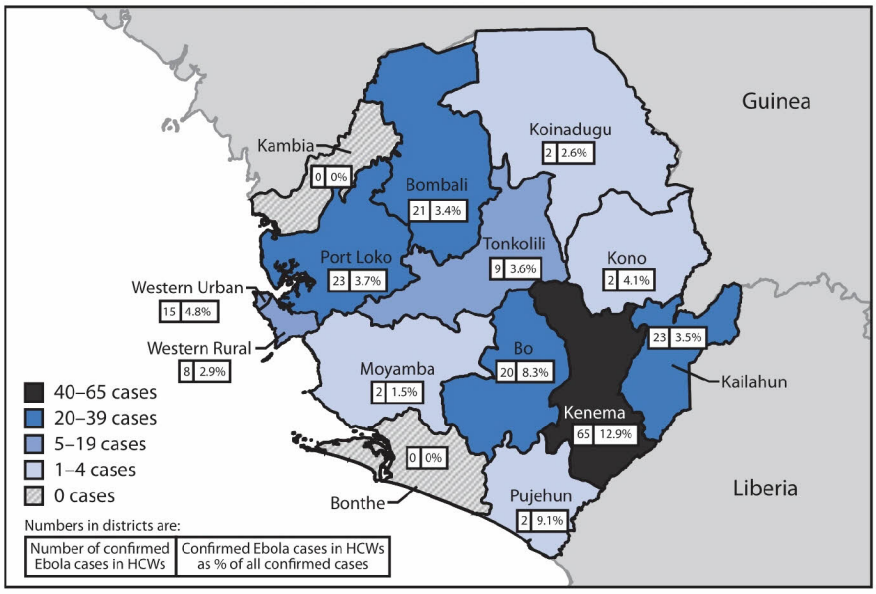
Analysis of the national Viral Hemorrhagic Fever database found 199 cases of Ebola in the Sierra Leone health workforce. Using the number of HCWs reported in 2009 (*3*) as a denominator for HCWs and comparing with infection rates in the general population aged ≥15 years, the estimated confirmed Ebola incidence rate was approximately 100-fold higher in HCWs than in non-HCW adults in Sierra Leone.

The number and proportion of all confirmed Ebola patients that were HCWs peaked in August. The subsequent reductions might be attributable to concurrent implementation of infection prevention and control measures, including training and availability of personal protective equipment, and could reflect a closure of many health facilities and reduction in availability of health care services and HCW exposure as the outbreak progressed. However, many Ebola cases in HCWs continued to be reported in October. The highest number of confirmed Ebola cases and the proportion of all confirmed Ebola case that were HCWs occurred in Kenema District. There were 43 Ebola cases in HCWs in Kenema District in July and August, mostly among Kenema General Hospital staff. Inquiries about breaches of infection prevention and control at Kenema General Hospital indicated, among other problems, challenges with overall site management and administrative controls, such as correct and consistent triage and isolation of Ebola patients. Although some districts, such as Kenema, were more heavily affected, confirmed Ebola cases in HCWs have been reported in 12 of 14 districts in Sierra Leone, including all districts that have reported more than 35 confirmed Ebola cases. Also, although most cases in HCWs occurred in facilities operated by the Ministry of Health and Sanitation, including both general care facilities and those designated for Ebola care, there were a small number of confirmed Ebola cases in HCWs at Ebola care facilities established

and managed by international implementing partners. These findings underscore the widespread challenges with infection prevention and control in Sierra Leone.

Compared with non-HCW patients, HCW patients were less likely to have attended a funeral and were more likely to have had contact with a live Ebola patient or ill person in the 30 days before symptom onset. However, a substantial proportion of both HCW and non-HCW Ebola patients reported funeral attendance or contact with a corpse, highlighting the overall importance of transmission from corpses in this outbreak. HCW patients were not significantly less likely than non-HCW patients to be dead at the time their cases were recorded by the surveillance system. The finding that 12% of HCW patients were dead at the time of recording indicates shortcomings in contact tracing, early case identification, and access to medical care, even in HCWs, who might have been expected to have better awareness and access to health care.

FIGURE 2. Number of laboratory-confirmed Ebola virus disease (Ebola) cases in health care workers (HCWs) and confirmed Ebola cases in HCWs as a percentage of all confirmed cases, by district — Sierra Leone, May–October 2014



The findings in this report are subject to at least four limitations. First, public health surveillance data were incomplete, especially in the context of a health emergency in a resource-poor setting. It has been estimated that overall case numbers represent only one third to one half of all cases (*4*). Second, data on key information such as occupation was missing or might have been incorrect on many case investigation forms, and many cases were not included in the analysis because of missing or out-of-range dates of onset of symptoms. Third, members of some cadres, such as ambulance drivers, burial team members, and community health workers, might not have been consistently recorded as HCWs on case investigation forms or in the Ministry of Health and Sanitation 2009 report on the health workforce (*3*), and the number of health workers might have changed since 2009. As a result, these findings likely undercount the number of *Ebolavirus*-infected HCWs in Sierra Leone. However, Ebola reporting might be more complete for HCWs than non-HCWs, so the ratio of the Ebola cumulative incidence in HCWs compared with non-HCWs might be an overestimate. Finally, data on exposures are also likely to be incomplete. For example, the finding that contact with an Ebola patient or ill person was reported for only 19% of HCWs with Ebola is likely an underestimate.

A broad range of potential problems with infection prevention and control were reported at both general care facilities and those designated for Ebola care. The Ministry of Health and Sanitation, together with Sierra Leonean and international partners, are implementing a wide range of interventions, including policies, training, procurement, renovation, construction, and monitoring and evaluation, in accordance with established recommendations (*5*). As is the case with prevention of nosocomial transmission of tuberculosis (*6*), many observed breaches of infection prevention and control practices appeared to be attributed to failures of administrative controls, such as incorrect triage, or infrastructure limitations of renovated facilities, such as lack of barriers separating Ebola wards, rather than personal protective equipment failures; particular attention to these issues is recommended in the control of Ebola.

Cases of Ebola in HCWs are currently being investigated as sentinel public health events. An infection in an HCW might represent transmission from an Ebola patient in a health care facility, but might also be a signal for transmission to and from HCWs in the community, and for facility-based transmission from patient to patient and from HCWs to patients or to other HCWs. New, high-quality, dedicated Ebola treatment units are being established by international partners in Sierra Leone, but because the number of these beds does not meet the need in high-transmission areas, other, less well-resourced facilities, including Ebola care, holding, and isolation centers, are being established by the Ministry of Health and Sanitation. Given the high risk of nosocomial transmission of *Ebolavirus* (*5*), health authorities must be vigilant in implementation of strict infection prevention and control measures in all health care settings and alert to the possibility that less well-controlled settings might inadvertently act to propagate rather than interrupt transmission. Prevention of Ebola in HCWs is also critical to sustain the health workforce to address all causes of morbidity and mortality in Sierra Leone.

What is already known on this topic?

Health care workers (HCWs) are at increased risk for infection in outbreaks of Ebola virus disease (Ebola). Adherence to good infection prevention and control practices are required to prevent Ebola in HCWs.

What is added by this report?

As of October 31, 2014, of the total of 3,854 laboratory-confirmed Ebola cases reported from Sierra Leone, 199 (5.2%) were in HCWs. This was estimated to be a much higher cumulative incidence of confirmed Ebola in HCWs compared with non-HCWs. A broad range of breaches of good infection prevention and control practices were reported, and Ebola cases in HCW continued to be reported in October.

What are the implications for public health practice?

In Ebola outbreaks, comprehensive programs to reduce the risk for Ebola in HCWs in all health care settings are needed, including development of standard operating procedures (including safe triage), recruiting and training staff, procuring needed commodities and equipment, renovating and constructing safe Ebola care facilities, monitoring and evaluating infection prevention and control practices; and investigating new cases of Ebola in HCWs as sentinel public health events to identify and address ongoing prevention failures.

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References

1. World Health Organization. Fact sheet no. 103: Ebola virus disease. Geneva, Switzerland: World Health Organization; 2014. Available at http://www.who.int/mediacentre/factsheets/fs103/en.
2. Incident Management System Ebola Epidemiology Team, CDC; Ministries of Health of Guinea, Sierra Leone, Liberia, Nigeria, and Senegal; Viral Special Pathogens Branch, National Center for Emerging and Zoonotic Infectious Diseases, CDC. Ebola virus disease outbreak—West Africa, September 2014. MMWR Morb Mortal Wkly Rep 2014;63:865–6.
3. Ministry of Health and Sanitation, Sierra Leone. National health strategic plan 2010–2015. Freetown, Sierra Leone: Ministry of Health and Sanitation; 2009.
4. Meltzer MI, Atkins CY, Santibanez S, et al. Estimating the future number of cases in the Ebola epidemic—Liberia and Sierra Leone, 2014–2015. MMWR Surveill Summ 2014 Sep 26;63:1–14.
5. World Health Organization. Infection prevention and control guidance for care of patients in health-care settings, with focus on Ebola. Geneva, Switzerland: World Health Organization; 2014. Available at http://www.who.int/csr/resources/publications/ebola/filovirus_infection_control/en.
6. World Health Organization. WHO policy on TB infection control in health-care facilities, congregate settings and households. Geneva, Switzerland: World Health Organization; 2009. Available at http://whqlibdoc.who.int/publications/2009/9789241598323_eng.pdf.

Rapid Assessment of Ebola Infection Prevention and Control Needs — Six Districts, Sierra Leone, October 2014

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As of October 31, 2014, the Sierra Leone Ministry of Health and Sanitation had reported 3,854 laboratory-confirmed cases of Ebola virus disease (Ebola) since the outbreak began in May 2014; 199 (5.2%) of these cases were among health care workers. Ebola infection prevention and control (IPC) measures are essential to interrupt Ebola virus transmission and protect the health workforce, a population that is disproportionately affected by Ebola because of its increased risk of exposure yet is essential to patient care required for outbreak control and maintenance of the country's health system at large. To rapidly identify existing IPC resources and high priority outbreak response needs, an assessment by CDC Ebola Response Team members was conducted in six of the 14 districts in Sierra Leone, consisting of health facility observations and structured interviews with key informants in facilities and government district health management offices. Health system gaps were identified in all six districts, including shortages or absence of trained health care staff, personal protective equipment (PPE), safe patient transport, and standardized IPC protocols. Based on rapid assessment findings and key stakeholder input, priority IPC actions were recommended. Progress has since been made in developing standard operating procedures, increasing laboratory and Ebola treatment capacity and training the health workforce. However, further system strengthening is needed. In particular, a successful Ebola outbreak response in Sierra Leone will require an increase in coordinated and comprehensive district-level IPC support to prevent ongoing Ebola virus transmission in household, patient transport, and health facility settings.

Rapid needs assessments were conducted in Bombali, Moyamba, Port Loko, Pujehun, Tonkolili, and Western districts during October 1–5, 2014. These districts varied widely in Ebola case burden (8.3 cumulative confirmed cases per 100,000 population in Pujehun to 115.6 in Bombali [*1*]) and in the number of Ebola care facilities (one in Moyamba to 12 in Western). Data on existing IPC resources and activities currently under way as part of the Ebola response were collected in each district through key informant structured interviews and observations at health facilities using a standardized questionnaire.

The assessment team interviewed the district medical officer or a health management team representative to assess district-twide IPC activities, as well as a senior nursing or physician staff member at a convenience sample of 12 government-run referral health facilities. This included a district hospital as well as one to three Ebola "holding centers" per district (transitional care facilities where suspected Ebola patients are referred for diagnostic testing and supportive care until they can be transferred to a free-standing Ebola treatment unit for isolation and care), except in Tonkolili District where only the district hospital was visited. District hospitals are expected to screen for Ebola and properly isolate suspected patients while awaiting transfer to an Ebola treatment unit. Their Ebola isolation areas can become holding centers by default because of transportation delays and limited Ebola treatment unit bed availability. Standardized interview and assessment tools were based on World Health Organization Ebola infection prevention recommendations (*2*) and included questions on Ebola IPC response plans, procedures, facilities, staffing, transportation teams, and supplies. Interviewee responses were recorded by hand and compiled for qualitative review. Assessment team members were doctoral-level international health professionals from CDC. They did not enter active Ebola care wards to directly observe IPC systems or practices.

Widespread gaps in IPC systems and resources critical for Ebola prevention and response were identified through interviews with key informants in all six districts visited (Table). None of the districts had dedicated infection control focal persons or supervisors within district health management structures to coordinate IPC activities and conduct routine quality assurance at the time of the rapid assessment. Furthermore, no IPC standard operating procedures existed at facility, district, or national levels for proper screening, isolation, care, and transport of suspected, probable, and confirmed Ebola patients.

Ebola screening procedures at all facilities visited were inadequate to facilitate appropriate triage and separation of patients suspected of having Ebola from those not suspected of having Ebola. Overall, there was a need for a standard routine screening protocol to minimize case misclassification, screening positioning at the initial access-controlled point of entry, and proper use of PPE among screeners. PPE supplies were reported to be insufficient for patient care and transport activities in every district, with larger gaps for rural facilities,

clinics, and ambulance teams. Other deficiencies in supplies and infrastructure included lack of running water, working incinerators for burning disposable waste, chlorine, and blood collection supplies. A detailed list of district-specific needs was compiled for presentation to key national stakeholders.

Key informants reported that the availability of hospital and holding center staff competent in IPC practices also was inadequate. The shortage was compounded by deaths of health care workers from Ebola infection and workforce attrition resulting from delays in receiving hazard pay and from staff fatigue (in two districts, medical officers responsible for operating Ebola isolation wards and ensuring staff adherence to IPC had not had a day off in over 2 months). However, the biggest barrier to adequate staffing was that IPC training and mentoring had not yet been uniformly delivered to staff members before the opening of the Ebola care facility. Only three of six districts reported that basic training had been provided to facility health care workers, including PPE use. In two districts, basic training had not been provided to most staff members, although PPE was being used. Ambulance teams and cleaners were reported to have undergone formal IPC training less consistently than burial teams and laboratory technicians, and staff members at peripheral health units (community clinics in Sierra Leone) were not yet routinely trained to safely screen for or isolate persons suspected with Ebola before transport to Ebola care facilities. Overwhelmingly, refresher IPC training and mentorship were desired, even in districts where IPC training activities had taken place.

Finally, delays in Ebola patient transportation and reporting of laboratory results hindered the separation of confirmed Ebola patients from suspected Ebola patients in holding centers, or from their families and communities. In areas distant from Ebola diagnostic laboratories, sample result turnaround time varied and sometimes took as long as 1 week. In two districts, home care was occurring regularly because of delays in patient transport systems and Ebola care bed availability, but without clear guidance for families on how this could be done safely. In all assessed districts, additional all-terrain vehicles and fuel were urgently needed for burial and ambulance teams, as well as specimen transport. No standard operating procedures were readily available for cleaning and decontamination of these vehicles which, in conjunction with limited training, improper use of PPE, and poor separation between clean and contaminated areas in the vehicles, put transport teams and potentially uninfected but suspected Ebola passengers at risk for infection.

Discussion

Based on these findings and key stakeholder input, priority IPC actions for the Ebola response in Sierra Leone were recommended. The Ministry of Health and Sanitation and international Ebola response partners have developed IPC protocols for care and transport procedures for implementation at the district and facility levels. They are increasingly procuring and organizing necessary supplies and support, and prioritizing growth of laboratory and Ebola treatment capacity. Given the lack of a preexisting infection control cadre and the overwhelming need for well-trained staff at all facility levels, the team recommended the rapid establishment of a large-scale Ebola treatment and IPC training program adapted to the varied health responder workforce. This program now exists

TABLE. Infection prevention and control (IPC) response assessment as reported by district medical officers and stakeholders — six districts, Sierra Leone, October 1–5, 2014

	Bombali	Moyamba	Port Loko	Pujehun	Tonkolili	Western
Ebola cumulative incidence per 100,000 population	115.6	34.5	99.8	8.3	48.3	88.7
IPC standard operating procedures in place	No	No	No	No	No	No
IPC practitioner on staff	No	No	No	No	No	No
Proper screening by protocol	No	No	No	No	No	No
Recommended personal protective equipment available*	No	No	No	No	—†	No
Adequate staff	No	No	No	No	No	No
Persons with any IPC training§						
Health care workers	Yes¶	Yes¶	No	No	Yes¶	No
Burial teams	Yes¶	Yes¶	—	Yes¶	—	Yes¶
Ambulance teams	No	No	No	No	—	No
Cleaners	No	Yes¶	Yes¶	No	Yes¶	No
Laboratory technicians	Yes¶	Yes¶	Yes¶	Yes¶	—	—
Refresher training desired	Yes	Yes	Yes	Yes	Yes	Yes
No. of ambulances (% coverage**)	5 (38%)	1 (7%)	3 (27%)	1 (8%)	—	6
Reported no. of days until return of Ebola laboratory results	2–7	2¶	2–5	2¶	2–6	2–3
Care in homes occurring††	Rare¶	Rare¶	50–100	Rare¶	—	Many

* Recommended refers to appropriate quantity and quality.
† Information not available.
§ IPC training was only counted if it included personal protective equipment procedures and participation by the majority of staff members.
¶ Response needs being met.
** Percentage coverage of chiefdoms (assuming goal of one ambulance per chiefdom). There are no chiefdoms in the Western District.
†† Estimated number of known Ebola cases remaining in homes.

and is being scaled up with international partner support. IPC training and delivery of PPE and other supplies to 1,185 peripheral health units is under way with technical support from CDC. Finally, monitoring and evaluation through a comprehensive Ebola IPC quality assurance system, including core IPC metrics, is planned and is expected to reinforce prevention efforts.

Additionally, national Ebola IPC coordination is ensuring that identified IPC gaps are addressed rapidly, correctly, and efficiently. Lead IPC response partners are coordinating standard operating procedure implementation, providing comprehensive IPC assessment and remediation of deficits at health care facilities, implementing routine IPC monitoring, and supporting facility-level commodity management. Strict administrative controls of patient screening and care in facilities continue to be needed to prevent infection of health care workers, uninfected patients, and visitors. Trained IPC specialists embedded within health care facilities and at the district level are recognized as critical to providing oversight of IPC strategy implementation; efforts to train and place these staff are underway.

Moving forward, ongoing IPC refresher training and corrective IPC practice reinforcement will be needed at the facility level following initial training. Ambulance transport capacity should be increased with improved IPC protocols to avoid transportation-related infections and, if care is to take place increasingly in homes, a clear protocol and strategy for this is imperative to prevent further community transmission. Finally, consensus criteria should be established both for IPC standards to be met before Ebola care facility opening and for closing facilities that fail to meet minimum standards.

Results from this rapid assessment were limited by time constraints, absence of assessment in Ebola patient care areas, and potential response bias from interviews administered to district-level stakeholders. In addition, the assessment team had varied success with key informant availabilities and the number of sites visited. Nevertheless, the assessment provides rapid insight into current IPC practices and preparedness in communities, patient transport, and health facility settings.

What is already known on this topic?

Sierra Leone continues to have a large number of Ebola cases. Ebola infection prevention and control (IPC) measures are essential to interrupt Ebola virus transmission and protect the health workforce.

What is added by this report?

A rapid needs assessment of six districts in Sierra Leone identified widespread gaps in IPC systems and resources critical for Ebola prevention and response in communities, patient transport, and health facility settings. In particular, there were shortages of trained staff members, personal protective equipment, safe transport, and standardized IPC protocols.

What are the implications for public health practice?

Based on rapid assessment findings and key stakeholder input, priority IPC actions for the Ebola response in Sierra Leone were recommended. A successful response will require an increase in coordinated and comprehensive district-level IPC support to prevent ongoing Ebola virus transmission in the country.

An increasingly coordinated and comprehensive IPC program with district and health facility level support is urgently needed to prevent Ebola in districts where the prevalence is low and to strengthen the existing IPC response in areas with high prevalence of Ebola.

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Acknowledgments

Sierra Leone Ministry of Health and Sanitation; Health Management Teams in Bombali, Moyamba, Port Loko, Pujehun, Tonkolili, and Western districts.

References

1. Ministry of Health and Sanitation. Ebola virus disease—situation report volume 157-1, November 2014. Freetown, Sierra Leone: Ministry of Health and Sanitation; 2014.
2. World Health Organization. Infection prevention and control (IPC) guidance summary: Ebola guidance package. Geneva, Switzerland: World Health Organization; 2014. Available at http://www.who.int/csr/resources/publications/ebola/evd-guidance-summary/en.

MAJOR ARTICLE

Epidemiology and Risk Factors for Ebola Virus Disease in Sierra Leone—23 May 2014 to 31 January 2015

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Background. Sierra Leone has the most cases of Ebola virus disease (EVD) ever reported. Trends in laboratory-confirmed EVD, symptom presentation, and risk factors have not been fully described.

Methods. EVD cases occurring from 23 May 2014 to 31 January 2015 are presented by geography, demographics, and risk factors for all persons who had laboratory-confirmed EVD, which was identified by Ebola virus–specific reverse-transcription polymerase chain reaction–based testing.

Results. During the study period, 8056 persons had laboratory-confirmed EVD. Their median age was 28 years; 51.7% were female. Common symptoms included fever (90.4%), fatigue (88.3%), loss of appetite (87.0%), headache (77.9%), joint pain (73.7%), vomiting (71.2%), and diarrhea (70.6%). Among persons with confirmed cases, 47.9% reported having had contact with someone with suspected EVD or any sick person, and 25.5% reported having attended a funeral, of whom 66.2% reported touching the body. The incidence of EVD was highest during 1–30 November 2014, at 7.5 per 100 000 population per week, and decreased to 2.1 per week during 1–31 January 2015. Between 23 May and 30 August 2014, two districts had the highest incidence of 3.8 and 7.0 per 100 000 population per week which decreased >97% by 1–31 January 2015. In comparison, the districts that include the capital city reported a 10-fold increase in incidence per week during the same time periods.

Conclusions. Almost half of patients with EVD in Sierra Leone reported physical contact with a person ill with EVD or a dead body, highlighting prevention opportunities.

Keywords. Ebola; epidemiology; Sierra Leone; surveillance; Filoviridae.

The West Africa Ebola virus (species *Zaire ebolavirus*) outbreak is the largest in history with sustained transmission in multiple countries. Guinea, Sierra Leone, and Liberia have been the most heavily affected. The first presumed fatality was in Guinea in December 2013 [1], and the first cases in Sierra Leone were detected in May 2014 [2]. Initial transmissions in Sierra Leone were concentrated in the eastern districts of Kailahun and Kenema; the cases then became more prevalent in the western districts, including the capital city, Freetown (estimated 2014 population, 1 304 507) [2, 3].

Ebola virus disease (EVD) is caused by viruses in the genus *Ebolavirus* (family Filoviridae). Ebola virus, the prototype virus of the genus, was first detected in Zaire (now the Democratic Republic of the Congo) in 1976 and is the virus responsible for the current outbreak in West Africa [4]. EVD is characterized by the sudden onset of fever and malaise, usually accompanied by myalgia, headache, vomiting, diarrhea, and abdominal pain [4]. In the current epidemic, fewer patients manifested hemorrhagic signs at the time of presentation [4]. In severe cases, shock develops, leading to multiorgan failure and death, with an overall case fatality rate of 50%–90% [4].

Currently, there is no specific treatment for EVD; supportive care involves early volume resuscitation,

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electrolyte repletion, treatment of concomitant infections, and symptomatic treatment. Successfully controlling an Ebola virus outbreak requires several key interventions: safe burials, contact tracing, early identification of cases, prompt isolation, accessible and timely laboratory testing, and care for those infected [5]. It is also necessary to have medical staff and communities trained to recognize cases of EVD and adhere to infection control practices so that suspected cases, including unexplained deaths, are reported and the risks of transmission are minimized.

To monitor the epidemic, the Sierra Leone Ministry of Health and Sanitation (MoHS), the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO) set up a surveillance system, the Sierra Leone Viral Hemorrhagic Fever (VHF) database, which includes both laboratory data and data reported by suspected case patients or their relatives and collected by case investigators. EVD laboratory results were also monitored and reported daily in the MoHS situation report (Sit-Rep) [3]. In this article, we analyze the epidemiologic data in Sierra Leone from 23 May 2014 to 31 January 2015, using both the daily reports from the MoHS and the Sierra Leone VHF database. The VHF data include sociodemographic characteristics as well as potential exposures to infection.

PATIENTS AND METHODS

EVD Surveillance

Sierra Leone implemented an alert and response system as the main process for identification of persons with possible EVD (both dead and alive). Alerts were generated by the community, family members, contact tracers, and/or medical practitioners and called into a national or local Ebola hotline. These alerts were screened, organized by districts, and shared with each district health office so that a response team could investigate. In addition, some potential case patients sought care at a health center because of illness, thus initiating case investigations.

EVD Case Definition

All potential EVD cases were initially investigated and assessed to determine whether they met the definition of a suspected or probable case. In May through July, the definitions for a suspected, probable and confirmed case of EVD were adapted from WHO recommendations [5]; however, the definitions were inconsistently applied in the field. In August, the Ministry of Health established the following definitions: a suspected or probable case met ≥1 of 3 criteria: (1) a person with fever and ≥3 of the following symptoms: vomiting, headache, nausea, diarrhea, difficulty breathing, fatigue, abdominal pain, loss of appetite, muscle or joint pain, unexplained bleeding, difficulty swallowing, and hiccups; (2) a symptomatic person (see list above) who attended a funeral or cared for someone who was sick; and (3) an unexplained death. Confirmed cases, including in corpses, were those that tested positive with a reverse-transcription polymerase chain reaction (RT-PCR) test specific for Ebola virus.

Laboratory Testing

Whole blood from live patients and oral swab specimens from corpses were sent to one of several laboratories in Sierra Leone. EVD was identified by Ebola virus–specific RT-PCR–based testing [6]. In patients with EVD, the virus is generally detectable by quantitative RT-PCR within 72 hours after symptom onset [7]. Symptomatic persons whose specimen yielded indeterminate or negative results were recommended to have a second specimen collected ≥72 hours after symptom onset and tested.

Data Analysis

We analyzed data from the VHF surveillance system submitted as of 4 February 2015 for confirmed cases reported as of 31 January 2015 and data from the MoHS Sit-Rep published 1 February 2015 for all confirmed cases reported as of 31 January 2015 [3]. These 2 data sources complement each other: the VHF surveillance system includes information unavailable in the MoHS Sit-Rep but has a delay of approximately 2–4 weeks before case reports are complete, and the MoHS Sit Rep reports the number of confirmed cases within 1 day of testing and thus provides a more current number.

Many healthcare workers, including phlebotomists, surveillance officers, nurses, physicians, and Red Cross volunteers, were responsible for completing case investigation forms. They interviewed patients or family members using a standardized case investigation form and collected information, such as address, age, sex, occupation, date of symptom onset, possible exposures, and symptoms. Information from this form was entered into the VHF surveillance system using the Epi Info Viral Hemorrhagic Fever application developed in Epi Info 7 software (CDC). Clinical outcome and laboratory test results were entered into the patient's case record in the VHF surveillance system as results were reported to the CDC and WHO surveillance teams in each health district. District data were merged at the national level to create a national VHF data set.

We analyzed the national database using SAS software version 9.3 (SAS Institute). In the data from the VHF surveillance system, we analyzed confirmed cases by date of report, date of symptom onset, district residence, sex, age, occupation, and reported attendance at a funeral or contact with a suspected case patient or sick person during the month before symptom onset. We also analyzed reported symptoms at the time of case investigation. District 2014 population estimates were reported on the MoHS Sit-Rep [2] and age population estimates are from the United Nations [8]. Relative risks and 95% confidence intervals were calculated for each age group compared with the youngest age group. Incidence rates per week were calculated

by dividing the total number of confirmed cases during the reporting period from the MoHS Sit-Rep by the number of days in the reporting period and then multiplying by 7. We performed χ^2 tests to assess for statistically significant differences by month in the percentage of all confirmed cases both by risk factor and among healthcare workers.

RESULTS

Incidence

Based on the MoHS Sit-Rep data, 8056 confirmed cases of EVD occurred in Sierra Leone between 23 May 2014 and 31 January 2015. Nationally, the peak incidence was 7.5 per 100 000 residents per week during 1–30 November 2014, with a total of 2042 confirmed cases, and decreased to 2.1 per week during 1–31 January 2015, with 580 confirmed cases. Between 23 May and 30 August 2014, Kenema and Kailahun districts had the highest number of confirmed cases (356 and 470, respectively), representing 74.1% of all confirmed cases during that time (Figure 1). The incidence rates during this time were 3.8 and 7.0 per 100 000 population per week in Kenema and Kailahun, respectively, peaking in August in both districts.

The incidence in these 2 districts decreased, with respective incidence rates in Kenema and Kailahun of 0.2 and 0 per 100 000 population per week in 1–31 January 2015. However, the confirmed case incidence in 2 western districts, Western Area Rural and Western Area Urban (per 100 000 population per week) increased from 0.4 in the period from 23 May to 30 August to 17.7 in 1–30 November and then decreased to 4.7 in 1–31 January 2015. For the entire time period, from 23 May 2014 to 31 January 2015, Western Area Urban and Western Area Rural districts, which include Freetown, had the highest number of cumulative confirmed cases (n = 3158), 39.2% of all cases nationwide. Port Loko district had the second-highest number, with 1322 cases, 16.2% of all cases nationwide.

Cumulative Cases

As of 31 January 2015, a cumulative total of 8311 confirmed EVD cases were reported in the VHF surveillance system. Approximately 22.4% of all confirmed cases (1865 of 8311) were first identified in corpses. This proportion increased over time and was greatest during November (30.4%), when the most confirmed cases were reported and then decreased in December (16.5%) and January (3.9%). Among cases with information on the week of symptom onset (6773 of 8311), the most confirmed cases by week of symptom onset was in week 38 (14–20 September 2014) (n = 406), the week of the 3-day National House-to-House Campaign with active surveillance; the number confirmed cases was lower in week 39 but continued to increase during weeks 40–44 and then decrease (Figure 2). Kailahun and Kenema, the 2 districts with the most EVD cases early in the epidemic, have had decreasing numbers since week 31 (28 July to 2 August) for Kailahun and week 32 (3–9 August) for Kenema, whereas case numbers in other districts increased in September through November and then began decreasing in December and January.

Median Age in EVD Cases

The median age in all confirmed EVD cases in Sierra Leone was 28 years (interquartile range, 6–49 years), with 7.3% of those affected aged <5 years, 14.5% aged 5–14 years, 62.8% aged 15–49 years, and 15.3% aged ≥50 years. The EVD incidence rate during 23 May 2014 to 31 January 2015 increased with increasing age, from 66.5 per 100 000 children aged <5 years to 236.2 per 100 000 adults aged ≥50 years (relative risk, 3.5; 95% confidence interval, 3.4–3.7) (Table 1). Approximately half (51.7%) of those with confirmed cases were female.

Behavioral Risk Factors

Information was collected on whether the case patient being investigated had attended a funeral or had contact with someone with a known or suspected case of EVD or with any sick person within 1 month before symptom onset. In the 55.6% of those with confirmed cases (4621 of 8311) for whom data were available, 25.5% (1179 of 4621) reported having attended a funeral within 1 month of symptom onset; among these, 66.2% (518 of 782) reported touching the body (Table 2). In addition, among the 58.8% (4885 of 8311) with confirmed cases who responded to the question on contact with a suspected case patient or sick person within 1 month of symptom onset, 47.9% (2340 of 4885) reported having contact with such a person. Specifically, 28.7% (1402 of 44 885) reported contact with someone after death, 11.4% (558 of 4885) reported contact with a living ill person, <1.0% (53 of 4885) reported contact with both a living ill person and someone after death, 6.7% (327 of 4885) had missing information on whether the contact was dead or living, and 52.1% (2545 of 4885) were recorded to have had no contact with someone with suspected EVD or any sick person (data not shown). Combined, 49.2% of case patients reported attending a funeral and/or contact with a suspected case patient or sick person.

Risk factors for Ebola virus infection have not changed significantly during the course of the epidemic, except for the proportion reporting attending a funeral, which was lower in the last 5 months of the study period (October–January) than in the first 5 months (May–September) (Table 2). In addition, the proportion and number of confirmed cases reported among healthcare workers decreased from 9.3% of all cases (67 of 723) in August to 2.2% (22 of 1013) in December and 1.2% (3 of 250) in January ($P < .001$) (Table 3). From 23 May 2014 to 31 January 2015, a total of 264 healthcare workers were reported in the VHF database to be infected with Ebola virus.

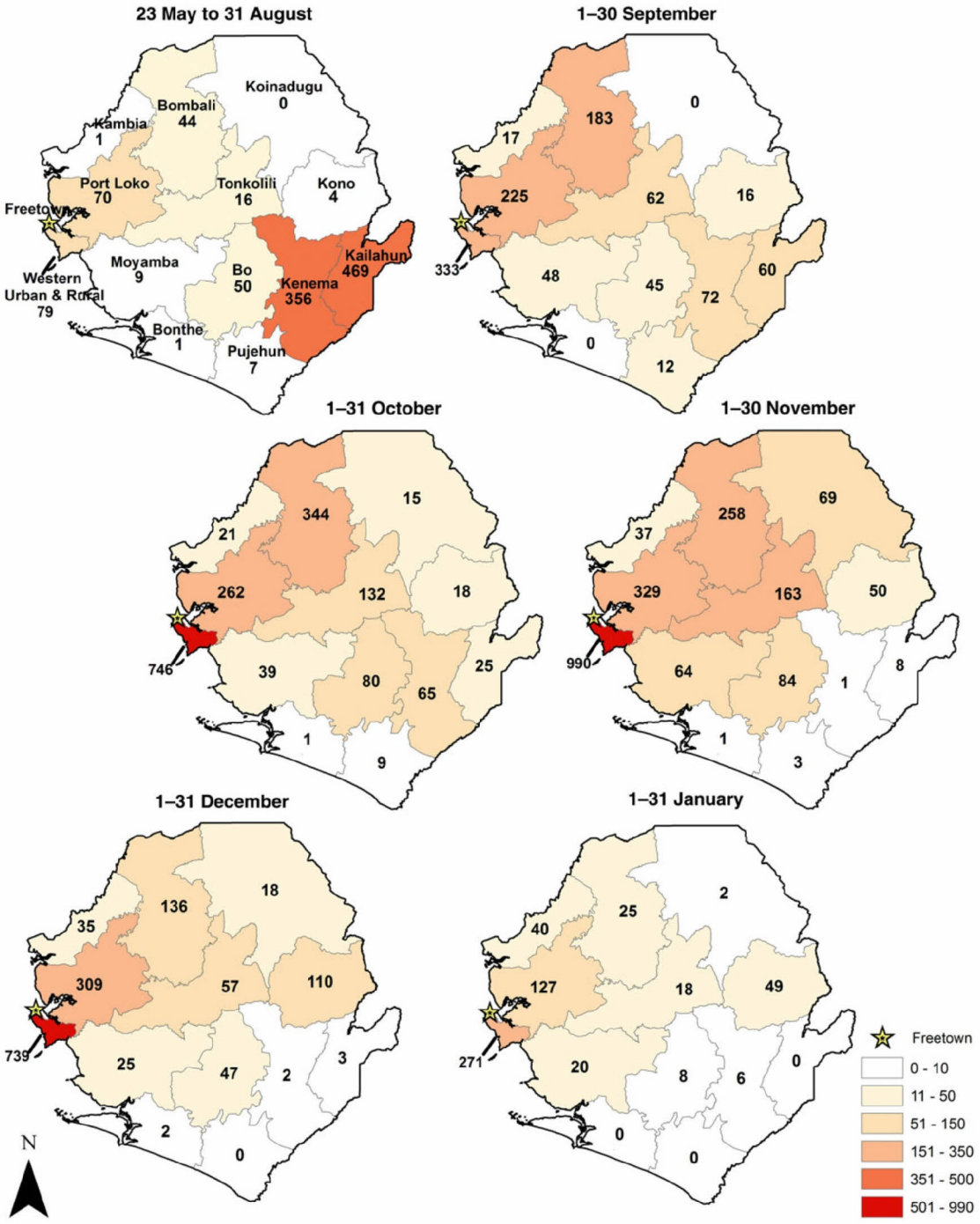

Figure 1. Geographic distribution of cumulative confirmed cases of Ebola virus disease in Sierra Leone during 6 periods from 23 May 2014 to 31 January 2015.

Symptoms

Among all confirmed cases with specific signs and symptoms recorded, fever was recorded in 90.4% (4423 of 4893), intense fatigue or general weakness in 88.3% (4195 of 4752), loss of appetite in 87.0% (4063 of 4671), headache in 77.9% (3312 of 4252), joint pain in 73.7% (3037 of 4118), vomiting in 71.2% (2870 of 4029), diarrhea in 70.6% (2747 of 3891), muscle pain in 70.2% (2824 of 4025), and abdominal pain in 70.1%

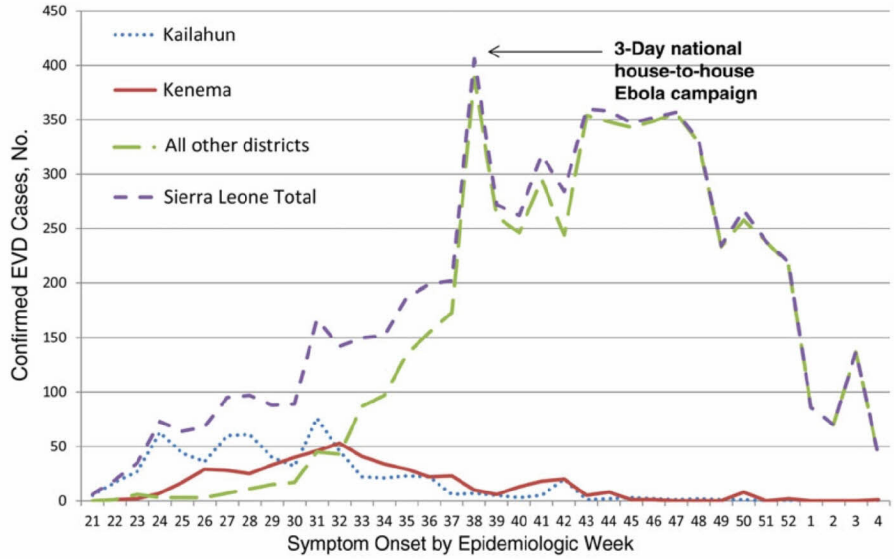

Figure 2. Confirmed cases of Ebola virus disease (EVD) in Sierra Leone and selected districts by week of symptom onset, from 23 May 2014 to 31 January 2015 (data from Viral Hemorrhagic Fever database; n = 6773).

(2849 of 4065). Other less commonly recorded symptoms included conjunctivitis, rash, cough, difficulty swallowing, sore throat, jaundice, confusion, and hiccups; unexplained bleeding was recorded in 3.7% (7 of 187).

DISCUSSION

The West African Ebola virus outbreak is the largest EVD epidemic on record and has spread to multiple countries. In past Ebola virus outbreaks, strict measures to identify and isolate cases quickly, trace their contacts, and reduce transmission from exposure to symptomatic persons and to dead bodies through safe burial practices have been successful [9–11]. In addition, strict infection control practices among healthcare workers within Ebola treatment centers have been used successfully in past outbreaks to reduce infection in healthcare workers once Ebola virus has been identified as the etiologic agent [11]. In the latest outbreak, the size of the epidemic, the mobility of the population, and the early spread and sustained transmission in densely populated urban settings have challenged the resources of the public health community and its ability to effectively implement these same control strategies [12]. The exposures reported in this outbreak—contact with suspected cases by healthcare workers and family members, including contact with corpses and touching of bodies at funerals—are consistent with those reported in other outbreaks [9–11]. However, approximately half of the cases in the VHF data had no known exposure recorded. This may reflect the stigma associated with an EVD diagnosis [13]. Other important contributing factors may include variations in interviewing and data collection skills among those who conducted the case investigations, many of whom had no previous experience with this activity.

Table 1. Confirmed Ebola Virus Disease Cases by Age Group in Sierra Leone (23 May 2014 to 31 January 2015)

Age Group, y	Confirmed EVD Cases, No. (%)	2012 Population	Rate Per 100 000	Relative Risk (95% CI)
<5	609 (7.3)	915 492	66.5	
5–14	1206 (14.5)	1 509 296	79.9	1.2 (1.0–1.4)
15–49	5213 (62.8)	2 787 803	187.0	2.8 (2.6–3.0)
≥50	1274 (15.3)	539 385	236.2	3.5 (3.4–3.7)

Abbreviations: CI, confidence interval; EVD, Ebola virus disease.

[a] Age information was missing for 9 confirmed cases. The 2012 Sierra Leone age population estimates are from the United Nations [8].

The decreased incidence rates of EVD in Kenema and Kailahun since early August 2014 and decreases in other districts indicate that reducing the rate of EVD is possible. In Kenema, interventions were implemented that may have reduced the number in new cases, including establishment of a treatment center and laboratory, enabling isolation and rapid identification of new cases; greater access to and use of immediate safe burials for deaths; formation and use of case investigation teams; and a district-wide team of >400 community health workers who monitored contacts in their own communities. Other measures that have not been fully evaluated include

Table 2. Reported Attendance at a Funeral or Contact With a Suspected Case Patient or Sick Person During Month Before Symptom Onset Among Persons With Confirmed Ebola Virus Disease in Sierra Leone (23 May 2015 to 31 January 2015)

Month	Persons With Confirmed EVD, No. (%)			
	Attended a Funeral[a,b]	Touched Body at Funeral[c]	Contact With Suspected Case Patient or Any Sick Person[d]	Contact With Suspected Case Patient or Any Sick Person and/or Funeral Attendance[e]
May 2014	1/3 (33.3)	0	1/4 (25.0)	1/4 (25.0)
June 2014	44/119 (37.0)	15/23 (65.2)	82/138 (59.4)	90/137 (65.7)
July 2014	71/252 (28.2)	24/50 (48.0)	133/265 (50.2)	155/267 (58.1)
August 2014	185/560 (33.0)	102/137 (74.4)	327/565 (57.9)	346/562 (61.6)
September 2014	310/884 (35.1)	151/211 (71.6)	474/942 (50.3)	511/928 (55.1)
October 2014	215/905 (23.8)	111/150 (74.0)	426/945 (45.1)	456/922 (49.5)
November 2014	187/972 (19.2)	61/103 (59.2)	481/1055 (45.6)	497/1032 (48.2)
December 2014	127/584 (17.9)	37/80 (46.2)	304/749 (40.6)	316/728 (43.4)
January 2015	32/199 (16.1)	13/24 (54.2)	100/205 (48.8)	103/201 (51.2)
Month unknown	8/23 (34.8)	4/4 (100)	15/23 (65.2)	15/25 (60.0)
Total	1179/4621 (25.5)	518/782 (66.2)	2340/4885 (47.9)	2487/5055 (49.2)

Abbreviation: EVD, Ebola virus disease.

[a] Data missing in 3690.

[b] $P < .001$ (χ^2 test for independence).

[c] Reported for only those who attended a funeral (n = 1179); data missing in 397 of 1179.

[d] Data missing in 3426.

[e] Data missing in 3256.

education of local paramount chiefs (who control the judicial system in their chiefdom) and the general population, a strong district structure for Ebola response (including a task force, coordinating committee, and emergency operations center) to direct funds and address immediate problems, and an alert toll-free number for reporting suspected cases and corpses

Table 3. Number and Proportion of Healthcare Workers With Ebola Virus Disease by Month of Reported Case

Month	Case Patients, No.			HCWs as Proportion of All Case Patients, %[b]
	HCWs	Non-HCWs	Total	
May 2014	0	27	27	0
June 2014	23	247	270	8.5
July 2014	36	407	443	8.1
August 2014	67	656	723	9.3
September 2014	39	1126	1165	3.3
October 2014	52	1376	1428	3.6
November 2014	21	1472	1493	1.4
December 2014	22	991	1013	2.2
January 2015	3	247	250	1.2
Total[a]	264	8047	8311	3.2

Abbreviation: HCWs, healthcare workers.

[a] Cases with month unknown are included in the total (1 HCW, 1498 non-HCWs, 1499 total.

[b] $P < .001$ (χ^2 test for independence).

(personal communication with Andrew Ramsay, WHO district coordinator, Kenema District). The fact that these 2 districts were the center of previous endemic Lassa fever transmission and the site of specific donor-funded Lassa fever programs may have also significantly contributed to the public health and community response there.

This report has summarized data from 2 sources, the VHF surveillance system and the MoHS reports of laboratory-confirmed cases by district. Although the numbers of confirmed cases reported in this article are large, they may represent only a fraction of all cases. Many suspected cases and deaths related to suspected and probable cases were never reported, investigated, or tested for Ebola virus. At some points during the height of the Ebola epidemic, cases may have been reported to district health officials but not investigated because of the lack of personnel. One model estimated that the number of true cases of EVD may be ≥2.5 times that of reported cases, based on evaluation of a case alert system currently in place and field experience with frequent hidden cases or deaths in various communities [14]. In Sierra Leone, the number of true cases may be twice as high as the reported number. In addition, the relatively strict case definition (fever plus 3 other symptoms for those without a known case contact) used since August may lead to the underreporting of atypical or milder cases.

Many cases reported in the VHF surveillance system were missing information on symptoms, potential exposure to

infection, and final outcome, and there was a delay of 2–4 weeks in case reporting. The magnitude of this outbreak is one reason for the incomplete and delayed reporting of cases in the VHF system, because many districts were limited by available personnel who could fully investigate cases and enter data. Symptoms and risk factors were self-reported and were recorded by many personnel with varying levels of training and experience, leading to potential underestimation of true symptom prevalence as well as misclassification of symptoms. Thus, the characteristics of EVD cases reported herein may not be representative of all cases in Sierra Leone.

Without the availability of vaccines or definitive treatment, application of standard public health control measures is essential to slow and stop the epidemic. These include comprehensive contact tracing, followed by daily monitoring of contacts for symptoms, with prompt transport to a treatment center where suspected cases can be cared for safely, and safe burials, all performed thoroughly and effectively. Implementation of these measures is essential for ending Ebola virus outbreaks.

Notes

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Author contributions. P. D. was the primary author, had full access to the data, and takes responsibility for the integrity of the data and the accuracy of the data analysis. A. J., J. T. P., Z. Y., and T. G. K. helped design and edit the article and take full responsibility for its contents.

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References

1. Baize S, Pannetier D, Oestereich L, et al. Emergence of Zaire Ebola virus disease in Guinea. N Engl J Med **2014**; 371:1418–25.
2. Government of Sierra Leone, Ministry of Health and Sanitation. Ebola virus disease—situation report (Sit-Rep). 2 December 2014. Available at: http://health.gov.sl/wp-content/uploads/2014/12/Ebola-Situation-Report_Vol-188.pdf. Accessed 8 December 2014.
3. Government of Sierra Leone, Ministry of Health and Sanitation. Ebola virus disease—situation report (Sit-Rep). 2 February 2015. Available at: http://health.gov.sl/wp-content/uploads/2015/02/Ebola-Situation-Report_Vol-249.pdf. Accessed 26 May 2015.
4. WHO Ebola Response Team. Ebola virus disease in West Africa: the first 9 months of the epidemic and forward projections. N Engl J Med **2014**; 371:1481–95.
5. World Health Organization. Ebola and Marburg virus disease epidemics: preparedness, alert, control, and evaluation. Interim manual version 1.2.2014. Available at: http://www.who.int/csr/disease/ebola/manual_EVD/en. Accessed 4 November 2014.
6. Ksiazek TG, West CP, Rollin PE, et al. ELISA for the detection of antibodies to Ebola viruses. J Infect Dis **1999**; 179(suppl 1):S192.
7. Towner JS, Rollin PE, Bausch DG, et al. Rapid diagnosis of Ebola hemorrhagic fever by reverse transcription-PCR in an outbreak setting and assessment of patient viral load as a predictor of outcome. J Virol **2004**; 78:4330–41.
8. United Nations, Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section. World population prospects: the 2012 revision. Available at: http://esa.un.org/unpd/wpp/Excel-Data/population.htm. Accessed 4 November 2014.
9. Lamunu M, Lutwama JJ, Amugisha J, et al. Containing a haemorrhagic fever epidemic: the Ebola experience in Uganda (October 2000-January 2001). Int J Infect Dis **2004**; 8:27–37.
10. Okware SI, Omaswa FG, Zaramba S, et al. An outbreak of Ebola in Uganda. Trop Med Int Health **2002**; 7:1068–75.
11. Breman JG, Johnson KM. Ebola then and now. N Engl J Med **2014**; 371:1663–6.
12. Bausch DG, Schwarz L. Outbreak of Ebola virus disease in Guinea: where ecology meets economy. PloS Negl Trop Dis **2014**; 8:e3056.
13. Davtyan M, Brown B, Folayan MO. Addressing Ebola-related stigma: lessons learned from HIV/AIDS. Glob Health Action **2014**; 7:26058.
14. Meltzer M, Atkins CY, Santibanez S, et al. Estimating the future number of cases in the Ebola epidemic—Liberia and Sierra Leone, 2014–2015. MMWR Morb Mortal Wkly Rep **2014**; 63:1–14.

PLOS | CURRENTS OUTBREAKS

Community Event-Based Surveillance for Ebola Virus Disease in Sierra Leone: Implementation of a National-Level System During a Crisis

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Citation

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Abstract

INTRODUCTION: There are few documented examples of community networks that have used unstructured information to support surveillance during a health emergency. In January 2015, the Ebola Response Consortium rapidly implemented community event-based surveillance for Ebola virus disease at a national scale in Sierra Leone.

METHODS: Community event based surveillance uses community health monitors in each community to provide an early warning system of events that are suggestive of Ebola virus disease transmission. The Ebola Response Consortium, a consortium of 15 nongovernmental organizations, applied a standardized procedure to implement community event-based surveillance across nine of the 14 districts. To evaluate system performance during the first six months of operation (March to August 2015), we conducted a process evaluation. We analyzed the production of alerts, conducted interviews with surveillance stakeholders and performed rapid evaluations of community health monitors to assess their knowledge and reported challenges.

RESULTS: The training and procurement of supplies was expected to begin in January 2015 and attain full scale by March 2015. We found several logistical challenges that delayed full implementation until June 2015 when the epidemic was past its peak. Community health monitors reported 9,131 alerts during this period. On average, 82% of community health monitors reported to their supervisor at least once per week. Most alerts (87%) reported by community health monitors were deaths unrelated to Ebola. During the rapid evaluations, the mean recall by community health monitors was three of the six trigger events. Implementation of the national system achieved scale, but three months later than anticipated.

DISCUSSION: Community event based surveillance generated consistent surveillance information during periods of no- to low-levels of transmission across districts. We interpret this to mean that community health monitors are an effective tool for generating useful, unstructured information at the village level. However, to maximize validity, the triggers require more training, may be too many in number, and need increased relevance to the context of the tail end of the epidemic.

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Introduction

In August 2014, the WHO declared the outbreak of Ebola virus disease (EVD) in West Africa to be a Public Health Emergency of International Concern.[1] The number of EVD cases across the region rose sharply during the following four months, with Sierra Leone having reported a total of 7,476 confirmed EVD cases by the end of 2014.[2] The rapid spread of the virus overwhelmed the country's health system. Due to the high caseload, the EVD surveillance system (consisting of case investigation of reported cases, contact tracing, screening of patients at health facilities and swab testing of corpses) could not rapidly identify and respond to alerts resulting in a high proportion of cases detected after death.[3] As is usual for surveillance systems, there was no community level system to quickly detect and report new cases. In the absence of such system, the surveillance system was mainly passive, relying on the identification of suspect cases at facilities and contact tracing. This fueled the exponential spread of EVD across Sierra Leone.

The complexity of the response required coordinated support at the district level throughout the nation. The International Rescue Committee (IRC) initiated the creation of the Ebola Response Consortium (ERC) in August 2014 to support the Sierra Leone Ministry of Health and Sanitation (MoHS) in the EVD response. The ERC is a consortium of 15 NGOs with operational presence across the country backing this response through the implementation of district-wide programs in surveillance, infection prevention and control in primary health care facilities, and water, sanitation, and hygiene.

Although past EVD outbreaks highlighted the importance of community volunteers in detecting and reporting suspect cases, these outbreaks occurred across much smaller geographic contexts.[4] Recognizing the opportunity to bring this concept to scale, the ERC partnered with the U.S. Centers for Disease Control and Prevention (CDC) and the MoHS to design and implement a community event-based surveillance (CEBS) system in 9 of the 14 districts of Sierra Leone beginning in January 2015. This was based on a pilot of the project in Bo district in October 2014.[3] The objectives of CEBS were to improve the timeliness with which EVD cases were detected, isolated, and provided with the appropriate care before they created further chains of transmission. To fulfill the objective of early warning through increased sensitivity and rapid reporting from the village level, the ERC used a structured approach to identify events and rumors suggestive of EVD rather than case-based surveillance. Such event-based reporting is often used to detect new clusters of disease and to track health conditions at large events.[5]

This paper introduces the CEBS model, describes the ERC's experiences during the first six months of CEBS implementation, and highlights key programmatic challenges. The overall aim is to better inform the design and implementation of community surveillance systems for future outbreaks of epidemic-prone disease. In parallel, an epidemiological evaluation of the effectiveness and sensitivity of the detection of confirmed cases was previously outlined and the results have been published elsewhere.[3,6]

Methods

Context

Near the peak of the EVD epidemic in West Africa in October 2014, the IRC, Sierra Leone's Bo District Health Management Team, and the US CDC developed CEBS to promote the early warning of EVD clusters at the village-level[3] . National surveillance was not detecting infected persons until after they had died. The system comprised contact tracing, healthcare facility surveillance, and a telephone hotline for reporting events. As a result, opportunities for virus transmission in the community were prolonged[3]. CEBS was designed to supplement the surveillance system by training community members to identify unsafe burials and persons with signs and symptoms compatible with EVD infection. This made is possible to detect EVD cases that were not epidemiologically linked to other confirmed cases at the time of detection. In turn, this could provide early warning of unknown and new chains of transmission. The system was based primarily of a pre-existing network of community health workers in most of the districts.

CEBS Model and Implementation

At the base of the CEBS model are the Community Health Monitors, who are volunteers located in each community. Community Health Monitors are trained to detect and immediately report on a set of six trigger events that may be associated with EVD transmission (**Table 1**). Upon detecting a trigger event, the Community Health Monitors uses a mobile phone to inform his or her Community Surveillance Supervisor. The Community Surveillance Supervisor determines if an investigation is needed to assess whether a person meets criteria for a suspected EVD case. With the local Community Health Officer, a clinically-trained MoHS staff member working at the Chiefdom level, the Community Surveillance Supervisor conducts a preliminary screening of the alert. If the Community Surveillance Supervisor and Community Health Officer determine that a suspected case has occurred, they call in the alert to the District Ebola Response Center (DERC)—the emergency response unit set up by the national government to respond to all alerts—which dispatches a team to conduct a formal case investigation. A flow diagram of the system is presented in Figure 1.

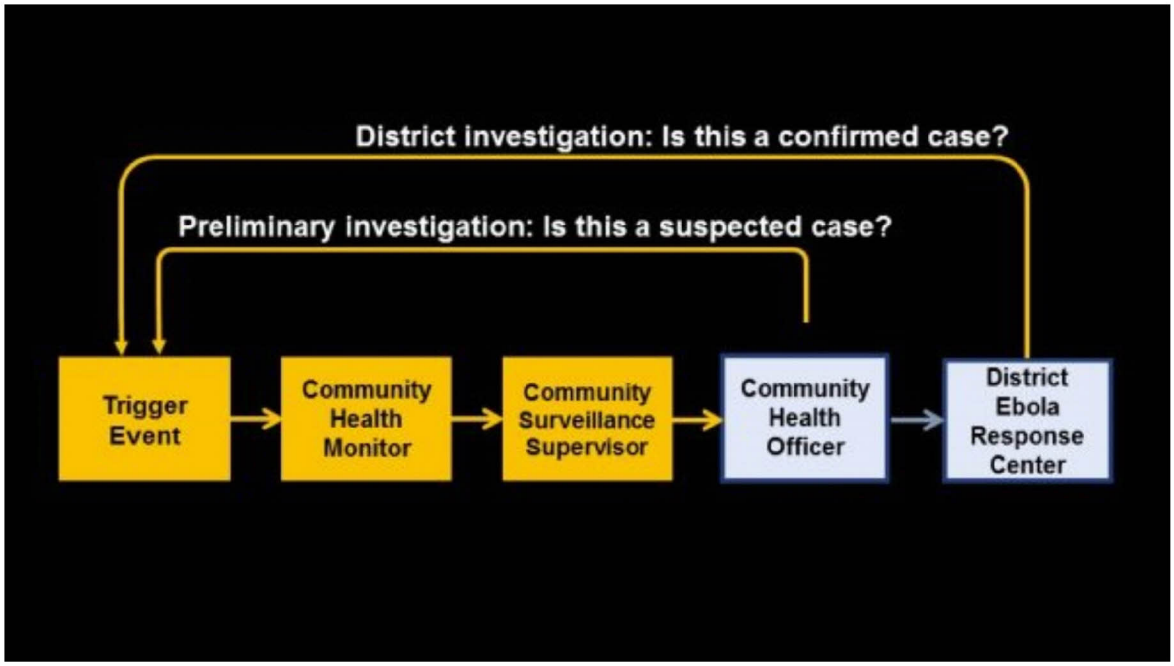

Fig. 1: Flow diagram of CEBS

Table 1: Trigger Events Detected by Community Health Monitors

	Trigger Events
1	Two or more family or household members become sick or die within a short period of time (less than seven days)
2	Anyone becomes sick or dies within three weeks of taking part in an unsafe burial or washing/touching a corpse
3	Any healthcare worker or traditional healer becomes sick or dies of an unknown cause
4	Any traveler (or recently returned traveler who is from that village) becomes sick or dies
5	Anyone who was a contact of a suspect EVD case (whether or not they were being contact traced) becomes sick or dies
6	Any unsafe burial or washing of a dead body that took place in the village or surrounding community (this trigger event would alert the surveillance and response team that there might be cases in the near future)

The CEBS model was designed and piloted in 100 villages in Bo district by the IRC, Bo District Health Management Team, and CDC during November 2014 as a complement to the passive EVD surveillance activities ongoing at the time.[3] A consultative process involving participatory meetings with the Community Health Officers and Bo District Health Management Team was used to develop and refine the list of six trigger events to be detected by Community Health Monitors. The pilot findings were shared with the national MoHS in December 2014, who worked with IRC and CDC staff to develop a CEBS standard operating procedure to enable the ERC's support of implementation at the national level.

In January 2015, ERC partners began supporting the implementation of CEBS in 9 of the 14 districts of Sierra Leone. To ensure standardized implementation across districts, all ERC partners adhered to the same six-step implementation plan included in the CEBS standard operating procedures (**Table 2**). This plan included creating district CEBS management teams (comprised of representatives of the ERC partner organization, the District Health Management Team, and the DERC), training Community Health Monitors and Community Surveillance Supervisors, procuring motorbikes and mobile phones, and setting up Closed User Group phone networks in each district with the goal of having all nine districts fully operational by the first week of March 2015. Closed User Group networks enable calling at no costs to all persons in the network.

Table2: Key Steps to CEBS Implementation

	Step
1	Form a district CEBS management team consisting of representatives from the District Health Management Team, ERC partner, and other surveillance partners (e.g. CDC, WHO).
2	Introduce CEBS to district stakeholders and secure endorsement.
3	Introduce CEBS to Chiefdom stakeholders, including traditional leaders, and secure endorsement.
4	Identify and train Community Surveillance Supervisors and Community Health Officers in each Chiefdom.
5	Identify Community Health Monitors in each village in collaboration with traditional leaders. Community Health Officers and Community Surveillance Supervisors train the Community Health Monitors with support of district CEBS management team.
6	Establish a small team at the district level to plan and oversee CEBS data collection, analysis, and reporting.

The CEBS SOP recommended that one Community Health Monitor be selected per 50 households, while taking into consideration the geographic size and population density of each community. This ratio was based on the ratio used in the national Community Health Worker program.[7] Similarly, at least one Community Surveillance Supervisor was selected per Chiefdom (sub-district level), depending on Chiefdom size, population density, and number of Community Health Monitors. The selection criteria for Community Health Monitors were that they should be respected residents of their communities with previous experience in a role of responsibility within their communities (such as teachers), while ideal candidates for the role of Community Surveillance Supervisor would be individuals with some health-related work experience who are capable of supervising others and had a strong knowledge of the Chiefdoms they serve.

Sierra Leone has had a community health worker program since 2006, and thus there was already a network of community health workers who had been elected by their communities and were already providing health promotion and basic health services before the EVD outbreak. Whenever possible, the community health workers and their supervisors were selected to serve as Community Health Monitors and Community Surveillance Supervisors, as it was believed that community health workers had already built the level of rapport and trust within their communities that would be critical for the successful functioning of CEBS.

Alert system, Data compilation, and Analysis

Community Health Monitors immediately notified their Community Surveillance Supervisors of detected triggers by mobile phone. This initiated the investigation process involving the Community Surveillance Supervisors and Community Health Officers. Each Community Surveillance Supervisor completed a weekly CEBS Alert Log where each alert raised by their Community Health Monitors are recorded along with the resulting response actions. The data captured on this form include the date, time, trigger event, the type of each alert (classified as sickness, death, unsafe burial, or “other”), as well as the name, age, sex, and location of the individual(s) being reported as sick or deceased. The Alert Log also contains sections to document suspicious events detected by the Community Health Monitors that were not represented by one of the triggers (classified as “Trigger 7- Other”). The Community Surveillance Supervisors update these forms every time an alert is received and submit their forms to the district CEBS team at the end of each week. On a weekly basis, the team entered the data into an Excel-based reporting tool and submits it to the ERC coordinating unit for cleaning and compilation into a central database. For this evaluation, the central CEBS database was used to analyze the alerts generated by CEBS between March and August 2015. Descriptive analyses were conducted by disaggregating the total number of alerts by alert trigger event and type.

Each Community Surveillance Supervisor also keeps a Community Health Monitor Weekly Reporting Form where they track how often each Community Health Monitor reports to them and how many alerts they report. Each Community Health Monitor is expected to report to their Community Surveillance Supervisor at least once per week, even if they have not detected any alerts. This “zero reporting” feature indicates that the Community Health

Monitor is active and looking for triggers in their community. Zero reporting was only feasible on a weekly basis as a double check. Daily zero reporting would have been overwhelming for Community Surveillance Supervisors. On the other hand, event reporting was immediate. This form is also submitted to the district CEBS team at the end of each week and a summary is submitted weekly to the ERC coordinating unit.

Process Evaluation of CEBS

In this evaluation, the routine data were used to analyze: (1) the proportion of Community Health Monitors reporting at least once per week and (2) the number of alerts reported by Community Health Monitors between March and August 2015 disaggregated by type and trigger. Between April and June 2015, the ERC, IRC, and CDC conducted a process evaluation of CEBS in the nine districts to evaluate how acceptable the CEBS structure was to Community Health Monitors, Community Surveillance Supervisors and other partners on the ground, in addition to knowledge and attitudes of Community Health Monitors and Community Surveillance Supervisors. The assessment included key informant interviews with approximately 50 Community Health Monitors, 27 Community Surveillance Supervisors, and 31 district stakeholders (such as District Health Management Teams, DERCs, and WHO). A semi-structured questionnaire was used to guide the interviews, which included quantifiable responses and open-ended questions. Due to the rapid nature of the assessment, Community Health Monitors and Community Surveillance Supervisors were selected using a purposive sample. We aimed to include at least two Chiefdoms that were close to, and far away from, the district capital in order to assess a variety of contexts. Quantitative interview data were aggregated and qualitative data were compiled for analysis.

Ethical review

This assessment was a part of a nonresearch public health response activity and thus did not undergo institutional review board review. In addition, we used only information that had already been collected for public health surveillance purposes, so informed consent was not obtained.

Results

Implementation Process

Implementation began in January 2015 with the formation of the district CEBS teams, completion of the district- and Chiefdom-level stakeholder meetings, and implementation planning (comprising steps 1 to 3 in Table 2). The purpose of the district- and Chiefdom-level stakeholder meetings was to secure endorsement from local leaders and encourage community ownership and participation in the program. The Community Health Monitor trainings began in mid-February and were completed in all nine ERC districts by the end of March. While the stakeholder meetings and trainings were ongoing, ERC partners began the process of procuring motorbikes and mobile phones and creating Closed User Groups to allow Community Surveillance Supervisors and Community Health Monitors to call each other free of charge. The process of working with telecommunication companies to establish large Closed User Groups was time-consuming. By August 2015, Closed User Groups had not been established in three of the nine districts. In place of Closed User Groups, Community Health Monitors and Community Surveillance Supervisors in these districts were provided with a monthly allowance of pre-paid phone credit. Delays were also experienced with the procurement, licensing, and registration of motorbikes. Motorbikes were fully procured and licensed in all nine operational districts by July 2015.

CEBS Coverage

A total of 137 Community Surveillance Supervisors and 7,142 Community Health Monitors were trained across the nine districts to cover an estimated population of 3,981,665 (approximately 63% of the total projected population for Sierra Leone).[8] Across the nine districts, the average number of households overseen by a Community Health Monitor was 118 to 1, while the ratio of Community Health Monitors to Community Surveillance Supervisors was 52 to 1. The household coverage varied by district and ranged from 78 households per Community Health Monitor (in

Kono and Kambia) to 184 households per Community Health Monitor (in Bombali). Similar variations exist in the number of Community Health Monitors per Community Surveillance Supervisors, which ranges from 24 Community Health Monitors per Community Surveillance Supervisor in Moyamba to 68 Community Health Monitors per Community Surveillance Supervisor in Bo and Kambia (**Table 3**).

Table 3: CEBS Coverage in ERC Districts

District	Estimated Population	Households	CSSs Trained	CHMs Trained	CHM:CSS Ratio	Household:CHM Ratio
Bo	654,142	131,396	18	1228	68:1	107:1
Bombali	494,139	100,832	15	548	36:1	184:1
Kailahun	465,048	93,288	14	676	48:1	138:1
Kambia	341,690	68,640	13	880	68:1	78:1
Kenema	653,013	130,779	20	1321	66:1	99:1
Kono	325,003	65,130	15	835	56:1	78:1
Moyamba	278,119	55,752	17	404	24:1	138:1
Pujehun	335,574	67,000	12	500	42:1	134:1
Tonkolili	434,937	87,000	13	750	58:1	116:1
Total or average	3,981,665	842,756	137	7,142	52:1	118:1

CSS: Community Surveillance Supervisor; CHM: Community Health Monitor

Community Health Monitor Reporting and CEBS Alerts

Community Health Monitors in three districts (Moyamba, Pujehun, and Tonkolili) began reporting in March, five districts (Bo, Bombali, Kambia, Kenema, and Kono) began in April and May, and Community Health Monitors in Kailahun began reporting in June. Every district experienced an initial lag in reporting in their first month of operation, with increasing reporting coverage in the following months. The number of alerts reported by Community Health Monitors increase from 401 in March, when three districts were fully operational, to 1849 in June when all districts were operational. For the following two months, the number of alerts continued to increase to 2199 in July and 2330 in August (**Figure 2**).

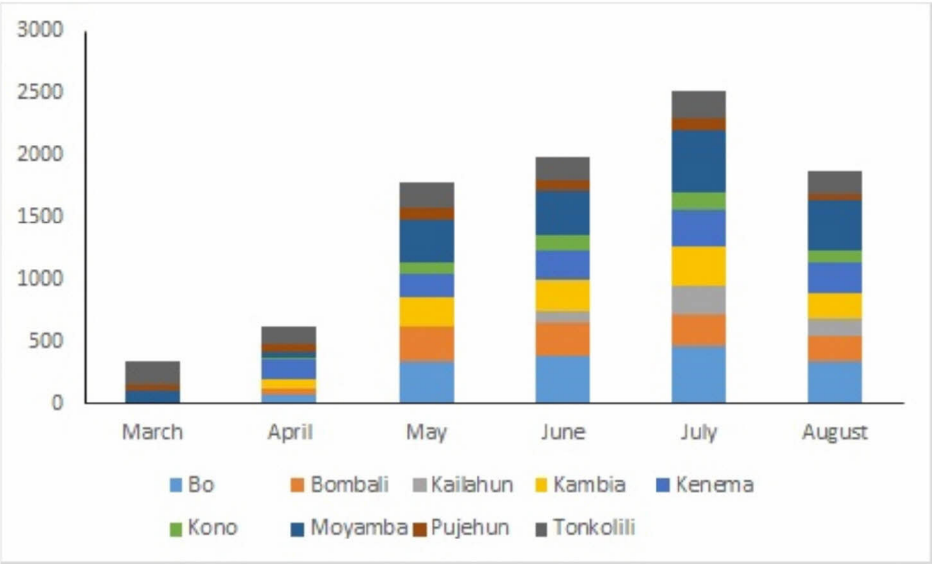

Fig. 2: Number of CEBS Alerts by District and by Month, March-August 2015

The average proportion of Community Health Monitors reporting alerts or the absence of alerts at least once per week increased from March to May, decreased in June, and increased again through July and August. The June decrease can be attributed to the low percentage of Community Health Monitors reporting in Kailahun, the first month of Community Health Monitors reporting for that district. In August, 92% of Community Health Monitors across the nine districts reported alerts or a zero report at least once per week (**Table 4**).

Table 4: Proportion of Community Health Monitors Reporting at least Once per Week, March-August 2015

District	March	April	May	June	July	August	Average
Bo	–	74%	92%	96%	91%	93%	89%
Bombali	–	80%	93%	98%	98%	98%	93%
Kailahun	–	–	–	28%	74%	85%	62%
Kambia	–	64%	82%	96%	94%	95%	86%
Kenema	–	54%	97%	92%	96%	95%	87%
Kono	–	–	87%	95%	95%	97%	93%
Moyamba	23%	63%	97%	98%	94%	96%	78%
Pujehun	22%	53%	65%	52%	74%	73%	56%
Tonkolili	70%	93%	97%	92%	95%	93%	90%
Average	38%	69%	89%	83%	90%	92%	82%

Of the 9,131 alerts generated in the period under review, 7,930 alerts (87%) represented deaths, while 1,183 (13%) represented illnesses (**Table 5**). 8,627 (94%) were reported as “Trigger 7- Other” meaning that the Community Health Monitor did not classified them as one of the six trigger events that Community Health Monitors were trained to detect. Among the 9,131 alerts, the most commonly reported of the six trigger events were “two or more sick/dead in same household” (n=194, 2.1%) and “sick/death among traveler” (n=158, 1.7%).

Table 5: CEBS Alerts by Trigger Event and Alert Type, March-August 2015

Trigger Event	Death	Other	Sick	Unsafe burial	Total
Two or more sick/dead in same household	132	0	62	0	194
Sick/death after unsafe burial/corpse washing	54	0	5	0	59
Sick/death among health worker/healer	40	0	18	0	58
Sick/death among traveler	100	0	58	0	158
Sick/death in contact of EVD case	16	0	12	0	28
Unsafe burial/corpse washing	6	0	0	1	7
Other	7582	17	1028	0	8627
Total	7930	17	1183	1	9131

Note: Five of the six alerts identified through the unsafe burials trigger were classified as deaths under “alert type”. It is unclear whether these alerts were actually for unsafe burials (in which case the alert type would be categorized incorrectly) or for deaths occurring after an unsafe burial (in which case the trigger event would be categorized incorrectly). Given this uncertainty and the impossibility to recode either alert type or trigger event with 100% certainty, no changes have been made to the data.

Community Health Monitors and Community Surveillance Supervisor Interviews

The rapid assessment of CEBS involved interviews with 50 Community Health Monitors, 27 Community Surveillance Supervisors and 31 stakeholders. We found that Community Health Monitors recalled, on average, three of the six trigger events. Twenty of 50 Community Health Monitors (40%) remembered between 1 and 3 triggers, while 24 Community Health Monitors (48%) remembered between 4 and 6 trigger events. As shown in **Figure 3**, some triggers were more frequently recalled than others. The most commonly-recalled triggers were those concerning an illness or death among a traveler (35/50, 70%) and an illness or death among two or more members of the same household (33/50, 66%). The least frequently-recalled trigger was the occurrence of illness or death among a contact of an EVD case, which was only recalled by 14 (28%) Community Health Monitors.

All Community Health Monitors reported that they actively seek information about illnesses and deaths in their communities. Strategies mentioned by Community Health Monitors included visiting households, speaking to community leaders, or speaking with other key informants such as teachers and health care workers. Sixty-eight percent reported that their community supports their work. The 27 Community Surveillance Supervisors interviewed recalled an average of five of the seven actions they were trained to take when they receive an alert from a Community Health Monitors. The most common challenges Community Health Monitors and Community Surveillance Supervisors reported was the malfunction of the Closed User Group phone system and lack of motorbike.

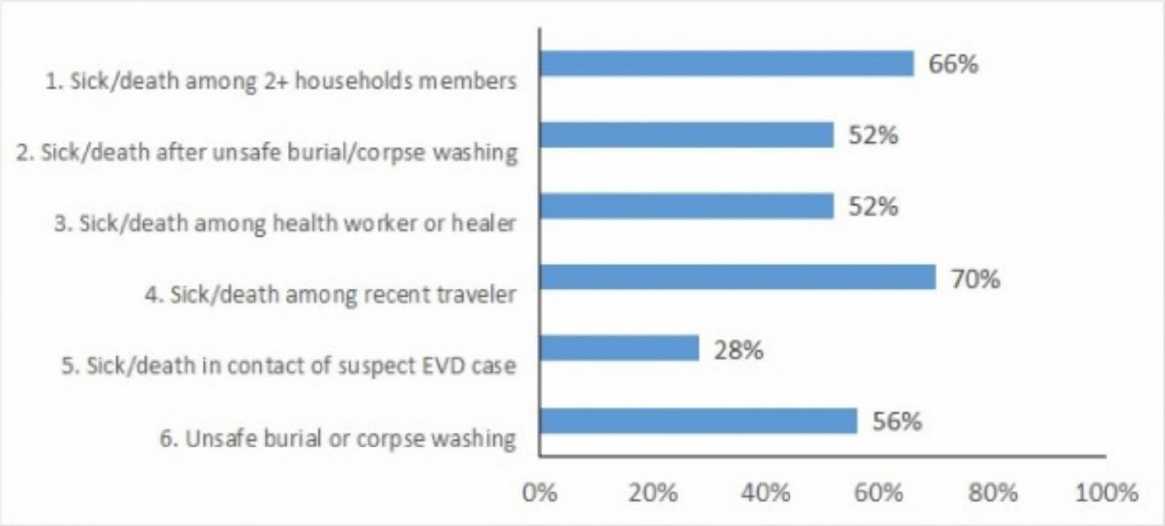

Fig. 3: Proportion of Community Health Monitors Who Recalled Each Trigger Event

Interviews with District Stakeholders

Stakeholders interviewed included representatives from the District Health Management Team, such as District Medical Officers and District Surveillance Officers, as well as members of other district EVD response agencies, such as DERC Coordinators, WHO Field Coordinators, and CDC epidemiologists. Eighteen stakeholders (58%) had a general understanding of the structure and function of CEBS. Twenty-three stakeholders (74%) interviewed stated that CEBS had benefited their district through enhanced community engagement and/or increased detection of suspected EVD cases. Stakeholders discussed challenges and concerns related to CEBS. The need for strengthened coordination between CEBS and other EVD response activities in terms of the sharing of surveillance reports was the most frequently-cited challenge and was noted by 13 (42%) interviewees. The sustainability of CEBS—both financially and programmatically when the DERCs begin to scale down—was also a major concern that was noted in eight (26%) of the interviews.

Discussion

Few surveillance systems in humanitarian emergencies are formally described and evaluated to assess efficiency and effectiveness[9,10]. This report attempts to assess the efficiency and implementation strategies of a national, disease-specific surveillance system. The rapid implementation of CEBS at a national scale in Sierra Leone was estimated to take two months to become fully operational by March 2015. In practice, the implementation process took six months and all nine districts began reporting alerts in June 2015, well after the peak in caseload. Although the planning and stakeholder meetings were time-consuming, the findings of the field assessment interviews indicate that the program was well-received by Community Health Monitors, Community Surveillance Supervisors and community members. This community ownership was an important aspect of CEBS considering the sensitive nature in some communities of reporting EVD cases and events during the outbreak.

We note three main advantages of a community based surveillance system. First, monthly reporting is considered to be very high (>80%) for most months in operation. The first six months of implementation saw a steady increase in the percentage of Community Health Monitors reporting at least once each week and the number of alerts reported by Community Health Monitors. In August 2015, 92% of Community Health Monitors reported at least once each week to their Community Surveillance Supervisors, indicating that most Community Health Monitors were actively performing community surveillance and are able to communicate with their Community Surveillance Supervisors. Second, reporting was consistent across time and geography. CEBS generated consistent surveillance information during periods of no- to low- transmission across districts when contact tracing was no longer active. This provided additional information to use to rule-out the presence of transmission during quiet periods. Third, the introduction of a community–based element to surveillance made a sufficient and satisfying linkage between communities and the overall EVD response. This was indicated by the satisfaction level of community members that was reported by Community Health Monitors.

Despite these advantages, there were three important weaknesses of the system. First, logistical delays proved to be the biggest challenge for CEBS implementation and resulted a delay in achieving geographical coverage goals until most districts were no longer documenting EVD cases. Issues with large-scale procurement of vehicles and the Closed User Group resulted in trained Community Health Monitors and Community Surveillance Supervisors who were unable to carry out their responsibilities effectively. The lack of communication and transportation may be responsible for the low number of alerts reported in the first three months of implementation. In a future crisis, it is advisable to search for preexisting sources transportation means and streamline the setup of Closed User Groups or distribution of mobile credit through a central source rather than a district-based approach in order to speed up the implementation process or prioritize procurement as a first step in implementation.

Second, the anticipated ratio of Community Health Monitors to population and Community Health Monitors to Community Surveillance Supervisors between districts was not consistently achieved. Partners were given flexibility within the SOP to establish the network of Community Health Monitors and Community Surveillance

Supervisors themselves and took different approaches to doing so, with some districts using only pre-existing community health workers while others selected additional Community Health Monitors in areas that were not previously covered by a community health worker. To get the system running as quickly as possible, it was decided that some decisions would be decentralized and made at the district level, instead of the national level. Though the CEBS SOP recommended a ratio of one Community Health Monitor per 50 households, a ratio of one Community Health Monitor per 118 households was achieved across the nine districts. It is not known how much this higher ratio affected the Community Health Monitors' ability to detect trigger events in their communities.

Third, the distribution of trigger events favored deaths over live alerts. Eighty-seven percent of alerts reported by Community Health Monitors were for deaths, most of which were not a trigger event and were not alerted as deaths linked to EVD. Since early on in the EVD outbreak, the MoHS has required that all deaths, regardless of cause, be reported to DERCs in order for the body to receive a swab test for EVD and be buried safely by a trained burial team. Nationally, the requirement for reporting deaths has been widely and frequently communicated to the population. CEBS was not intended to serve as a reporting system for community deaths, but assumed this role as many Community Health Monitors either felt it was their responsibility to report all deaths or were required to by policies pertaining to safe burial. In many respects, this was a positive development, as community death reporting is a means to both monitor whether Community Health Monitors are staying active and the activity helped to confirm zero transmission in districts without transmission. However, our data cannot describe the validity or completeness of this death reporting. Clustering of illnesses and deaths (ie, trigger 1) was reported less frequently than anticipated. The low proportion of reporting sick alerts can be partially attributed to lack of clarity about who is considered "sick." Due to the prevalence of disease in Sierra Leone, illness is a daily occurrence in rural communities of Sierra Leone. Community Health Monitors may not consider a person to be sick unless they have severe or unusual symptoms. More refinement of this trigger is needed, as such indications of clustering are the major link to early warning of transmission at the community level. It is informative that during the rapid evaluation, most Community Health Monitors interviewed did not recall all six triggers. The challenges in trigger recall may be due, in part, to the lack of EVD transmission by the time CEBS became fully operational, resulting in a lack of Community Health Monitor exposure to these events, which were much more common during peak transmission during late 2014 and early 2015. This challenge may also indicate that there are too many triggers for Community Health Monitors to easily remember and the content may be too abstract. Notably, the most commonly-reported of the six trigger events, including illness or death among a traveler and an illness or death among two or more members of the same household, were also the most commonly reported triggers after "Trigger 7- Other". These two events are likely the easiest for Community Health Monitors to understand and the easiest to detect.

There are important limitations to this evaluation. While the population-to-Community Health Monitor ratios presented are useful in giving a broader view of the overall distribution of Community Health Monitors, they are not able to truly assess CEBS coverage through identifying which villages have Community Health Monitors and which villages do not. In addition, population ratios are based off of data from the 2004 census that have been extrapolated to 2014 based on expected annual population increases, which does not take into account migration between and within districts. The Community Health Monitors and Community Surveillance Supervisors interviewed during the field assessment were selected via purposive sampling due to time and logistical constraints that would have been posed by random sampling. However, we aimed for representation geographically within each district. In addition, the sampling fractions were small, with interviews being conducted with only 50 of the 7,050 Community Health Monitors (0.7%) and 27 of the 137 Community Surveillance Supervisors (20%).

Conclusion

The implementation of CEBS has shown that a national system can be implemented at scale and that community volunteers are capable of detecting and reporting important health related events in their communities. Participation of community leaders in the implementation process proved to be an important step in ensuring that communities are supportive of the program and Community Health Monitors are able to carry out their

responsibilities effectively. The experience with CEBS implementation shows that planning to implement a large-scale community based program in two months across many partners requires well-planned and well-coordinated logistic procedures. The system as it stands may be utilized to inform the long-term Integrated Disease Surveillance and Response system.

Competing Interests

The authors have declared that no competing interests exist.

Data Availability

Data is available upon request. Please contact Laura Miller, laura.miller@rescue.org.

Acknowledgements

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References

1. World Health Organization. Statement on the 1st meeting of the IHR Emergency Committee on the 2014 Ebola outbreak in West Africa. August 8, 2014

REFERENCE LINK

2. Briand S, Bertherat E, Cox P, et al. The international Ebola emergency. N Engl J Med 2014; 371(13): 1180-3.

3. Crowe S, Hertz D, Maenner M, Ratnayake R, Baker P, Lash R, Klena J, Lee-Kwan SH, Williams C, Jonnie GT, Gorina Y, Anderson A, Saffa G, Carr D, Tuma J, Miller L, Turay A, Belay E. A plan for community event-based surveillance to reduce Ebola transmission - Sierra Leone, 2014-2015. MMWR Morb Mortal Wkly Rep 2015; 64(3): 70-3.

REFERENCE LINK

4. Lamunu M, Lutwama JJ, Kamugisha J, Opio A, Nambooze J, Ndayimirije N, Okware S. Containing a haemorrhagic fever epidemic: the Ebola experience in Uganda (October 2000-January 2001). Int J Infect Dis 2004; 8(1): 27-37.

5. WHO Western Pacific Region. A guide to establishing event-based surveillance. 2008

REFERENCE LINK

6. Ratnayake R, Crowe S, Jasperse J, Privette G, Stone E, Miller L, Hertz D, Maener M, Fu C, Jambai A, Morgan O. Assessment of community event–based surveillance for Ebola Virus Disease, Sierra Leone, 2015 Emerging Infectious Diseases 22: 8. Emerg Infect Dis 2016; 22(8).

REFERENCE LINK

7. Government of Sierra Leone. Ministry of Health and Sanitation. Policy for Community Health Workers in Sierra Leone. 2012

8. Koroma D, Turay AB, Moigua MB. 2004 Population and Housing Census: Analytical Report on Population Projection for Sierra Leone. 2004;

9. Early warning surveillance and response in emergencies: WHO technical workshop, December 2009. Wkly Epidemiol Rec. 2010 Apr 2;85(14/15):129-36. PubMed PMID:20391643.

REFERENCE LINK

10. Polonsky J, Luquero F, Francois G, Rousseau C, Caleo G, Ciglenecki I, Delacre C, Siddiqui MR, Terzian M, Verhenne L, Porten K, Checchi F. Public health surveillance after the 2010 haiti earthquake: the experience of médecins sans frontières. PLoS Curr. 2013 Jan 7;5. pii: ecurrents.dis.6aec18e84816c055b8c2a06456811c7a.

REFERENCE LINK

ORIGINAL ARTICLE

Ebola RNA Persistence in Semen of Ebola Virus Disease Survivors — Final Report

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ABSTRACT

BACKGROUND

Ebola virus has been detected in the semen of men after their recovery from Ebola virus disease (EVD). We report the presence of Ebola virus RNA in semen in a cohort of survivors of EVD in Sierra Leone.

METHODS

We enrolled a convenience sample of 220 adult male survivors of EVD in Sierra Leone, at various times after discharge from an Ebola treatment unit (ETU), in two phases (100 participants were in phase 1, and 120 in phase 2). Semen specimens obtained at baseline were tested by means of a quantitative reverse-transcriptase–polymerase-chain-reaction (RT-PCR) assay with the use of the target sequences of NP and VP40 (in phase 1) or NP and GP (in phase 2). This study did not evaluate directly the risk of sexual transmission of EVD.

RESULTS

Of 210 participants who provided an initial semen specimen for analysis, 57 (27%) had positive results on quantitative RT-PCR. Ebola virus RNA was detected in the semen of all 7 men with a specimen obtained within 3 months after ETU discharge, in 26 of 42 (62%) with a specimen obtained at 4 to 6 months, in 15 of 60 (25%) with a specimen obtained at 7 to 9 months, in 4 of 26 (15%) with a specimen obtained at 10 to 12 months, in 4 of 38 (11%) with a specimen obtained at 13 to 15 months, in 1 of 25 (4%) with a specimen obtained at 16 to 18 months, and in no men with a specimen obtained at 19 months or later. Among the 46 participants with a positive result in phase 1, the median baseline cycle-threshold values (higher values indicate lower RNA values) for the NP and VP40 targets were lower within 3 months after ETU discharge (32.4 and 31.3, respectively; in 7 men) than at 4 to 6 months (34.3 and 33.1; in 25), at 7 to 9 months (37.4 and 36.6; in 13), and at 10 to 12 months (37.7 and 36.9; in 1). In phase 2, a total of 11 participants had positive results for NP and GP targets (samples obtained at 4.1 to 15.7 months after ETU discharge); cycle-threshold values ranged from 32.7 to 38.0 for NP and from 31.1 to 37.7 for GP.

CONCLUSIONS

These data showed the long-term presence of Ebola virus RNA in semen and declining persistence with increasing time after ETU discharge. (Funded by the World Health Organization and others.)

The authors' full names, academic degrees, and affiliations are listed in the Appendix. Address reprint requests to Dr. Deen at Connaught Hospital, Freetown, Sierra Leone, or at gibrilladeen1960@yahoo.com.

Drs. Deen, Broutet, Xu, and Knust and Drs. Formenty, Ströher, and Sahr contributed equally to this article.

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On March 17, 2016, the World Health Organization (WHO), the Chinese Center for Disease Control and Prevention (China CDC), and the Centers for Disease Control and Prevention (CDC) joined the government of Sierra Leone in marking the end of the most recent flare-up of Ebola virus disease (EVD) in the country; and in June 2016, the WHO declared the end of Ebola virus (EBOV) transmission in the Republic of Guinea and in Liberia.[1] Unprecedented in its magnitude, this epidemic was responsible for the deaths of at least 3590 people in Sierra Leone.[1]

The main mode of transmission of EBOV is direct contact with the blood or body fluids of a person with EVD or from the body of a person who died from EVD.[2,3] In addition, EBOV can persist in the body fluids of survivors of EVD during convalescence,[4,5] and this persistence could result in transmission of the virus. The potential for the persistence of EBOV, particularly in the semen of male survivors, arouses concern about the risk of sexual transmission.[6]

Previously, EVD survivors had been advised to practice sexual abstinence or to use a condom during sexual activity for 3 months after recovery. These recommendations were based on EBOV-detection results from semen specimens that were obtained from eight survivors of EVD or Marburg virus disease in previous epidemics,[5,7-11] in which the longest period that infectious virus was detected in semen after symptom onset was 82 days.[5,7]

In March 2015, a woman in Liberia received a diagnosis of EVD, and her only potential exposure that could be ascertained was sexual contact with a male survivor of EVD. Further investigation showed EBOV RNA in the survivor's semen 199 days after the onset of his symptoms, and the genetic sequence matched the sequence in the sample obtained from the case patient.[12] Although no infectious virus was detected in this semen specimen, the possibility that infectious EBOV could persist in the semen of survivors approximately 6 months after symptom onset prompted the WHO and the CDC to revise their guidelines regarding the length of time that survivors should practice safer sex (in particular, with the use of condoms) or sexual abstinence.[13,14]

A study that was published in August 2016 described 429 survivors of EVD who were enrolled in the National Semen Testing Program in Liberia.[15] The authors found that the longest interval between discharge from an Ebola treatment unit and a positive result on reverse-transcriptase–polymerase-chain-reaction (RT-PCR) assay was 565 days (18.5 months). Furthermore, a report from Guinea presented data on a male survivor in whom EBOV was detected by means of PCR in semen 531 days (17.4 months) after symptom onset, and sequencing data provided evidence of sexual transmission approximately 470 days (15.4 months) after symptom onset.[16] Cases that have been linked to sexual contact with survivors of EVD from the West African outbreak of EVD have not been systematically documented, and fewer than 20 cases in total have been reported (Knust B, CDC; Formenty P, WHO: personal communication).

The Sierra Leone Ministry of Health and Sanitation, in collaboration with the Sierra Leone Ministry of Defense; the Sierra Leone Ministry of Social Welfare, Gender, and Children's Affairs; the WHO; the CDC; and later the China CDC initiated a cohort study investigating the duration of virus persistence in the body fluids of survivors of EVD in Sierra Leone. This article describes the participants' characteristics at entry in the cohort of male survivors of EVD whose semen was tested by means of RT-PCR; it is an update of a preliminary report, which is available with the full text of this article at NEJM.org.

METHODS

STUDY DESIGN, CONDUCT, AND OVERSIGHT

This was an observational cohort study of a convenience sample of 220 male survivors of EVD in Sierra Leone.[17] The study was designed by the Sierra Leone Ministry of Health and Sanitation; the Sierra Leone Ministry of Social Welfare, Gender, and Children's Affairs; the WHO; and the CDC. The Sierra Leone Ministry of Defense, the Sierra Leone Ministry of Health and Sanitation, the WHO, the CDC, and the China CDC gathered the data. Semen specimens were analyzed by the CDC during phase 1 and by the China CDC during phase 2 (phases 1 and 2 are defined below). Data analysis was performed and supervised by the WHO, the CDC, and the China CDC. Manuscript planning and drafting were overseen and performed by the Sierra Leone Ministry of Health and Sanitation, the WHO, the CDC, and the China CDC. The overall coordination of the study was ensured by WHO, in collaboration with the

Sierra Leone Ministry of Health and Sanitation and the Sierra Leone Ministry of Defense. All the research activities were performed in accordance with all the applicable laws, regulations, and policies related to the protection of human participants and animals. The research protocol was reviewed and approved by the Sierra Leone Ethical Review Board and the WHO Ethical Review Committee. Participants received a compensation for each visit to the study site. A complete list of the members of the Sierra Leone Ebola Virus Persistence Study Group is provided in the Supplementary Appendix, available with the full text of this article at NEJM.org.

STUDY POPULATION, SAMPLING, AND ELIGIBILITY CRITERIA

The 220 male survivors of EVD who were included in the cohort were identified at informational events that were held in conjunction with local associations for survivors of EVD.[17] Men who indicated their interest in participation were offered enrollment in the study. Recruitment was conducted in two phases. Phase 1 enrolled 100 male participants (who had only semen tested) who had been recruited from the Western Area District in the capital of Freetown, and phase 2 enrolled 120 male participants (who had semen and other body fluids tested; only the results of the semen testing are reported in this article) who had been recruited from the Western Area District and from Lungi (Port Loko District).

Participants were eligible for inclusion if they were men, 18 years of age or older, and could provide an official EVD survivor certificate that had been issued by the Sierra Leone Ministry of Health and Sanitation. Such certificates were provided to persons with laboratory-confirmed cases of EVD when they were discharged from an Ebola treatment unit. Entry in the study began after an informed-consent form was signed; enrollment was followed by a standardized questionnaire and specimen collection.

DATA COLLECTION AND COUNSELING

At the time of enrollment, all the participants were administered a standardized questionnaire by a member of the study team in order to gather information about their sociodemographic characteristics, EVD episode, self-reported health status, and sexual behavior. The date of discharge from an Ebola treatment unit was ascertained from the participants' EVD survivor certificates.

Participants received pre–Ebola-test counseling at the time of enrollment and post–Ebola-test counseling 2 weeks later, when they received their individual RT-PCR results. The counseling included information about the test performed, the meaning of the results, and education about sexual risk-reduction practices, including appropriate condom use and disposal.[18] Participants were referred to a clinic for survivors of EVD if needed, as determined by the trained medical study staff, or requested.

SPECIMEN COLLECTION AND LABORATORY ANALYSES

Only semen specimens were obtained and tested for EBOV persistence in phase 1, and specimens of semen and other body fluids were obtained and tested for EBOV persistence in phase 2. At enrollment, participants were asked to provide a semen specimen in a private room and were provided instructions to ensure that proper infection-control procedures were followed. Trained counselors also offered participants a voluntary, confidential rapid test for the human immunodeficiency virus (HIV) in accordance with the national testing algorithm. However, this article focuses only on the semen testing.

Semen specimens were refrigerated (at 5 to 8°C) for no longer than 3 days. The semen specimens that had been obtained from phase 1 participants were transported to and tested at the CDC field laboratory in Bo District, Sierra Leone, and the semen specimens that had been obtained from phase 2 participants were transported to and tested at the China CDC Jui Laboratory in Freetown.

In phase 1, quantitative RT-PCR assays were performed that targeted EBOV NP and VP40 gene targets and the human β_2-microglobulin (*B2M*) gene (Thermo Fisher Scientific), as described previously.[19-21] A specimen was considered to be positive if the NP and VP40 gene targets were both detected within 40 cycles of replication, and the results were considered to be indeterminate if one of the NP or VP40 gene targets was detected but not both.

In phase 2, a double-channel quantitative RT-PCR detection kit was used to detect EBOV NP and GP genes[22] and *B2M*. A specimen was

considered to be positive if either or both of the NP or GP gene targets were detected within 38 cycles of replication. There was no indeterminate result. For the semen samples in both phase 1 and phase 2, the specimen was considered to be negative if both EBOV gene targets were not detected and the findings with respect to *B2M* status were positive. Amplification of *B2M* served as an extraction control and RNA quality control.

The cycle-threshold value for each gene target is reported as the number of replication cycles that had occurred when the target was first detected. Cycle-threshold values have an inverse association with RNA quantity, such that lower cycle-threshold values indicate higher quantities of RNA in given specimens.[23]

STATISTICAL ANALYSIS

For the analysis of EBOV persistence in semen, baseline data from phase 1 and phase 2 were pooled into one sample of 220 male survivors of EVD. The descriptive analysis that we present here focuses on two aspects: the sociodemographic data of all the participants, according to the site of origin (from Freetown, an urban area; and from Lungi, a semiurban area); and the number of participants who had a positive, indeterminate, or negative result on quantitative RT-PCR at enrollment, according to the number of days between the date of discharge from an Ebola treatment unit and the date that the semen specimen was obtained. When the duration between discharge and the date of the specimen collection was reported in months, a 30-day interval per month applied. We report the median cycle-threshold values, according to months after discharge, with the range (minimum and maximum) of values that was observed for the NP and VP40 gene targets (phase 1) and for the NP and GP gene targets (phase 2). For other quantitative variables, means with standard deviations and medians with interquartile ranges are reported. Data analysis was performed with the use of SAS/STAT software (SAS Institute).[24]

RESULTS

STUDY PARTICIPANTS

A total of 220 male survivors of EVD were enrolled: 100 participants were enrolled in the Freetown urban site during phase 1 (May 27, 2015, through July 7, 2015), and 120 participants (60 in the Freetown urban site and 60 in the semiurban Lungi site) during phase 2 (November 11, 2015, through May 12, 2016).

The sociodemographic characteristics of the study participants are presented in Table 1, according to study site and phase. There were key differences between the sites. As compared with the participants from the Freetown urban site, participants from the Lungi semiurban site were slightly older, were more likely to have received no formal education, were more often engaged in a long-term relationship or married, reported that there were more people in their household, and reported that more household members had been infected with EBOV. Among 195 men (89%) who agreed to be tested for HIV, 1 was found to be HIV-positive.

Overall, the mean (SD) duration between the date of discharge from an Ebola treatment unit and the baseline visit was 10.0 4.9 months. This duration was longer among the participants in phase 2 of the study (11.5 3.2 months in Freetown and 15.6 2.9 months in Lungi) than among those in phase 1 (5.9 1.9 months in Freetown) because of delayed recruitment that started after the epidemic had ended (Table 1).

DETECTION OF EBOLA VIRUS RNA IN SEMEN

Of the 210 participants who provided a semen specimen for analysis at study entry, 57 (27%) had positive results on quantitative RT-PCR (Table 1); 46 were participants from phase 1 of the study and 11 were from phase 2. Overall, EBOV RNA was detected in semen in all 7 men from whom a specimen was obtained within 3 months after discharge from an Ebola treatment unit, in 26 of 42 (62%) from whom a specimen was obtained 4 to 6 months after discharge, in 15 of 60 (25%) from whom a specimen was obtained 7 to 9 months after discharge, in 4 of 26 (15%) from whom a specimen was obtained 10 to 12 months after discharge, in 4 of 38 (11%) from whom a specimen was obtained 13 to 15 months after discharge, and in 1 of 25 (4%) from whom a specimen was obtained 16 to 18 months after discharge; all 12 semen specimens that were obtained 19 months or more after discharge were negative (Fig. 1). In addition, the results of 4 semen specimens obtained at 4 to 6 months after discharge from an Ebola treatment unit,

Table 1. Characteristics of Study Participants at Baseline, According to Study Site and Phase.*

Characteristic	Freetown Site		Lungi Site	Total
	Phase 1 (N=100)	Phase 2 (N=60)	Phase 2 (N=60)	Phases 1 and 2 (N=220)
Recruitment period	May 27, 2015–July 7, 2015	Nov. 11, 2015–Feb. 17, 2016	Feb. 3, 2016–May 12, 2016	May 27, 2015–May 12, 2016
Age				
Mean — yr	29.7 8.4	31.3 8.3	34.8 11.5	31.5 9.5
Median (interquartile range) — yr	27 (24–34)	30 (25–36)	34 (26–43)	29 (25–36)
Distribution — no./total no. (%)				
≤25 yr	36/99 (36)	18/60 (30)	13/60 (22)	67/219 (31)
26–35 yr	44/99 (44)	25/60 (42)	22/60 (37)	91/219 (42)
>35 yr	19/99 (19)	17/60 (28)	25/60 (42)	61/219 (28)
Highest level of education — no. (%)†				
No education	14 (14)	10 (17)	19 (32)	43 (20)
Primary education	49 (49)	13 (22)	8 (13)	70 (32)
Secondary education	37 (37)	37 (62)	33 (55)	107 (49)
Marital status — no. (%)				
Married or in a long-term relationship	51 (51)	31 (52)	40 (67)	122 (55)
Single, divorced, widowed, or separated	49 (49)	29 (48)	20 (33)	98 (45)
Current household size, including self — no./total no. (%)				
≤4 persons	32/100 (32)	17/57 (30)	7/59 (12)	56/216 (26)
5–8 persons	30/100 (30)	35/57 (61)	8/59 (14)	73/216 (34)
9–12 persons	27/100 (27)	4/57 (7)	12/59 (20)	43/216 (20)
>12 persons	11/100 (11)	1/57 (2)	32/59 (54)	44/216 (20)
No. of household members with EVD, excluding self — no. (%)				
0	36 (36)	16 (27)	6 (10)	58 (26)
1 or 2	34 (34)	16 (27)	11 (18)	61 (28)
3 or 4	15 (15)	13 (22)	14 (23)	42 (19)
≥5	15 (15)	15 (25)	29 (48)	59 (27)
Duration between ETU discharge and semen-specimen collection				
Mean — mo	5.9 1.9	11.5 3.2	15.6 2.9	10.0 4.9
Median (interquartile range) — mo	6.2 (4.5–7.1)	11.3 (9.0–14.0)	15.5 (13.7–17.5)	8.6 (6.2–14.2)
Range — mo	1.3–11.2	4.1–19.3	8.5–22.3	1.3–22.3
No semen specimen — no.	2	5	3	10
Result of Ebola RT-PCR semen testing at baseline — no./total no. (%)				
Positive	46/98 (47)	8/55 (15)	3/57 (5)	57/210 (27)
Indeterminate‡	13/98 (13)	0/55	0/57	13/210 (6)
Negative	39/98 (40)	47/55 (85)	54/57 (95)	140/210 (67)

* Plus–minus values are means SD. The Freetown site is in an urban area, and the Lungi site in a semiurban area. Percentages may not total 100 because of rounding. ETU denotes Ebola treatment unit, EVD Ebola virus disease, and RT-PCR reverse transcriptase–polymerase chain reaction.

† Primary education was defined as 1 to 8 years of school, and secondary education as more than 8 years of school.

‡ An indeterminate result indicates that one of the gene targets was detected and one was not detected; this finding applies only to the assay from the Centers for Disease Control and Prevention that was used during phase 1.

7 obtained at 7 to 9 months after discharge, and 2 obtained at 10 to 12 months after discharge were indeterminate (only one target positive) when the NP and VP40 targets were assessed. The proportion of men with semen specimens that tested negative by means of quantitative RT-PCR increased with the duration between the date of discharge from an Ebola treatment unit and the date that the specimen was obtained.

In phase 1, the median cycle-threshold values of the detected NP and VP40 target genes in semen specimens increased over time after discharge from an Ebola treatment unit. For specimens obtained within 3 months after discharge, the values were 32.4 with the NP gene target and 31.3 with the VP40 gene target; for those obtained at 4 to 6 months, the values were 34.3 and 33.1, respectively; and for those obtained at 7 to 9 months, the values were 37.4 and 36.6, respectively (Table 2). For a single baseline specimen that was obtained at 10 to 12 months, the cycle-threshold values were 37.7 for NP and 36.9 for VP40. A total of 11 participants in phase 2 tested positive for NP and GP target genes (these participants were recruited at a later stage after discharge from an Ebola treatment unit), and the cycle-threshold values ranged from 32.7 to 38.0 for the NP target gene and from 31.1 to 37.7 for the GP target gene; the numbers were too small for us to investigate trends over time.

The longest time that was reported between discharge from an Ebola treatment unit and the initial time that the semen specimen was obtained in a man who tested positive was 470 days (15.7 months). Conversely, the shortest time after discharge that a participant had a negative result on an initial semen specimen was 100 days (3.3 months). Indeterminate results were encountered in 13 initial specimens that were obtained in the range of 144 to 335 days (4.8 to 11.2 months) after discharge from an Ebola treatment unit.

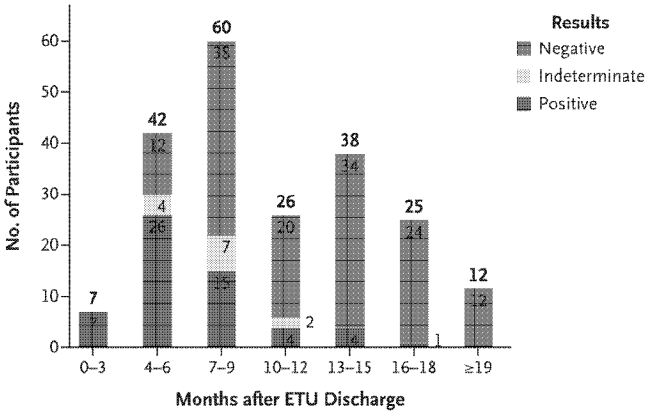

Figure 1. Results on Reverse Transcriptase–Polymerase Chain Reaction in Semen Specimens Obtained at Baseline from Survivors of Ebola Virus Disease, According to Time after Discharge from an Ebola Treatment Unit (ETU).

An indeterminate result indicates that one of the gene targets was detected and one was not detected; this finding applies only to the assay from the Centers for Disease Control and Prevention that was used during phase 1.

DISCUSSION

We conducted a cross-sectional analysis involving 220 male survivors of EVD who had enrolled in a prospective observational cohort for the investigation of EBOV persistence in semen. Participants were recruited in two different phases and at different study sites: Freetown in the Western Area District, and Lungi in the Port Loko District.

Sampling was not random, and further analysis was conducted to understand how the group of participants that was recruited in this study is representative of the overall population of survivors of EVD in Sierra Leone. The participants in phase 1 were recruited between 4 and 6 months earlier than those in phase 2. The differences between the participants in phase 1 and those in phase 2 are therefore biased by this difference in the number of months after discharge at the time of enrollment.

In the preliminary report, the semen RT-PCR test results at baseline were provided with respect to time since symptom onset, whereas in the current analysis we used time after discharge from an Ebola treatment unit. This change was made because discrepancies were found in the symptom-onset date for the cohort during data cleaning, and the team opted to use the discharge date instead in order to ensure validity. Although this change affected the distribution and the longest duration to a negative result at study entry, the date of discharge was retained as a reference for the analysis. Therefore, the exact number of days of RNA persistence in semen cannot be directly compared between the two reports.

All seven participants who provided a semen specimen during the first 3 months after discharge from an Ebola treatment unit had positive results on quantitative RT-PCR. This finding

Table 2. Proportion of Positive Findings on Quantitative Reverse-Transcriptase–Polymerase-Chain-Reaction (RT-PCR) Assay and Cycle-Threshold Values in the Semen of Survivors of EVD, According to Time after ETU Discharge.

Time after ETU Discharge	Phase 1			Phase 2		
	Positive Result	Cycle-Threshold Value*		Positive Result	Cycle-Threshold Value†	
		NP target	VP40 target		NP target	GP target
	no./total no. (%)	*median (range)*		*no./total no. (%)*	*median (range)*	
0–3 Mo	7/7 (100)	32.4 (20.9–36.0)	31.3 (20.2–34.9)	—	—	—
4–6 Mo	25/39 (64)	34.3 (26.3–38.6)	33.1 (26.1–39.7)	1/3 (33)	35.8	34.8
7–9 Mo	13/48 (28)	37.4 (28.5–38.8)	36.6 (28.2–38.3)	2/12 (17)	35.0–35.1	32.9–34.4
10–12 Mo	1/4 (25)	37.7	36.9	3/22 (14)	38.0‡	37.1 (36.0–37.5)
13–15 Mo	—	—	—	4/38 (11)	35.3 (32.7–37.4)	34.4 (31.1–36.7)
16–18 Mo	—	—	—	1/25 (4)	37.9	37.7
≥19 Mo	—	—	—	0/12	—	—

* Cycle-threshold values were assessed in participants who had positive results; if only one participant had a positive result, that value is shown. The value was determined by means of the assay from the Centers for Disease Control and Prevention, which was a quantitative RT-PCR assay that used Ebola virus–specific gene targets (NP and VP40) and the human β_2-microglobulin (*B2M*) gene, as described previously.[19-21] The findings were considered to be positive if the VP40 and the NP gene targets were both detected within 40 cycles of replication. Higher cycle-threshold values indicate lower RNA levels. The findings were considered to be negative if both Ebola virus gene targets were not detected and the findings regarding *B2M* status were positive. The findings were ruled to be indeterminate if one of the VP40 or NP gene targets was detected but not both. The results for one participant from whom a specimen was obtained at 10 months were indeterminate.

† Cycle-threshold values were assessed in participants who had positive results. For phase 2, the median of the cycle-threshold value is not presented if data were available for fewer than three participants; in that case, the range is presented if there were two observations, and a single value is presented when there was just one observation. The value was determined by means of the assay from the Chinese Center for Disease Control and Prevention, which was a double-channel quantitative RT-PCR detection kit that used Ebola virus NP and GP and *B2M*.[22] The findings were considered to be positive if either the NP or GP gene target was detected within 38 cycles of replication. The findings were considered to be negative if both Ebola virus gene targets were not detected and the findings regarding *B2M* status were positive.

‡ A cycle-threshold value of 38.0 indicates a negative result. A single value is reported here because values were missing for the other two participants.

is consistent with those of previous studies involving male survivors of the Ebola and Marburg virus diseases. The percentage of male participants with positive results declined with the increased time between the date of discharge and the date of enrollment in the study. Because the longitudinal analysis of EBOV RNA shedding in semen over time is ongoing, we do not yet know how long this detection will continue. Follow-up analysis is ongoing to elucidate the dynamic of the clearance of EBOV in semen at different points in time.

The quantitative RT-PCR assays that were used in this study to test semen specimens are the same that were used to test blood specimens obtained from patients with suspected EVD. The assays are highly sensitive,[19,22] and the detection of viral RNA does not necessarily indicate that infectious virus is present in blood or semen.[21,25,26]

We found that the median cycle-threshold values for the EBOV gene targets increased (indicating lower RNA values) when the analysis was performed with samples that had been obtained from participants who had a longer duration between the date of discharge from an Ebola treatment unit and the date of entry in the study. The cycle-threshold values that were obtained for EBOV target genes have been shown to correlate with viral load in blood,[23] with an increasing cycle-threshold value indicating a decrease in the viral load. However, the detection of viral RNA does not necessarily indicate that infectious virus is present. A limited study that examined the relationship between cycle-threshold values and virus isolation did not detect infectious virus in blood specimens obtained from patients with EVD when cycle-threshold values were greater than 35.5 with the NP gene target.[25] Similarly, in semen obtained from survivors of EVD that was tested in the United States, the highest cycle-threshold value for the NP target gene that yielded a virus isolate was 30; a total of 12 specimens with a cycle-threshold value greater than 30 did not yield any virus isolates.[27] In this study cohort, we found that men provided specimens that were positive on quantitative RT-PCR several months after the discharge date and that the cycle-threshold values increased with time.

The potential contribution of sexual transmission to the scale of the epidemic is largely unknown, and we do not yet have sufficient information to assess the risk of transmission by means of sexual intercourse, oral sex, or other sex acts from men with viable virus in their semen. However, the unprecedented number of more than 16,000 survivors of EVD across Sierra Leone, Guinea, and Liberia, roughly half of whom are male, creates the potential for transmission and the initiation of new chains of transmission, even months after the outbreak has ended. Even though only rare cases of EVD have been linked to sexual transmission, research is needed to investigate whether infectious virus may be present in vaginal fluid or other body fluids after recovery, and the testing of additional body fluids in both male and female survivors is planned. It is also important to note that the three affected countries have a very low rate of HIV infection and other sexually transmitted infections, with a prevalence of HIV infection among adults of 1.3% in Sierra Leone,[28] 1.6% in Guinea,[29] and 1.1% in Liberia[30]; these rates may also have influenced risks of EBOV sexual transmission.

Understanding the duration of Ebola virus shedding in survivors of EVD, and preventing further transmission, was essential for ultimately controlling the Ebola epidemic in West Africa. On the basis of the preliminary report of this study, the WHO, the CDC, and other partners engaged with the Ministries of Health of the three affected countries to establish and implement national semen-testing programs and preventive behavioral counseling. These efforts were essential to help survivors of EVD who participated in the initiatives, and they may have mitigated the risks of sexual transmission. Such programs helped men and women to understand their individual risk and to take appropriate measures to protect their sexual partners, specifically with regard to condom use and disposal. Such programs could also provide links to care and counseling programs for survivors. At the beginning of the epidemic and throughout the period that it lasted, survivors of EVD were stigmatized. There were instances when survivors were denied access to their homes after being discharged from the Ebola treatment unit. After the epidemic, the level of stigmatization of survivors has decreased.[31,32] Currently, most survivors of EVD have been reintegrated into their communities, but health care access for survivors of EVD remains a concern.[33,34] Because the implementation of semen-testing programs has been limited, outreach activities are needed to provide education

regarding recommendations and risks to survivor communities and sexual partners of survivors in a way that does not further stigmatize the community of survivors of EVD. Due respect and continuing efforts that have strong sustainable support from within the local communities are crucial in mitigating negative effects in terms of further stigma attached to survivors.

The views expressed in this article are those of the authors and do not necessarily represent the official positions of the Sierra Leone Ministry of Health and Sanitation, the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), or the Chinese Center for Disease Control and Prevention (China CDC).

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Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

APPENDIX

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REFERENCES

1. World Health Organization. Ebola situation report. June 10, 2016 (http://apps.who.int/iris/bitstream/10665/208883/1/ebolasitrep_10Jun2016_eng.pdf).
2. Dowell SF, Mukunu R, Ksiazek TG, Khan AS, Rollin PE, Peters CJ. Transmission of Ebola hemorrhagic fever: a study of risk factors in family members, Kikwit, Democratic Republic of the Congo, 1995. J Infect Dis 1999;179:Suppl 1:S87-S91.
3. Dietz PM, Jambai A, Paweska JT, Yoti Z, Ksiazek TG. Epidemiology and risk factors for Ebola virus disease in Sierra Leone — 23 May 2014 to 31 January 2015. Clin Infect Dis 2015;61:1648-54.
4. Kreuels B, Addo MM, Schmiedel S. Severe Ebola virus infection complicated by gram-negative septicemia. N Engl J Med 2015;372:1377.
5. Rodriguez LL, De Roo A, Guimard Y, et al. Persistence and genetic stability of Ebola virus during the outbreak in Kikwit, Democratic Republic of the Congo, 1995. J Infect Dis 1999;179:Suppl 1:S170-S176.
6. Rogstad KE, Tunbridge A. Ebola virus as a sexually transmitted infection. Curr Opin Infect Dis 2015;28:83-5.
7. Rowe AK, Bertolli J, Khan AS, et al. Clinical, virologic, and immunologic follow-up of convalescent Ebola hemorrhagic fever patients and their household contacts, Kikwit, Democratic Republic of the Congo. J Infect Dis 1999;179:Suppl 1:S28-S35.
8. Bausch DG, Towner JS, Dowell SF, et al. Assessment of the risk of Ebola virus transmission from bodily fluids and fomites. J Infect Dis 2007;196:Suppl 2:S142-S147.
9. Emond RT, Evans B, Bowen ET, Lloyd G. A case of Ebola virus infection. Br Med J 1977;2:541-4.
10. Martini GA, Schmidt HA. Spermatogenic transmission of the "Marburg virus" (causes of "Marburg simian disease"). Klin Wochenschr 1968;46:398-400. (In German.)
11. Thorson A, Formenty P, Lofthouse C, Broutet N. Systematic review of the literature on viral persistence and sexual transmission from recovered Ebola survivors: evidence and recommendations. BMJ Open 2016;6(1):e008859.
12. Christie A, Davies-Wayne GJ, Cordier-Lassalle T, et al. Possible sexual transmission of Ebola virus — Liberia, 2015. MMWR Morb Mortal Wkly Rep 2015;64:479-81.
13. World Health Organization. Interim advice on the sexual transmission of the Ebola virus disease. January 21, 2016 (http://www.who.int/reproductivehealth/topics/rtis/ebola-virus-semen/en/).
14. Centers for Disease Control and Prevention. Ebola (Ebola virus disease) — transmission. 2015 (https://www.cdc.gov/vhf/ebola/transmission/index.html).
15. Soka MJ, Choi MJ, Baller A, et al. Prevention of sexual transmission of Ebola in Liberia through a national semen testing and counselling programme for survivors: an analysis of Ebola virus RNA results and behavioural data. Lancet Glob Health 2016;4(10):e736-e743.
16. Diallo B, Sissoko D, Loman NJ, et al. Resurgence of Ebola virus disease in Guinea linked to a survivor with virus persistence in seminal fluid for more than 500 days. Clin Infect Dis 2016;63:1353-6.
17. Deen GF, McDonald SLR, Marrinan JE, et al. Implementation of a study to examine the persistence of Ebola virus in the body fluids of Ebola virus disease survivors in Sierra Leone: Methodology and lessons learned. PLoS Negl Trop Dis 2017;11(9):e0005723.
18. Abad N, Malik T, Ariyarajah A, et al. Development of risk reduction behavioral

counseling for Ebola virus disease survivors enrolled in the Sierra Leone Ebola Virus Persistence Study, 2015-2016. PLoS Negl Trop Dis 2017;11(9):e0005827.
19. Centers for Disease Control and Prevention. Ebola virus VP40 real-time RT-PCR assay. 2014 (https://www.fda.gov/MedicalDevices/Safety/EmergencySituations/ucm161496.htm#ebola).
20. Centers for Disease Control and Prevention. Ebola virus NP real-time RT-PCR assay. 2014 (https://www.fda.gov/downloads/medicaldevices/safety/emergencysituations/ucm436307.pdf).
21. Erickson BR, Sealy TK, Flietstra T, et al. Ebola virus disease diagnostics, Sierra Leone: analysis of real-time reverse transcription-polymerase chain reaction values for clinical blood and oral swab specimens. J Infect Dis 2016;214:Suppl 3:S258-S262.
22. Wang Q, Zhang Y, Wang HY, et al. Detection and analysis of Ebola virus in Sierra Leone-China Friendship Biosafety Laboratory from March 11 to April 20, 2015. Biomed Environ Sci 2016;29:443-7.
23. Towner JS, Rollin PE, Bausch DG, et al. Rapid diagnosis of Ebola hemorrhagic fever by reverse transcription-PCR in an outbreak setting and assessment of patient viral load as a predictor of outcome. J Virol 2004;78:4330-41.
24. The SAS system for Windows, release 9.4. Cary, NC: SAS Institute, 2014.
25. Spengler JR, McElroy AK, Harmon JR, Ströher U, Nichol ST, Spiropoulou CF. Relationship between Ebola virus real-time quantitative polymerase chain reaction-based threshold cycle value and virus isolation from human plasma. J Infect Dis 2015;212:Suppl 2:S346-S349.
26. Sissoko D, Duraffour S, Kerber R, et al. Persistence and clearance of Ebola virus RNA from seminal fluid of Ebola virus disease survivors: a longitudinal analysis and modelling study. Lancet Glob Health 2017;5(1):e80-e88.
27. Uyeki TM, Erickson BR, Brown S, et al. Ebola virus persistence in semen of male survivors. Clin Infect Dis 2016;62:1552-5.
28. UNAIDS. Sierra Leone: HIV and AIDS estimates (2015) (http://www.unaids.org/en/regionscountries/countries/sierraleone).
29. UNAIDS. Guinea: HIV and AIDS estimates (2015) (http://www.unaids.org/en/regionscountries/countries/guinea).
30. UNAIDS. Liberia: HIV and AIDS estimates (2015) (http://www.unaids.org/en/regionscountries/countries/liberia).
31. Lee-Kwan SH, DeLuca N, Adams M, et al. Support services for survivors of Ebola virus disease — Sierra Leone, 2014. MMWR Morb Mortal Wkly Rep 2014;63:1205-6.
32. Rabelo I, Lee V, Fallah MP, et al. Psychological distress among Ebola survivors discharged from an Ebola treatment unit in Monrovia, Liberia — a qualitative study. Front Public Health 2016;4:142.
33. Van Bortel T, Basnayake A, Wurie F, et al. Psychosocial effects of an Ebola outbreak at individual, community and international levels. Bull World Health Organ 2016;94:210-4.
34. Medecins Sans Frontieres. Surviving Ebola, then helping others fight it. 2014 (http://www.doctorswithoutborders.org/article/surviving-ebola-then-helping-others-fight-it).

From: Chris Vanlangendonck <c.vanlangendonck@onehealthplatform.com>
Subject: Call for abstracts !
Sent: Thu, 2 Nov 2017 10:37:37 +0100
Cc: David De Pooter <d.depooter@onehealthplatform.com>, John MacKenzie <J.MacKenzie@curtin.edu.au>, Ab Osterhaus <Albert.Osterhaus@tiho-hannover.de>
To: Martyn Jeggo [redacted], MARK RWEYEMAMU <mark.rweyemamu@btinternet.com>, Amadou Sall <asall@pasteur.sn>, "Dr. Ottorino Cosivi" <cosivio@paho.org>, Baljit Singh <baljit.singh1@ucalgary.ca>, Malik Peiris <malik@hkucc.hku.hk>, Marietjie Venter <marietjie.venter@up.ac.za>, Penina Munyua <ikg2@cdc.gov>, Susan Kutz <skutz@ucalgary.ca>, samuel.iverson@canada.ca, Craig Stephen <cstephen@cwhc-rcsf.ca>, Patrick Leighton <patrick.a.leighton@umontreal.ca>, Wang Linfa <linfa.wang@duke-nus.edu.sg>, "Andrew P. Dobson" <dobber@princeton.edu>, "William B. Karesh" <karesh@ecohealthalliance.org>, "Gerdts, Volker" <volker.gerdts@usask.ca>, Casey Barton Behravesh <dlx9@cdc.gov>, Lorne Babiuk <lbabiuk@ualberta.ca>, Jonna Mazet <jkmazet@ucdavis.edu>
OHP_5OHC_callforabstracts.pdf

Dear members of the OHS Programme Committee

We are ready to receive abstracts ! - thanks to your hard work in the Programme Committee. Many thanks for that - also on behalf of John and Ab !
We made a flyer to promote the call for abstracts - Feel free to distribute it as widely as possible within your network.

Many thanks !

Kind regards
Chris

ONE HEALTH PLATFORMIt's all connected
Chris Vanlangendonck
co-founder / management
0032 475 81 38 59
www.onehealthplatform.com

Dear members of the OHS Programme Committee
We are ready to receive abstracts ! - thanks to your hard work in the Programme Committee. Many thanks for that - also on behalf of John and Ab !
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2018 www.onehealthcongress.com

Call for abstracts

You are kindly invited to submit an abstract for the 5th International One Health Congress through the congress website at www.onehealthcongress.com.

Guidelines and the abstract submission tool are available online. Be sure to submit your abstract by the deadline of 15 February 2018.

Accepted abstracts will be allocated to the appropriate session. Notification of acceptance and instructions for oral or poster presentations will be sent by 15 March 2018 via e-mail.

The 5th International One Health Congress welcomes the submission of abstracts on the following topics:

OHS ONE HEALTH SCIENCE

- Pathogen discovery
- Surveillance and early detection
- Diagnostics
- Intervention strategies
- Social science and politics
- Pathogenesis
- Drivers for emerging diseases
- One Health in underprivileged communities
- Vaccines
- Infectious diseases from an ecohealth perspective

AMR ANTIMICROBIAL AGENTS AND RESISTANCE

- Use of antibiotics in human and animals, in food and agriculture and the link to AMR and environmental impact
- Genomic epidemiology/ evolution of antimicrobial transmission
- Real life applications of whole genome sequencing
- Prevalence and surveillance of antimicrobial resistance
- Novel strategies for AMR interventions and preparedness
- Alternative approaches to tackling resistant infections
- Rapid diagnostics in AMR interventions

About the 5th International One Health Congress

In June 2018, the 5th International One Health Congress will bring together some 1,500 researchers, policy makers and practitioners from universities, governments and industry who are working towards integrated approaches and effective responses to complex global health challenges.

To capture the multifaceted One Health concept, the congress will have three separate programme tracks. The **One Health Science (OHS)** track focuses on zoonoses and emerging and re-emerging infectious diseases. The **Antimicrobial Resistance (AMR)** track is dedicated to investigating, preventing and controlling antibiotic resistance. The **Science Policy Interface (SPI)** track is a tailor-made programme for public health officials and government representatives, offering information and practical application based on the most recent scientific insights.

A series of plenary sessions and satellite symposia will provide a platform for trans-disciplinary interaction and exchange of ideas in a true One Health spirit.

The 5th International One Health Congress is organized by the **One Health Platform** and the **University of Saskatchewan**, in close collaboration with the **Southern African Centre for Infectious Disease Surveillance (SACIDS)**, **CDC Kenya** and **One Health Eastern & Central Africa (OHCEA)**.

UNIVERSITY OF SASKATCHEWAN

ONE HEALTH PLATFORM

✓ All information: www.onehealthcongress.com

From: REDACTED
To: David John Wolking <djwolking@ucdavis.edu>, "Alisa Pereira Emerging Threats Division" <apereira@usaid.gov>, Alison Andre <andre@ecohealthalliance.org>, Amanda Andre <amanda.andre@ecohealthalliance.org>, Ava Sullivan <sullivan@ecohealthalliance.org>, Brooke Genovese <bgenovese@ucdavis.edu>, Cassandra Louis Duthil <clouisduthil@usaid.gov>, Catherine Machalaba <Machalaba@ecohealthalliance.org>, Christine Kreuder Johnson <ckjohnson@UCDAVIS.EDU>, "Clements, Andrew (GH/HIDN" <AClements@usaid.gov>, Eddy Rubin <erubin@metabiota.com>, Evelyn Luciano <luciano@ecohealthalliance.org>, Leilani Franciso <francisco@ecohealthalliance.org>, Lindsay Parish <lparish@usaid.gov>, "Molly Turner" <turner@ecohealthalliance.org>, Peter Daszak <daszak@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>, "Shana Gillette" <sgillette@usaid.gov>, William Karesh <karesh@ecohealthalliance.org>, "predict@ucdavis.edu" <predict@ucdavis.edu>, PREDICTMGT <predictmgt@usaid.gov>
Subject: PREDICT Jan 9 MT call cancelled
Sent: Wed, 27 Dec 2017 23:08:38 +0000

Dear PREDICT Management team,
The next management team call on Tuesday January 9th has been cancelled due to the PREDICT meeting in Brussels.
Have a great holiday,

REDACTED

REDACTED
Fellow
One Health Institute
School of Veterinary Medicine
University of California, Davis

From: Andrew Clements <aclements@usaid.gov>
Sent: Mon, 8 Jan 2018 06:06:43 -0800
Subject: Fwd: US Chargé visit to PREDICT activity site
To: djwolking@ucdavis.edu, Jonna Mazet <jkmazet@ucdavis.edu>

FYI

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

Begin forwarded message:

From: Zandra Andre <zandre@usaid.gov>
Date: January 8, 2018 at 12:41:49 PM GMT+1
To: Kalpy Julien COULIBALY [REDACTED]
Cc: REGINA BLANDINE N'GUESSAN KOKO <nkoko@usaid.gov>, Anne Laudisoit <laudisoit@ecohealthalliance.org>, Mireille Dosso <[REDACTED] Peter Daszak <daszak@ecohealthalliance.org>, PREDICT HQ Mgmt <PREDICTmgt@usaid.gov>, Jenny-Christelle Debrimou <jdebrimou@usaid.gov>, Molly Turner <turner@ecohealthalliance.org>, Alice Latinne <latinne@ecohealthalliance.org>
Subject: US Chargé visit to PREDICT activity site

Dear All,
I've got an exciting announcement for the PREDICT project--the Chargé will be visiting USG-supported activities in Western Côte d'Ivoire and I've successful advocated for the PREDICT project to be included!

She's very interested in wildlife and biodiversity. In fact, she has already met with the Minister of Water and Forests three times about ending wildlife trafficking and she happy to hear that we have a project trying to understand the dynamics of disease transmission between wildlife and humans.

The date/time that we are looking at is the morning of January 22nd. We have about 2.5 hours of dedicated time on her schedule in and around Bonon. It would be great to see Marahoué Forest and our activities there. We could also highlight the support that the project has provided to the Bonon Health Center. Meeting with a village in the forest and understanding their behaviors/interactions with the forest could be interesting. But again, we only have about two hours thus we'll need to come up with a plan that best captures what PREDICT does while also being an interesting unique experience. We're the only project working on wildlife and human in GHSA so let's fully take advantage of our time in the spotlight!

The next Embassy planning meeting Thursday, January 11th and the Chargé travel planning committee would like to have more detail about what she's going to do/see. We also need to understand that if we meet with the village, what formalities need to be completed with the village chief, what would be her interaction with the villagers, actual travel time between the locations such as the Bonon Health Center, the village, capture sites in the forest, etc. We should also think about press opportunities for PREDICT such as press releases, updates to the ETD/GHSA Bi-weekly update, USAID social media posting, etc.

Can we have a discussion today about this at 16:00?

Please let me know as soon as possible.

Thanks,
Zandra

Dr. Zandra Hollaway ANDRE
DVM, MPH, DACVPM
Global Health Security Team Lead
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
REDACTED
T: +225 22 49 43 35 M REDACTED
From the US: (301) 985-8627 x 4335

USAID.gov | ZAndre@usaid.gov | @USAIDWestAfrica
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From: David J Wolking <djwolking@ucdavis.edu>
Sent: Mon, 22 Jan 2018 12:08:52 -0800
To: Molly Turner <turner@ecohealthalliance.org>
Cc: David J Wolking <djwolking@ucdavis.edu>, William Karesh <karesh@ecohealthalliance.org>, Peter Daszak <daszak@ecohealthalliance.org>, Evelyn Luciano <luciano@ecohealthalliance.org>, Ava Sullivan <sullivan@ecohealthalliance.org>, Amanda Andre <amanda.andre@ecohealthalliance.org>, Alison Andre <andre@ecohealthalliance.org>, "predict@ucdavis.edu" <predict@ucdavis.edu>
Subject: [predict] Re: US Chargé visit to PREDICT activity site

Thanks Molly, figured but wanted to confirm.
Cheers,

D

On Mon, Jan 22, 2018 at 12:07 PM, Molly Turner <turner@ecohealthalliance.org> wrote:

> Hi David,
> The visit was cancelled due to the shutdown.

Molly

On Mon, Jan 22, 2018 at 3:01 PM, David J Wolking <djwolking@ucdavis.edu> wrote:

> Hi Peter and Billy,
> Any updates on how this visit went today in CIV? I recall talking to Anne (I think that's here name!) in Brussels about preparations so would be great to have an update available if we can for MT tomorrow (assuming it isn't cancelled due to the shutdown).

Thanks!

David

---------- Forwarded message ----------
From: **Andrew Clements** <aclements@usaid.gov>
Date: Mon, Jan 8, 2018 at 6:06 AM
Subject: Fwd: US Chargé visit to PREDICT activity site
To: djwolking@ucdavis.edu, Jonna Mazet <jkmazet@ucdavis.edu>

FYI

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

Begin forwarded message:

From: Zandra Andre <zandre@usaid.gov>
Date: January 8, 2018 at 12:41:49 PM GMT+1
To: Kalpy Julien COULIBALY <[REDACTED]>
Cc: REGINA BLANDINE N'GUESSAN KOKO <nkoko@usaid.gov>, Anne Laudisoit <laudisoit@ecohealthalliance.org>, Mireille Dosso <[REDACTED]>, Peter Daszak <daszak@ecohealthalliance.org>, PREDICT HQ Mgmt <PREDICTmgt@usaid.gov>, Jenny-Christelle

Debrimou <jdebrimou@usaid.gov>, Molly Turner <turner@ecohealthalliance.org>, Alice Latinne <latinne@ecohealthalliance.org>

Subject: US Chargé visit to PREDICT activity site

Dear All,

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Can we have a discussion today about this at 16:00?

Please let me know as soon as possible.

Thanks,
Zandra

Dr. Zandra Hollaway ANDRE
DVM, MPH, DACVPM
Global Health Security Team Lead
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
US Embassy - Abidjan, Côte d'Ivoire
T: +225 22 49 43 35 M: [redacted]
From the US: (301) 985-8627 x 4335

USAID.gov | ZAndre@usaid.gov | @USAIDWestAfrica

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Molly Turner
Federal Grants Coordinator
EcoHealth Alliance Operations

EcoHealth Alliance
460 West 34th Street – 17th floor
New York, NY 10001

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REDACTED cell)
www.ecohealthalliance.org

EcoHealth Alliance leads cutting-edge scientific research into the critical connections between human and wildlife health and delicate ecosystems. With this science, we develop solutions that prevent pandemics and promote conservation.

From: Jonna Mazet <jkmazet@ucdavis.edu>
To: Andrew Clements <aclements@usaid.gov>
CC: Alisa Pereira <apereira@usaid.gov>;Predict inbox <predict@ucdavis.edu>;Tracey Goldstein <tgoldstein@ucdavis.edu>;bhbird@ucdavis.edu <bhbird@ucdavis.edu>
Sent: 2/23/2018 11:39:14 AM
Subject: Re: SL follow up

Thanks Andrew,
I had been planning to go end of March or beginning of April, but I can shift. That said, we have our semi-annual the week of April 9 is our semiannual, and the week following (beginning with the 16th), I have a non-refundable vacation.
We'll stay tuned,
Jonna

On Fri, Feb 23, 2018 at 10:55 AM Andrew Clements <aclements@usaid.gov> wrote:
Just talked with Kendra. She's hoping to identify a time to talk with the Mission next week. (Some challenges getting key people.). Will get back to you on a day/time.

She also mentioned the possibility of a TDY in mid April to include some of you and some of us from ETD. If possible, keep your calendar open for that.

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

From: Andrew Clements <aclements@usaid.gov>
Sent: Fri, 9 Mar 2018 10:18:47 -0800
To: David J Wolking <djwolking@ucdavis.edu>
Cc: "predict@ucdavis.edu" <predict@ucdavis.edu>, PREDICTMGT <predictmgt@usaid.gov>
Subject: Re: [predict] Fwd: Invitation to Conference Call to Discuss "RespectingTaxpayers Resources" in Implementation of USAID Awards in Liberia with Mission Director

Yes, I think you're the target audience.

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

On Mar 9, 2018, at 6:35 PM, David J Wolking <djwolking@ucdavis.edu> wrote:

> Thanks Andrew, would you like us to join this call from HQ?
> David

On Fri, Mar 9, 2018 at 4:09 AM, Andrew Clements <aclements@usaid.gov> wrote:

> FYI

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

Begin forwarded message:

> **From:** Philippe Accilien <paccilien@usaid.gov>
> **Date:** March 9, 2018 at 12:58:26 PM GMT+1
> **To:** mthayer@acdivoca.org, cmosby@acdivoca.org, cbailey@acdivoca.org, trip@projectlastmile.com, alex@projectlastmile.com, rnackerdien@ifes.org, lcooper@ifes.org, mparry@ifes.org, knoyes@msh.org, kgunter@msh.org, Matt.Harder@tetratech.com, rtekeu@thekaizencompany.com, sscheening@opendevelopment.co, larry.henry@nreca.coop, prosty.oleary@nreca.coop, rachel.volmert@nreca.coop, veneicia.lockhart@nreca.coop, fbundunki@edc.org, sboucher@edc.org, krepp@edc.org, snogueirasanca@edc.org, sspencer@siaedge.com, cgowen@chemonics.com, jagee@checchiconsulting.com, ballen@checchiconsulting.com, Betsy.Hendrickson@jhpiego.org, tom.crick@cartercenter.org, lance.alloway@cartercenter.org, ramiro.martinez@cartercenter.org, craig.withers@cartercenter.org, ymalieieva@ibi-usa.com, REDACTED REDACTED | REDACTED Victoria.Pennacchia@crs.org, caverch@fhi360.org, sprew@rti.org, clehman@rti.org, jthenry@rti.org, jodom@rti.org, megan.huth@tetratech.com, david.felson@tetratech.com, molly.burtenshaw@crs.org, elundgren@socialimpact.com, fbunduki@edc.org
> **Cc:** Kendra Chittenden <kchittenden@usaid.gov>, "Dr. Charles W. Oliver Jr." <choliver@usaid.gov>, Lindsay Parish <lparish@usaid.gov>, Andrew Clements <aclements@usaid.gov>, Ricardo Echalar <rechalar@usaid.gov>, John Garrity <jgarrity@usaid.gov>, Karen Duca <kduca@usaid.gov>, Christopher Egaas <cegaas@usaid.gov>, Cheryl Hodge-Snead <chodge-snead@usaid.gov>, Jennifer Tikka <jtikka@usaid.gov>, Emily Krunic <ekrunic@usaid.gov>, Tara Milani

<tmilani@usaid.gov>, Malcom Phelps <mphelps@usaid.gov>, Sonjai Reynolds-Cooper <sreynoldscooper@usaid.gov>, "April O'Neill" <aoneill@usaid.gov>, Scott Rawson <drawson@usaid.gov>, Laurel Rushton <larushton@usaid.gov>, Sinu Kurian <skurian@usaid.gov>, Pamela Bernard-Sawyer <pbernard-sawyer@usaid.gov>, Jannie Horace <jhorace@usaid.gov>, Shelly Wright <shwright@usaid.gov>, Kaa Williams <kwilliams@usaid.gov>, Monica Dea <mdea@usaid.gov>, Michael Haines <mhaines@usaid.gov>, Gracia Buencamino <gmbuencamino@usaid.gov>, Roosevelt Tule <rtule@usaid.gov>, Thomas Kanneh <tkanneh@usaid.gov>, Louise Fahnbulleh <lfahnbulleh@usaid.gov>, Andrew Parks <aparks@usaid.gov>, Maxime Bainduah <mbainduah@usaid.gov>, Lisa Korte <lkorte@usaid.gov>, Yoel Kirschner <ykirschner@usaid.gov>, Maurice O Ogutu <mogutu@usaid.gov>, Beatrice Young St Victor <bvictor@usaid.gov>, Robert Pedraza <rpedraza@usaid.gov>, Matthew Hulse <mhulse@usaid.gov>, Thomas Gibb <tgibb@usaid.gov>, Mardea Nyumah <mnyumah@usaid.gov>, Miriam White <mwhite@usaid.gov>, Teresiah Gathenya <tgathenya@usaid.gov>, Jessica Kafuko <jkafuko@usaid.gov>, Ollie White <owhite@usaid.gov>, Samsudeen Amusa <samusa@usaid.gov>, Richard Nyarsuk <rnyarsuk@usaid.gov>, Wondwossen Teffera <wteffera@usaid.gov>, Teffera Betru <tbetru@usaid.gov>, John Gorlorwulu <jgorlorwulu@usaid.gov>, Girlta Yeayen <gyeayen@usaid.gov>, Haider Haider <hahaider@usaid.gov>, Olutomi Olutola <oolutola@usaid.gov>

Subject: Re: Invitation to Conference Call to Discuss "RespectingTaxpayers Resources" in Implementation of USAID Awards in Liberia with Mission Director

Correction on time:
Because of Daylight Saving Time change to take place this weekend, the Time in DC will be (10-11 AM) on Tuesday March 13, 2018.

Thanks to Karina Noyes of MSH for pointing this out.

Best regards,

Philippe

Philippe Accilien

Program Officer

On Fri, Mar 9, 2018 at 11:10 AM, Philippe Accilien <paccilien@usaid.gov> wrote:

Dear Implementing Partners,

To follow-up to the Mission's meeting last week with your Chief of Parties implementing with USAID/Liberia, I am writing to invite you (Home Office Staff) to a conference call with the Mission Director to continue the discussions on the Agency's focus on "Respecting Taxpayers Resources." The Mission and Mission Director is particularly interested in discussing issues related to internal controls, financial reviews, and monitoring and evaluation of activities for results. The conference call will take place:

Tuesday March 13, 2018 2-3 pm (Monrovia Time) or 9-10 am (Washington, DC Time)

To Participate please call at this number

REDACTED **(Toll Free)**

REDACTED **(Caller Pays)**

Access Code: REDACTED

We look forward to your participation and please let us know if you have any questions. Feel free to RSVP to paccilien@usaid.gov.

Best regards,

Philippe

Philippe Accilien

Program Officer

From: Andrew Clements <aclements@usaid.gov>
Sent: Wed, 14 Mar 2018 18:23:17 +0100
Subject: Fwd: New subaward request: Georgetown University (POP start 3/15/18)
To: Jonna Mazet <jkmazet@ucdavis.edu>, David J Wolking <djwolking@ucdavis.edu>, Predict inbox <predict@ucdavis.edu>, Elizabeth Leasure <ealeasure@ucdavis.edu>
Cc: PREDICTMGT <predictmgt@usaid.gov>
PREDICT-2_Sub-Award Letter_Georgetown_3.13.18.pdf
PREDICT-2_BASIS OF AWARD_Georgetown_3.13.18.pdf
AOR Checklist for Subaward Consent_UCD subaward to Georgetown_PREDICT-2.docx
Rate Agreement 05.26.2017.pdf
DRAFT Initial Subaward_PREDICT_GeorgetownUniv.pdf
PREDICT sub-award GU checklist (3-14-18).pdf

Hi Liz,

The GU sub-award is approved. I've attached the signed checklist.

Andrew

---------- Forwarded message ----------
From: **Elizabeth Leasure** <ealeasure@ucdavis.edu>
Date: Tue, Mar 13, 2018 at 11:28 PM
Subject: New subaward request: Georgetown University (POP start 3/15/18)
To: Andrew Clements <aclements@usaid.gov>
Cc: Jonna Mazet <jkmazet@ucdavis.edu>, Predict inbox <predict@ucdavis.edu>, David John Wolking <djwolking@ucdavis.edu>

Hi Andrew. Please find attached a request for approval to establish a new subaward with the O'Neill Institute for National and Global Health Law at Georgetown University for the Global Virome Project, which includes a requested start date of 3/15/18. Georgetown University is a US-based private university. As such, only AOR approval is required. If you have any questions or need anything else to approve, please let me know.

Thanks,

Liz

Elizabeth Leasure

Financial Operations Manager

One Health Institute

REDACTED *(cell)*

530-754-9034 (office)

Skype: ealeasure

--

Andrew Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health

U.S. Agency for International Development
Mobile phone: 1-571-345-4253
E-mail: aclements@usaid.gov

For more information on USAID's Emerging Pandemic Threats program, see: http://www.usaid.gov/ept2

Subaward Consent

Subawardee: O'Neill Institute for National and Global Health Law, Georgetown University	Subagreement No. (attached): A15-0146-S0XX (TBD) Subagreement Modification No: N/A	Dollar Value: $33,313 Period of Subaward: 3/15/18-9/30/18
Recipient: Regents of the University of California, Davis campus	Prime Award No: AID-OAA-A-14-00102	Agreement Officer (AO): Ryland Marbray
Agreement Officer Representative (AOR) Name: Andrew Clements	AOR Signature:	Date: 3/14/2018

The AOR must complete this checklist prior to approving any subawards. **For any response other than "Yes," the AOR must provide a written explanation to the AO. AO concurrence is required prior to subaward approval for any "no" response.** Upon successful completion (all responses are "Yes") of the checklist, the AOR can provide notice to the recipient that the AOR approves the subaward.

A copy of the completed package (checklist, subaward request with supporting documents, and AOR approval letter) must be provided to the AO (via email) at the same time that approval is provided to the prime recipient in order to maintain the agreement file. AOR is also responsible for maintaining their own records of approvals.

1. Did the Prime provide the AOR with a copy of the subaward? Yes☒ No ☐

   Explanation to AO:_____

2. Did the AOR verify that the provisions from the prime award flow down to subrecipients? Yes☒ No ☐

   Explanation to AO:_____

3. Did the AOR verify that the subrecipient is not on the Excluded Parties List (Debarred, Suspended, and Ineligible Contractors? Yes☒ No ☐

   Explanation to AO:_____

4. Did the AOR verify that the subrecipient is **not** on the OFAC list as ineligible? Yes☒ No ☐

   Explanation to AO:_____

5. Has the prime provided justification and rationale for selecting the sub awardee? Yes☒ No ☐

Explanation to AO:_____

6. Is the requirement of the particular activity or services technically justified within the existing program description?
Yes☒ No ☐

Explanation to AO:_____

7. Has the AOR reviewed the detailed budget line items and determined them to be fair and reasonable and within the applicable rules and regulations?
Yes☒ No ☐

Explanation to AO:_____

8. Has the prime made a responsibility determination of the subrecipient? Yes☒ No ☐

Explanation to AO:_____

9. If this is a no-cost extension is the period of the extension less than 9 months? Yes☐ No ☐

Explanation to AO:_____N/A_____

10. Did the AOR verify that the prime demonstrated that the subrecipient is **not** a non-U.S.foreign government or parastatal? Yes☒ No ☐

Explanation to AO:_____

11. Has AOR verified that the subagreement does **not** include; construction, pharmaceutical, vehicles, agricultural commodities, or other restricted goods? Yes☒ No ☐

Explanation to AO:_____

12. Has AOR verified that the subagreement does **not** include a change in the program description or the approved budget of the prime recipient?
Yes☒ No ☐

Explanation to AO:_____

This form only applies to Subagreements under Assistance *(including ceiling increases & extensions)*, not to Contracts under *Assistance* Awards, nor to Assistance/Grants under Contracts(GUCs). NOTE: Ceiling increases must not exceed the ceiling of the Prime Award.

Subaward Consent

Subawardee: O'Neill Institute for National and Global Health Law, Georgetown University	Subagreement No. (attached): A15-0146-S0XX (TBD) Subagreement Modification No: N/A	Dollar Value: $33,313 Period of Subaward: 3/15/18-9/30/18
Recipient: Regents of the University of California, Davis campus	Prime Award No: AID-OAA-A-14-00102	Agreement Officer (AO): Ryland Marbray
Agreement Officer Representative (AOR) Name: Andrew Clements	AOR Signature:	Date:

The AOR must complete this checklist prior to approving any subawards. **For any response other than "Yes," the AOR must provide a written explanation to the AO. AO concurrence is required prior to subaward approval for any "no" response.** Upon successful completion (all responses are "Yes") of the checklist, the AOR can provide notice to the recipient that the AOR approves the subaward.

A copy of the completed package (checklist, subaward request with supporting documents, and AOR approval letter) must be provided to the AO (via email) at the same time that approval is provided to the prime recipient in order to maintain the agreement file. AOR is also responsible for maintaining their own records of approvals.

1. Did the Prime provide the AOR with a copy of the subaward? Yes☐ No ☐

   Explanation to AO:_____

2. Did the AOR verify that the provisions from the prime award flow down to subrecipients? Yes☐ No ☐

   Explanation to AO:_____

3. Did the AOR verify that the subrecipient is not on the Excluded Parties List (Debarred, Suspended, and Ineligible Contractors? Yes☐ No ☐

   Explanation to AO:_____

4. Did the AOR verify that the subrecipient is **not** on the OFAC list as ineligible? Yes☐ No ☐

   Explanation to AO:_____

5. Has the prime provided justification and rationale for selecting the sub awardee? Yes☐ No ☐

Explanation to AO:_____

6. Is the requirement of the particular activity or services technically justified within the existing program description?
Yes☐ No ☐

Explanation to AO:_____

7. Has the AOR reviewed the detailed budget line items and determined them to be fair and reasonable and within the applicable rules and regulations?
Yes☐ No ☐

Explanation to AO:_____

8. Has the prime made a responsibility determination of the subrecipient? Yes☐ No ☐

Explanation to AO:_____

9. If this is a no-cost extension is the period of the extension less than 9 months? Yes☐ No ☐

Explanation to AO:_____

10. Did the AOR verify that the prime demonstrated that the subrecipient is **not** a non-U.S.foreign government or parastatal? Yes☐ No ☐

Explanation to AO:_____

11. Has AOR verified that the subagreement does **not** include; construction, pharmaceutical, vehicles, agricultural commodities, or other restricted goods? Yes☐ No ☐

Explanation to AO:_____

12. Has AOR verified that the subagreement does **not** include a change in the program description or the approved budget of the prime recipient?
Yes☐ No ☐

Explanation to AO:_____

This form only applies to Subagreements under Assistance *(including ceiling increases & extensions)*, not to Contracts under *Assistance* Awards, nor to Assistance/Grants under Contracts(GUCs). NOTE: Ceiling increases must not exceed the ceiling of the Prime Award.

March 13, 2018

ACTION MEMORANDUM

TO: **Ryland Marbray, Agreement Officer, USAID**

FROM: **Elizabeth Leasure, Financial Operations Manager, PREDICT-2**

SUBJECT: **BASIS OF AWARD (**O'Neill Institute for National and Global Health Law, Georgetown University**)**

1. **This document was prepared by** the University of California, Davis as prime recipient of the PREDICT-2 cooperative agreement (AID-OAA-A-14-00102) for the Emerging Pandemic Threats (EPT-2) Program.

2. **The nature and/or description of the action being approved:** This is a request to approve a subaward to the O'Neill Institute for National and Global Health Law, Georgetown University for $33,313. Under this action, the O'Neill Institute will assess the political feasibility of the Global Virome Project (GVP) through identifying laws, regulations & policies in selected key countries and forecasting foreseeable political positions & obstacles based on existing framework for sharing samples, viral and genetic sequencing data and research findings. Additionally, the Institute will describe the interaction between health systems strengthening, financing and Research & Development in the field of emerging infectious diseases and identify models for coordination and division of labor among various stakeholders, as well as making recommendations to GVP based on the political and legal landscape.

3. **Description of the assistance program or assistance activity under the proposed action including estimated value:** The PREDICT-2 project is conducting global surveillance to detect and prevent the spillover of pathogens of pandemic potential that can move between animals and people. Specific activities include: strengthening surveillance and laboratory capacities in order to monitor animals and people at high-risk interfaces for novel pathogens that may pose a significant public health threat; characterizing human and ecological drivers of disease transmission, evolution, amplification, and spread from animals to people; strengthening and optimizing models for predicting disease emergence and using this information to improve surveillance; and supporting outbreak response when requested.

4. **The facts and rationale that justifies selection of subrecipient and other options explored:** Members of the O'Neill Institute have voluntarily participated in GVP as members of the Ethical, Legal and Social Implications (ELSI) Working Group since 2016, and therefore have a thorough understanding of the objectives and rationale for GVP, as well as anticipated legal, ethical and social challenges that GVP will address. Since the scope of work requires a thorough understanding of GVP together with a high level of legal expertise, the GVP steering committee (composed of subject matter experts from around the world) propose the O'Neill Institute to carry out this work. Other options were not considered reasonably available due to the specific combination of expertise in

international and global health law that is required to satisfactorily complete the proposed scope of work.

Submitted:

_____ 3-13-18

Elizabeth Leasure, PREDICT-2
University of California, Davis

Date

March 13, 2018

Ryland Marbray
Agreement Officer
USAID
M/OAA/E3

Reference: Cooperative Agreement No. AID-OAA-A-14-00102; PREDICT-2

Subject: **O'Neill Institute for National and Global Health Law, Georgetown University subaward**

Through: Andrew Clements, Agreement Officer's Representative;

Cc: Alisa Pereira, Deputy Director, Emerging Threats Division

Dear Mr. Marbray:

As part of our attached request for approval to issue a subagreement to the O'Neill Institute for National and Global Health Law at Georgetown University in Washington, D.C., USA, on behalf of the Regents of the University of California, Davis campus, we are pleased to present the following budget narrative that supports the detailed subagreement budget, which is also attached. In developing its budget, the O'Neill Institute in Washington, D.C., USA sought to offer exceptional value to USAID by combining realistic and reasonable cost estimates that reflect the complexity and needs of the program.

As the basis for its cost estimates, the O'Neill Institute in Washington, D.C., USA has used a combination of vendor quotes, current data, labor rates and costing information provided by their team. To facilitate review, we have organized this budget narrative to be consistent with the format of the budget.

Subawardee: O'Neill Institute for National and Global Health Law, Georgetown University in Washington, D.C., USA

Subaward Program Title: PREDICT-2

Purpose: The O'Neill Institute at Georgetown University will work together with individuals in the GVP Ethical, Legal and Social Implications (ELSI) Working Group to assess the political feasibility of the Global Virome Project (GVP) through identifying laws, regulations & policies in selected key countries and forecasting foreseeable political positions & obstacles based on existing framework for sharing samples, viral and genetic sequencing data and research findings. Additionally, the Institute will describe the interaction between health systems strengthening, financing and Research & Development in the field of emerging infectious diseases and identify models for coordination and division of labor among various stakeholders, as well as making recommendations to GVP based on the political and legal landscape.

Anticipated Subaward POP: March 15, 2018 through September 30, 2018

Subaward Ceiling: $33,313

Award Type: Subagreement

Sincerely,

Elizabeth Leasure
PREDICT Financial Operations Manager
One Health Institute
University of California, Davis
530-754-9034
ealeasure@ucdavis.edu

Budget Justification – Georgetown University (O'Neill Institute)

Personnel ($21,492)
Amounts budgeted are based on current rates and inclusive of fringe benefits.

Mehgan Gallagher (12% effort, $7,548 direct cost for 6 months)
Gallagher will conduct analytics required for reporting of legal analysis, regulatory, social ethical and community issues in a metric-based report.

John Monahan (2% effort, $2,712 direct cost for 6 months)
Monahan will support efforts to identify laws, regulations and policies in selected key countries and determine foreseeable political positions and obstacles based on the existing framework for sharing samples, genetic sequencing, and research findings.

Rebecca Katz (3% effort, $5,766 direct cost for 6 months)
Katz will support efforts to identify laws, regulations and policies in selected key countries and determine foreseeable political positions and obstacles based on the existing framework for sharing samples, genetic sequencing, and research findings.

Additionally, funds are requested to support a Legal Research Assistants (**TBN @ $4,566/6 months)** and an Expert Legal Consultant **(TBN @ $900/6 months**) to assist with the identification and interpretation of relevant laws, regulations, and policies in key countries, as needed.

Indirect Costs ($11,821)

Indirect costs are calculated using Georgetown University's federally-negotiated indirect cost rate of 55% MTDC.

Staff	Cost/Month	# Months	Total Cost
Mehgan Gallagher - 12%	$ 1,258	6	$ 7,548
John Monohan - 2%	$ 452	6	$ 2,712
Rebecca Katz - 3%	$ 961	6	$ 5,766
Legal Research Assistants (45 hours/month)	$ 761	6	$ 4,566
Expert Legal Consultant	$ 150	6	$ 900
		Subtotal Personnel	*$ 21,492*
		55% Indirects	$ 11,821
		TOTAL	**$ 33,313**

COLLEGES AND UNIVERSITIES RATE AGREEMENT

EIN: 15-30196603A

ORGANIZATION:
Georgetown University
2121 Wisconsin Avenue, NW
Suite 431
Washington, DC 20007-

DATE:05/26/2017

FILING REF.: The preceding agreement was dated 03/17/2016

The rates approved in this agreement are for use on grants, contracts and other agreements with the Federal Government, subject to the conditions in Section III.

SECTION I: INDIRECT COST RATES

RATE TYPES: FIXED FINAL PROV. (PROVISIONAL) PRED. (PREDETERMINED)

EFFECTIVE PERIOD

TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
PRED.	07/01/2016	06/30/2018	55.50	On-Campus	Organized Research
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	Organized Research
PRED.	07/01/2016	06/30/2018	55.00	On-Campus	Instruction
PRED.	07/01/2016	06/30/2018	42.00	Off-Campus	Instruction (1)
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	Instruction (2)
PRED.	07/01/2016	06/30/2018	40.00	On-Campus	Other Sponsored Activities
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	Other Sponsored Activities
PROV.	07/01/2018	Until Amended			Use same rates and conditions as those cited for fiscal year ending June 30, 2018.

*BASE

Modified total direct costs, consisting of all salaries and wages, fringe benefits, materials, supplies, services, travel and subgrants and subcontracts up to the first $25,000 of each subgrant or subcontract (regardless of the period covered by the subgrant or subcontract). Modified total direct costs shall exclude equipment, capital expenditures, charges for patient care, student tuition remission, rental costs of off-site facilities, scholarships, and fellowships as well as the portion of each subgrant and subcontract in excess of $25,000.

(1) Adjacent off-campus: activities performed within the commuting area of Washington, DC.

(2) Remote off-campus: activities performed outside the communting area of Washington, DC.

SECTION I: FRINGE BENEFIT RATES**

TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
FIXED	7/1/2017	6/30/2018	27.30	All	Full-Time Employees
FIXED	7/1/2017	6/30/2018	20.20	All	
FIXED	7/1/2017	6/30/2018	6.50	All	
PROV.	7/1/2018	Until amended			Use same rates and conditions as those cited for fiscal year ending June 30, 2018.

** DESCRIPTION OF FRINGE BENEFITS RATE BASE:

Salaries and wages.

SECTION II: SPECIAL REMARKS

TREATMENT OF FRINGE BENEFITS:

The fringe benefits are charged using the rate(s) listed in the Fringe Benefits Section of this Agreement. The fringe benefits included in the rate(s) are listed below.

TREATMENT OF PAID ABSENCES

Vacation, holiday, sick leave pay and other paid absences are included in salaries and wages and are claimed on grants, contracts and other agreements as part of the normal cost for salaries and wages. Separate claims are not made for the cost of these paid absences.

OFF-CAMPUS DEFINITION: For all activities performed in facilities not owned by the institution and to which rent is directly allocated to the project(s), the off-campus rate will apply. Actual costs will be apportioned between on-campus and off-campus components. Each portion will bear the appropriate rate.

Fringe Benefits include: FICA, Retirement, Disability Insurance, Life Insurance, Employee Tuition Remission, Group Hospitalization, Labor Union, Sabbatical Leave, Workers' Compensation, Unemployment Insurance, Dental Insurance, FAS No. 106 Post Retirement Benefits other than Pension and Fringe Benefit Administration.

Fringe benefit rates exclude student salaries and wages.

Equipment means an article of nonexpendable tangible personal property having a useful life of more than one year, and an acquisition cost of $5,000 or more per unit.

This agreement updates the fringe benefits rates section only. All other terms and conditions remain unchanged.

**The next Fringe Benefit Proposal for FYE 06/30/2017 is due by 12/31/2017.

SECTION III: GENERAL

A. LIMITATIONS:

The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the organization were included in its facilities and administrative cost pools as finally accepted: such costs are legal obligations of the organization and are allowable under the governing cost principles; (2) The same costs that have been treated as facilities and administrative costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the organization which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. ACCOUNTING CHANGES:

This Agreement is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from facilities and administrative to direct. Failure to obtain approval may result in cost disallowances.

C. FIXED RATES:

If a fixed rate is in this Agreement, it is based on an estimate of the costs for the period covered by the rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

D. USE BY OTHER FEDERAL AGENCIES:

The rates in this Agreement were approved in accordance with the authority in Title 2 of the Code of Federal Regulations, Part 200 (2 CFR 200), and should be applied to grants, contracts and other agreements covered by 2 CFR 200, subject to any limitations in A above. The organization may provide copies of the Agreement to other Federal Agencies to give them early notification of the Agreement.

E. OTHER:

If any Federal contract, grant or other agreement is reimbursing facilities and administrative costs by a means other than the approved rate(s) in this Agreement, the organization should (1) credit such costs to the affected programs, and (2) apply the approved rate(s) to the appropriate base to identify the proper amount of facilities and administrative costs allocable to these programs.

BY THE INSTITUTION:

Georgetown University

(INSTITUTION)

(SIGNATURE)

(NAME) David Rubenstein

(TITLE) Vice President for Finance & University Treasurer

7/4/17

(DATE)

ON BEHALF OF THE FEDERAL GOVERNMENT:

DEPARTMENT OF HEALTH AND HUMAN SERVICES

(AGENCY)

Darryl W. Mayes -A

Digitally signed by Darryl W. Mayes -A
DN: c=US, o=U.S. Government, ou=HHS, ou=PSC, ou=People, 0.9.2342.19200300.100.1.1=2000131663, cn=Darryl W. Mayes -A
Date: 2017.05.31 08:21:20 -04'00'

(SIGNATURE)

Darryl W. Mayes

(NAME)

Deputy Director, Cost Allocation Services

(TITLE)

5/26/2017

(DATE) 0442

HHS REPRESENTATIVE: Steven Zuraf

Telephone: (301) 492-4855

AGREEMENT NUMBER A15-0146-S0XX

BETWEEN

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

AND

GEORGETOWN UNIVERSITY

This Agreement is made and entered into by and between **The Regents of the University of California (University)**, a public institution of higher education acting for and on behalf of its Davis Campus, and **Georgetown University (Participating Institution)**, an institution of higher education located in Washington, District of Columbia.

WHEREAS, University has received **Cooperative Agreement Number AID-OAA-A-14-00102 (Prime Agreement)** from **USAID (Prime Sponsor)** in support of the project entitled "Emerging Pandemic Threats Program 2 PREDICT-2" effective October 1, 2014;

WHEREAS, Prime Agreement provides authorization and funds for Participating Institution participation;

WHEREAS, Participating Institution has the facilities and skilled personnel necessary to pursue the objectives and fulfill the requirements of this Agreement;

WHEREAS, it is of mutual interest and benefit of University and the Participating Institution to collaborate;

WHEREAS, Participating Institution has agreed to perform the work hereunder as a collaborating Institution under a subaward relationship.

NOW THEREFORE, University and Participating Institution mutually agree as follows:

1. **General**. The terms of this Agreement are intended to be in concert with the terms and conditions of the Prime Agreement which is hereby incorporated by reference and attached as **Exhibit A**. Participating Institution hereby agrees to be bound by the terms and conditions of the Prime Agreement identified in Article 25 of this Agreement. For all actions requiring Prime Sponsor's prior approval, as identified in the Prime Agreement, Participating Institution must obtain prior written approval from University.

2. **Scope of Work.** The objectives of the Project are consistent with and will further the purposes of the Prime Agreement received by the University. The Participating Institution understands that the work of the Project is an integral part of the University's program plan.

   The Participating Institution shall enable its Principal Investigator to perform the work described in the work plan submitted to the University, incorporated by reference as **Exhibit B** (the "Project"). The actual performance of that work shall conform with all aspects of the Project proposal as submitted including:

   A. The description of the specific objectives of the Project;

   B. The description of the expected inputs, outputs, and indicators of the Project accomplishments;

   C. The description of any relationships with other Projects funded by the University under the previously referenced Prime Agreement;

   D. The description of the managerial responsibilities of the Project; and

   E. The description of arrangement for Project work in foreign sites.

3. **Period of Performance.** The performance period of this Agreement is March 15, 2018 through September 30, 2018.

4. **Reports.** Participating Institution's reports shall be incorporated into University's reports which are required to be submitted to the Prime Sponsor in accordance with the terms of the Prime Agreement. All reports shall be submitted to the following contact, unless otherwise directed:

Jonna Mazet Veterinary Medicine
One Shields Avenue
Davis, CA 95616-8686
jkmazet@ucdavis.edu

A. **Technical Reports.** Participating Institution shall provide University written progress reports for period of performance identified in Article 3 quarterly, or upon the request of the Principal Investigator, in a format required by the Prime Agreement.

B. **Patent Reports**. In accordance with 37 CFR 401.14, Participating Institution shall notify University's Administrative Officer, as stated in Article 6D, within two months after Participating Institution's inventor discloses invention(s) in writing to Participating Institution's personnel responsible for patent matters.

C. **Final Patent Report**. Participating Institution shall provide University's Administrative Officer, as stated in Article 6D, a written Final Patent Report within forty-five (45) days of the termination date of this Agreement. A negative report is required.

D. **Final Technical Report.** Participating Institution shall provide University a written Final Technical Report within forty-five (45) days of termination of this agreement in a format required by the Prime Agreement. The final technical report shall include, at a minimum, a summary statement of progress toward the achievement of the originally stated aims.

E. **Final Financial Report.** Participating Institution shall provide University a written Final Financial Report within forty-five (45) days of termination of this Agreement in the format required by the Prime Agreement.

5. **Allowable Cost, Compensation, Invoices.**

A. For the performance of work specified herein, University shall pay those expenses, direct and indirect, incurred by Participating Institution in accordance with the attached **Subaward Budget**, incorporated herein as **Exhibit C**. Allowable reimbursable Project costs shall be those costs incurred in accordance with the detailed Project budget, including its line item categories, as approved by the University for this Project. The maximum allowable costs for the period March 15, 2018 through September 30, 2018 under this Agreement is **Thirty Three Thousand Three Hundred Thirteen dollars ($33,313).**

B. **Ceiling Increases.** Increases to the ceiling of this subaward are not guaranteed and depend upon project needs, available funding, and approval of annual budgets by USAID.

C. **Travel.** All international travel is to be approved in advance. For any additional travel not already approved and incorporated in the Budget, Participating Institution shall submit a request to University's Project Director at least five weeks in advance of the anticipated foreign travel and the request shall include the following information: the number of trips, the number of individuals per trip, and the origin and destination countries or regions. This request will be submitted via an email sent to the contact in Article 5J below, and will be approved on a case-by-case basis.

D. **Participant Training**. All in-country and third-country training using USAID funds is to be approved in advance. All J-1 Visas for exchange visitors attending US-based training using USAID funds are to be issued by USAID in accordance with the instructions provided in USAID ADS 252. The University will coordinate J-1 Visa issuance with USAID Missions and central offices. Participating Institution is to notify University at least 120 days in advance of US-based training. Any proposed changes to the approved training activities must be submitted to the University for prior approval.

E. **Limitations on Reimbursement**. In addition to the foregoing limitations, the University obligation to reimburse the Participating Institution is subject to the following conditions:

1. All moneys provided for costs shall be expended in the amounts for the purposes indicated in the Budget, unless otherwise approved in writing by the University, provided:

a. That funds shall not be rebudgeted for additional international trips except with the prior written approval of the University; and

b. That rebudgeting of funds for the purpose of purchasing an item of equipment valued at $5,000 or more shall require the prior written approval of the University; and

c. That rebudgeting of funds for the purpose of purchasing any restricted items, as defined in Standard Provisions, will require the prior written approval of the University, and the request shall include the type of item, the amount to be spent, and the authorized geographic code; and

d. Without the written prior approval of the University, Participating Institution shall not rebudget funds to or allotted for participant training if the rebudget would result in changes to the approved training activities.

F. Costs must be expressed in U.S. dollars using an exchange rate applicable at the time the invoice is submitted. Please see the Prime Agreement for Mandatory Terms and Conditions regarding Facilities and Administrative Costs (F&A).

G. The University shall reimburse the Participating Institution for indirect costs in accordance with 2 CFR 200.331 (a)(4). Indirect costs reimbursed shall not exceed the amount indicated in the appropriate Budget line item category

H. Participating Institution must obtain prior written approval of University's Administrative Officer to rebudget funds where prior approval is required for such rebudgeting. Carry forward of unobligated funds requires prior approval.

I. The Participating Institution shall be obligated to refund to the University an amount or amounts equal to the sum of direct and indirect costs reimbursed by the University to the Participating Institution that is ultimately determined by either or both the University and USAID as unallowable.

J. Payment shall be on a cost reimbursement basis. Participating Institution shall submit monthly invoices that reflect expenditures incurred that provide detail commensurate with that appearing in the approved budget; invoices shall be numbered sequentially, and shall reference Agreement Number A15-0146-S0XX. Release of payment will be based upon notification and approval by the Principal Investigator that adequate documentation and corroboration of costs has been received. Participating Institution's invoices shall be submitted to:

Elizabeth Leasure
VM: One Health Institute

1089 Veterinary Medicine Drive
Davis, CA 95616-8671
ealeasure@ucdavis.edu

K. Participating Institution's final invoice shall be submitted to University not later than forty-five (45) days after expiration or termination of this Agreement.

6. Key Personnel

A. The scope of work supported by this Agreement shall be under the general guidance and technical direction of University's Jonna Mazet, Principal Investigator under the Prime Agreement.

B. Participating Institution's Principal Investigator John Monahan shall be responsible to the Participating Institution for the proper management and conduct of the activities hereunder. Participating Institution's Principal Investigator may be replaced only with the approval of University.

C. All communications regarding the technical, scientific, and programmatic aspects of this Agreement shall be between University's Jonna Mazet (or approved designee) and Participating Institution's John Monahan (or approved designee).

D. University's Administrative Officer responsible for matters of administration of the Agreement, including assistance in identification and interpretation of relevant policies and provisions, is:

Paula Noble
Contracts & Grants Officer
Office of Research, Sponsored Programs
1850 Research Park Drive, Suite 300
University of California
Davis, California 95618
(530) 754-7700
FAX (530)752-0333
subawards@ucdavis.edu

E. Participating Institution's Administrative Officer responsible for the coordination of fiscal and administrative management aspects of this Agreement is:

_____
_____
_____

F. Communications and correspondence regarding the fiscal and administrative aspects of this Agreement shall be between the designated Administrative Officers.

7. **Records and Audits.**

A. Participating Institution certifies by signing this Agreement that it complies with the Uniform Guidance, will provide notice of the completion of required audits and any adverse findings which impact this subaward as required by parts 200.501- 200.521, and will provide access to records as required by parts 200.336, 200.337, and 200.201 as applicable.

University reserves the right to inspect, upon University's reasonable advance notice and during normal business hours, Participating Institution's physical facilities, all aspects of the Statement of Work undertaken under this Agreement, and all books, records, and documents of any kind pertaining to this Agreement. Participating Institution agrees to provide copies of any records or other documentation to University in a timely fashion as reasonably requested by University. Participating Institution will keep all usual and proper records relating to performance of the Statement of Work for a minimum period of three (3) years after completion of closeout of this Agreement and after the final document has been submitted to University.

Participating Institution expressly acknowledges its understanding that its activities pursuant to this Agreement and all records pertaining thereto may be subject to audit by the Prime Sponsor, and Participating Institution agrees to cooperate fully in the performance of any such audit.

8. **Indemnification**.

A. University shall defend, indemnify and hold Participating Institution, its officers, employees and agents harmless from and against any and all liability, loss, expense (including reasonable attorneys' fees), or claims for injury or damages arising out of the performance of this Agreement but only in proportion to and to the extent such liability, loss, expense, attorneys' fees, or claims for injury or damages are caused by or result from the negligent or intentional acts or omissions of University, its officers, agents, or employees.

B. Participating Institution shall defend, indemnify and hold University, its officers, employees and agents harmless from and against any and all liability, loss expense (including reasonable attorneys' fees), or claims for injury or damages arising out of the performance of this Agreement but only in proportion to and to the extent such liability, loss, expense, attorneys' fees, or claims for injury or damages are caused by or result from the negligent or intentional acts or omissions of Participating Institution, its officers, agents, or employees.

9. **Disputes.** Resolution of disputes of a technical nature shall be resolved through good faith negotiations. Any dispute arising under or related to this Agreement shall be resolved to the maximum possible extent through negotiations and settlement. Failing settlement, despite good faith efforts by both parties, any such unresolved issues shall be arbitrated in accordance with the American Arbitration Association.

10. **Termination of Agreement**. Upon termination, Participating Institution must take immediate action to cease all expenditures financed by the Agreement and to cancel all unliquidated obligations to the extent possible. The Participating Institution may not enter into any additional obligations under the Agreement after receiving the notice of termination other than those reasonably necessary to effect the close out of the Agreement. Except as provided below, no further reimbursement will be made after the effective date of termination.

As soon as possible, but in any event no later than 90 days after the effective date of termination, the Participating Institution must repay to University all unexpended USAID funds that were not otherwise obligated prior to the effective date of termination by a legally binding transaction applicable to the Agreement. If the funds paid to the Participating Institution before the effective date of termination are not sufficient to cover the Participating Institution's obligations under a legally binding transaction, then the Participating Institution may submit a written claim for such amount to

USAID University within 120 days after the effective date of termination. The Agreement Officer will determine the amount(s) to be paid to the Participating Institution under the claim in accordance with the "Allowable Costs" provision of the Agreement. This agreement terminates, and authority to expend awarded funds shall cease, under any one of the following conditions:

A. The Prime Agreement is not extended past the end of the Period of Performance.

B. USAID cancels the Prime Agreement or reduces the available funding level.

C. USAID mandates ceasing activities in a geographic region or disallows continuance of the research as set forth in the Project.

D. The host government(s) formally objects to the presence of the Project or principal participants in the Project.

E. The Participating Institution's Principal Investigator resigns from the Project or the Participating Institution, or has not performed satisfactorily.

F. The Participating Institution has terminated the agreement with University.

G. The Participating Institution fails to comply with the terms of the Standard Provisions and/or tenets of this Agreement.

H. Evidence of gross incompetence and/or malfeasance by the Participating Institution.

11. Authorized Geographic Code. The authorized geographic code for procurement of goods and services under this Agreement is 937 – the United States, the cooperating/Participating Institution country, and developing countries other than advanced developing countries, and excluding prohibited sources.

12. Program Income. Program income is not expected to be generated by the Participating Institution. However, any program income that is generated shall be accounted for as program income and will be added to the Project, in accordance with 2 CFR 200.

13. Subcontractors. The Participating Institution's intention to procure services from a contractor (as defined in 2 CFR 200.330 b) by the Participating Institution under this Agreement must be identified in the Participating Institution's detailed Project proposal/work plan and detailed budget unless the intended subcontract is under the Simplified Acquisition Threshold (reference 2 CFR 200.88) and the entity providing the service is not a foreign governmental entity or parastatal. Any deviation from this condition requires the express written approval of the University. The Participating Institution shall make certain that any and all subcontracts issued under this Agreement to a contractor shall include the appropriate mandatory clauses (available at https://www.acquisition.gov/far/current/html/52_301Matrix.html) and flow-down provisions applicable to subcontracts issued under this Agreement. The Mandatory Flow-Down Provisions for U.S. Subcontractors are incorporated herein as Exhibit E, and the Mandatory Flow-Down Provisions for Foreign Subcontractors are incorporated herein as Exhibit F.

No subcontract issued by the Participating Institution shall relieve the Participating Institution from any obligation, responsibility, or liability to the University issuing from each and every term and condition of this Agreement.

Prior approval and flow-down requirements outlined in this section do not apply to contracts intended to procure services from individuals.

14. Subrecipients. The Participating Institution's intention to involve a subrecipient (as defined in 2 CFR 200.330 a) under this Agreement must be identified in the Participating Institution's detailed Project proposal/work plan and detailed budget. Any deviation from this condition requires the

express written approval of the University. The Participating Institution shall make certain that any and all subawards which it may issue under this Agreement to a subrecipeint shall include the same terms and conditions regarding financial, property, and operational reporting requirements as those to which the Participating Institution is subject to under the terms and conditions of this Agreement. Further, any subrecipients that receive a subaward under this Agreement must complete the Mini-Audit Questionnaire, incorporated herein as Exhibit D, once per project year.

No subaward issued by the Participating Institution shall relieve the Participating Institution from any obligation, responsibility, or liability to the University issuing from each and every term and condition of this Agreement.

Prior approval and flow-down requirements outlined in this section do not apply to contracts intended to procure services from individuals.

15. Inventory and Property Management.

The Participating Institution shall:

A. Take title to property, where authorized by the terms and conditions of the Prime Agreement, in such a way that the Participating Institution's financial records identify the source of funds; and

B. Reimburse the University for any costs or expenditures for which the University has compensated the Participating Institution and which either the University or USAID determines to be a disallowable cost; and

C. Comply with all equipment inventory and property management instructions which may hereafter be issued by the University and made applicable to the Participating Institution. A physical inventory will be conducted at least once per year, and the Principal Investigator will confirm in writing that the inventory of equipment purchased with funds under this Agreement is complete and correct; and

D. At the end of the subaward, all equipment and property held by the Participating Institution shall revert title to the University for use by other projects within the host country (reference USAID 2 CFR 200), and only if the University determines no use for the equipment within existing projects in-country, the equipment will then be disposed of as per USAID guidelines.

16. Mandatory Standard Provisions.

A. The following mandatory standard provisions are incorporated into this Agreement by reference with the same force and effect as if they were given in full text, shall hereinafter be referred to as "Domestic Mandatory Standard Provisions," and shall apply if the Participating Institution is an organization of the United States:

1. All provisions of 2 CFR 200; and

2. The Mandatory Standard Provisions for U.S. Nongovernmental Organizations revised 7/22/15 as provided in https://www.usaid.gov/ads/policy/300/303maa.

B. The following mandatory standard provisions are incorporated into this Agreement by reference with the same force and effect as if they were given in full text, shall hereinafter be referred to as "Foreign Mandatory Standard Provisions," and shall apply if the Participating Institution is not an organization of the United States:

1. The USAID's ADS 303mab, Standard Provisions for Non-U.S. Nongovernmental Organizations revised 7/22/15 (available for download at USAID website https://www.usaid.gov/ads/policy/300/303mab).

17. **Assignment.** Participating Institution shall not assign or transfer any responsibilities hereunder without the prior written consent of University.

18. **Protection of Human Subjects.** If human subjects are involved in the Project, Participating Institution shall conduct the activities in accordance with the Department of Health and Human Services regulations codified at 45 CFR 46 - Protection of Human Subjects. In such event, Participating Institution shall provide the designated University's Administrative Officer documentation that it is operating in accord with an approved Assurance of Compliance and shall cite the Assurance identification number. Participating Institution shall ensure that all personnel participating in the Project complete the education requirement on the protection of human subjects, as prescribed by the National Institutes of Health (NIH) in NIH Notice OD-00-039, and shall provide the designated University's Administrative Officer evidence that all such personnel have completed the requisite educational training. If planned activities involving human subjects are not exempt from said DHHS regulations, Participating Institution shall additionally provide certification of the review and date of approval by the Participating Institution's institutional review board, or equivalent thereof, of the planned involvement of human subjects in the Project. If applicable, the study protocol will also be reviewed and approved by the Institutional Review Board at the University of California, Davis.

19. **Care and Treatment of Laboratory Animals.** Participating Institution shall establish and maintain proper measures to ensure the appropriate care and use of live vertebrate animals involved in research supported by this Agreement, in accordance with the Animal Welfare Act as amended (7 USC 2131 et seq.) and the regulations promulgated thereunder by the Secretary of Agriculture (9 CFR, Subchapter A) pertaining to the care, handling, and treatment of warm-blooded animals held or used for research, teaching, or other activities supported by Federal funds. If Participating Institution's research hereunder involves vertebrate animals, execution of this document by Participating Institution's authorized official certifies that Participating Institution has on file with the NIH OPRR an approved Animal Welfare Assurance. Participating Institution shall submit to University's Administrative Officer verification of approval by Participating Institution's Institutional Animal Care and Use Committee of the planned care and use of animals in research activities to be supported hereunder.

20. **Alterations and Amendments.** No alteration or amendment of this Agreement shall be valid unless made by an instrument in writing, signed by authorized representatives of Participating Institution and University. No such alteration or amendment shall be construed to alter or amend any provisions of this Agreement unless expressly so stated in such written instrument.

21. **Debarment and Suspension.** Participating Institution certifies by signing this Agreement that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible or voluntarily excluded from participation in this transaction by any federal department or agency.

22. **Insurance**. Participating Institution agrees to maintain, for the duration of this Agreement, insurance or a program of self-insurance, in an amount that will be adequate to cover its obligations hereunder, and upon request, will provide the University with proof of insurance showing that such insurance is in place.

23. **Data, Publication and Copyrights**. Participating Institution shall have the right to copyright, publish, disclose, disseminate, and use, in whole or in part, any data and information developed by Participating Institution under this Agreement. Participating Institution shall provide University an advance copy of all materials intended for disclosure. All materials must comply with applicable provisions of the Prime Agreement.

    A. The Participating Institution is encouraged to give public notice of the receipt of this Agreement and announce progress and accomplishments. The Participating Institution agrees that in the release of information relating to this Agreement, such release shall include a statement to the effect that the Project or effort depicted was or is sponsored by

USAID Agreement Number AID-OAA-A-14-00102 that was awarded to The Regents of the University of California and subcontracted to Participating Institution, and the content of the information does not necessarily reflect the position or the policy of the U.S. Government, USAID, or University, and no official endorsement should be inferred.

B. The Participating Institution must provide copies of notices or announcements to the University, USAID's Agreement Officer's Representative (AOR), and to USAID's Office of Legislative and Public Affairs in advance of release, as practical. Press releases or other public notices must include a statement substantially as follows:

"The U.S. Agency for International Development administers the U.S. foreign assistance program providing economic and humanitarian assistance in more than 80 countries worldwide."

For the purpose of this provision, "information" includes news releases, articles, manuscripts, brochures, advertisements, still and motion pictures, speeches, trade association proceedings, symposia, et cetera.

C. Any public communication which has not been approved by USAID must contain the following disclaimer:

"*This study/report/audio/visual/other information/media product (specify) is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of [insert recipient name] and do not necessarily reflect the views of USAID or the United States Government*."

D. The following provision is included per 2 CFR 200, Marking:

"As a condition of receipt of this subaward, marking with the USAID Identity of a size and prominence equivalent to or greater than the recipient's, subrecipient's, other donor's or third party's is required. In the event the recipient chooses not to require marking with its own identity or logo by the subrecipient, USAID may, at its discretion, require marking by the subrecipient with the USAID Identity."

E. Participating Institution agrees not to use the name of University or its employees in any advertisement, press release, or publicity notice with reference to this Agreement or any product or service resulting from this Agreement without sending an informational copy to University at the time of release or publication. Participating Institution will acknowledge USAID's and University's support in its above-defined publications, disclosures, disseminations, advertisements, press releases, and publicity notices unless USAID desires otherwise and so advises University, who in turn shall advise Participating Institution.

F. Subject to its legal ability to do so, Participating Institution hereby grants University license to use data created in the performance of this Agreement.

G. Participating Institution hereby grants to University an irrevocable, royalty-free, non-transferable, non-exclusive right and license to reproduce, make derivative works, display, and perform publicly any copyrightable or copyrighted material (including any computer software and its documentation and/or database) developed and delivered under this Agreement.

24. Prime Agreement Provisions. The following provisions of the Prime Agreement, suitably modified as follows, are hereby incorporated by reference and carry the same force and effect as if included in full text:

Recipient shall mean Participating Institution

C. Article M6. Subagreements (June 2012)
D. Article M8, USAID Eligibility Rules for Goods and Services (June 2012)
E. Article M11, Equal Participation By Faith-Based Organizations (June 2012)
F. Article M12, Preventing Terrorist Financing (August 2013)
G. Article M17, Travel and International Air Transportation (August 2013)
H. Article M20, Trafficking in Persons (June 2012)
I. Article M22, Limiting Construction Activities (August 2013)
J. Article RAA12, Reporting host Government Taxes (June 2012)
K. Article RAA25, Human Rights Violations and Sanctions Program in Burma (June 2015)
L. Article RAA24, Protecting Life in Global Health Assistance (May 2017)

25. Entire Agreement. The terms and conditions contained herein and in the following attachments constitute the entire Agreement between **The Regents of the University of California** and **Georgetown University:**

Exhibit A – Prime Agreement
Exhibit B – Scope of Work
Exhibit C – Subaward Budget
Exhibit D – Mini-Audit Questionnaire
Exhibit E – Mandatory Flow-Down Provisions for U.S. Subcontractors
Exhibit F – Mandatory Flow-Down Provisions for Foreign Subcontractors
Exhibit G – Prohibition of Salary Supplements with PREDICT-2 Funds

IN WITNESS WHEREOF, the Parties have caused this contract to be effective as of the date specified in Article III above with signatory approval of their duly authorized representatives.

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA	**GEORGETOWN UNIVERSITY**
By: _____	By: _____
Paula Noble	Name:
Contracts and Grants Officer	Title:
Date: _____	Date: _____

SCOPE OF WORK

O'Neill Institute at Georgetown University

The O'Neill Institute at Georgetown University will work together with individuals in the GVP Ethical, Legal and Social Implications (ELSI) Working Group to assess the political feasibility of the Global Virome Project (GVP) through identifying laws, regulations & policies in selected key countries and determine foreseeable political positions & obstacles based on existing framework for sharing samples, genetic sequencing and research findings. Additionally, the Institute to will describe the interaction with health systems strengthening, financing, and R&D for neglected diseases, as well as identify models for division of labor and coordination among stakeholders.

The O'Neill Institute will use an adaptive management, collaborative working method. Specific tasks may be assigned to individual members according to task scope and member expertise. They will communicate closely with the GVP core steering committee and will routinely report goals and deliverables, progress towards stated goals and deliverables and agree-upon metrics for its activities. Deliverables include, but are not limited to semi-annual reports on the analysis of legal, regulatory, social, ethical and community issues either impacting GVP or developments that may influence GVP in the future, documents on governance models to effectively manage the GVP, reports on recommendations for action to work effectively in target communities in participating countries and presentation materials relevant to the project launch in 2018.

Members of the O'Neill Institute have voluntarily participated in GVP as members of the ELSI Working Group since 2016, and therefore have a thorough understanding of the objectives and rationale for GVP, as well as anticipated legal, ethical and social challenges that GVP will address. Since the scope of work requires a thorough understanding of GVP together with a high level of legal expertise, the GVP steering committee proposes the O'Neill Institute to carry out this work.

Staff	Cost/Month	# Months	Total Cost
Mehgan Gallagher - 12%	$ 1,258	6	$ 7,548
John Monohan - 2%	$ 452	6	$ 2,712
Rebecca Katz - 3%	$ 961	6	$ 5,766
Legal Research Assistants (45 hours/month)	$ 761	6	$ 4,566
Expert Legal Consultant	$ 150	6	$ 900
		Subtotal Personnel	*$ 21,492*
		55% Indirects	$ 11,821
		TOTAL	**$ 33,313**

MINI-AUDIT QUESTIONNAIRE

The purpose of this questionnaire is to help us determine your organization's fiscal responsibility.

Section A – Organizational Data

Name of Organization: _____

DUNS Number: _____ Year Established: _____ Organization Address: _____

Number of Employees: Full Time: _____ Part Time: _____ _____

Performance Site (if different): _____

Section B – Financial Status & Cash Management

1. Does your organization have its financial statements reviewed by an independent public accounting firm? ☐Yes ☐No

   If no, move to question 2. If yes, answer questions below.

   Date of last financial Audit: _____ Fiscal Period Audited: _____

   Audit firm: _____

   Was the auditor's Opinion on Financial Statements Qualified? ☐ Yes ☐ No

2. Other than financial statements, has any aspect of your organization's activities been audited within the last two years by a governmental agency or independent public accountant? ☐Yes ☐No If yes, please explain.

3. Are duties separated so that no one individual has complete authority over an entire financial transaction? ☐Yes ☐No

4. Are controls in place to prevent expenditure of funds in excess of approved, budgeted amounts? ☐Yes ☐No

5. Are Federal contract/grant funds deposited in a separate bank account? ☐Yes ☐No

   If a separate bank account is not maintained, can the Federal funds and expenses be readily identified? ☐Yes ☐No

6. Are all disbursements properly documented with evidence of receipt of goods or performance of services? ☐Yes ☐No

7. Are all bank accounts reconciled monthly? ☐Yes ☐No

Section C – Payroll, Procurement, Property Management

8. Are payroll charges checked against program budgets? ☐Yes ☐No

9. What system does your organization use to control paid time, especially time charged to sponsored agreements?

10. Are there procedures to ensure procurement at competitive prices? ☐Yes ☐No

11. Is there an effective system of authorization and approval of:

    Capital equipment expenditures? ☐Yes ☐No

    Travel expenditures? ☐Yes ☐No

12. Are detailed records of individual capital assets kept and periodically balanced with the general ledger accounts? ☐Yes ☐No

13. Are there procedures for authorizing and accounting for the disposal of property and equipment? ☐Yes ☐No

14. Are detailed property records periodically checked by physical inventory? ☐Yes ☐No

15. Briefly describe the organization's policies concerning capitalization and depreciation.

Section D – Cost Transfers, Indirect Costs, Cost Sharing

16. How does the organization ensure that all cost transfers are legitimate and appropriate?

17. Does the organization have an indirect cost allocation plan or a negotiated indirect cost rate? ☐Yes ☐No
Explain.

18. Does the organization have procedures which provide assurance that consistent treatment is applied in the distribution of charges to all grants? ☐Yes ☐No

19. How does the organization determine that it has met cost-sharing goals?

Section E – Compliance

20. Does your organization engage in any lobbying or partisan political activity which is charged, directly or indirectly, to a federally-assisted program? ☐Yes ☐No

21. Does your organization have a formal policy of nondiscrimination and a formal system for complying with Federal civil rights requirements? ☐Yes ☐No

22. Does your organization have cash forecasting process which will minimize the time elapsed between the drawing down of funds and the disbursement of those funds? ☐Yes ☐No

23. Is your organization familiar with Federal financial reports so that they will be completed in an accurate and timely manner when required? ☐Yes ☐No

24. Under which program(s), if any, does your organization receive Federal Student Financial Assistance Funds?

25. What was the dollar volume of Federal awards to your organization during the last fiscal year?

26. Registered in SAM.gov? ☐ Yes ☐ No

I certify that all necessary human subject, animal subject, and/or environmental health and safety approvals have been obtained prior to conducting work that requires such approvals. I certify to the best of my knowledge and belief that the foregoing statements are true and accurate.

Signature: _____ Title: _____

Name: _____ Date: _____

**Any references to "this award" in this Appendix shall be understood to refer to the cooperative agreement (AID-OAA-A-14-00102) received by the University of California, Davis from the US Agency for International Development (USAID) for the PREDICT-2 project. Any questions regarding the terms and conditions or information included in the prime agreement should be directed to the Purchaser.*

M6. SUBAWARDS AND CONTRACTS (DECEMBER 2014)

a. Subawardees and contractors have no relationship with USAID under the terms of this award. All required USAID approvals must be directed through the recipient to USAID.

b. Notwithstanding any other term of this award, subawardees and contractors have no right to submit claims directly to USAID and USAID assumes no liability for any third party claims against the recipient.

[END OF PROVISION]

M8. USAID ELIGIBILITY RULES FOR GOODS AND SERVICES (JUNE 2012)

a. This provision is not applicable to commodities or services that the recipient provides with private funds as part of a cost-sharing requirement, or with Program Income generated under this award.

b. Ineligible and Restricted Commodities and Services:

(1) Ineligible Commodities and Services. The recipient must not, under any circumstances, procure any of the following under this award:

(i) Military equipment,
(ii) Surveillance equipment,
(iii) Commodities and services for support of police or other law enforcement activities,
(iv) Abortion equipment and services,
(v) Luxury goods and gambling equipment, or
(vi) Weather modification equipment.

(2) Ineligible Suppliers. Any firms or individuals that do not comply with the requirements in Standard Provision, "Debarment, Suspension and Other Responsibility Matters" and Standard Provision, "Preventing Terrorist Financing" must not be used to provide any commodities or services funded under this award.

(3) Restricted Commodities. The recipient must obtain prior written approval of the Agreement Officer (AO) or comply with required procedures under an applicable waiver, as provided by the AO when procuring any of the following commodities:

(i) Agricultural commodities,

(ii) Motor vehicles,
(iii) Pharmaceuticals,
(iv) Pesticides,
(v) Used equipment,
(vi) U.S. Government-owned excess property, or
(vii) Fertilizer.

c. Source and Nationality:

Except as may be specifically approved in advance by the AO, all commodities and services that will be reimbursed by USAID under this award must be from the authorized geographic code specified in this award and must meet the source and nationality requirements set forth in 22 CFR 228. If the geographic code is not specified, the authorized geographic code is 937. When the total value of procurement for commodities and services during the life of this award is valued at $250,000 or less, the authorized geographic code for procurement of all goods and services to be reimbursed under this award is code 935. For a current list of countries within each geographic code, see: **http://www.usaid.gov/ads/policy/300/310**.

d. Guidance on the eligibility of specific commodities and services may be obtained from the AO. If USAID determines that the recipient has procured any commodities or services under this award contrary to the requirements of this provision, and has received payment for such purposes, the AO may require the recipient to refund the entire amount of the purchase.

e. This provision must be included in all subawards and contracts which include procurement of commodities or services.

[END OF PROVISION]

M12. PREVENTING TERRORIST FINANCING -- IMPLEMENTATION OF E.O. 13224 (AUGUST 2013)

a. The recipient must not engage in transactions with, or provide resources or support to, individuals and organizations associated with terrorism, including those individuals or entities that appear on the Specially Designated Nationals and Blocked Persons List maintained by the U.S. Treasury (online at: **http://www.treasury.gov/resource- center/sanctions/SDN-List/Pages/default.aspx**) or the United Nations Security designation list (online at: **http://www.un.org/sc/committees/1267/aq_sanctions_list.shtml**).

b. This provision must be included in all subawards and contracts issued under this award.

[END OF PROVISION]

M17. TRAVEL AND INTERNATIONAL AIR TRANSPORTATION (DECEMBER 2014)

a. TRAVEL COSTS

All travel costs must comply with the applicable cost principles and must be consistent with those normally allowed in like circumstances in the recipient's non-USAID-funded activities. Costs incurred by employees and officers for travel, including air fare, costs of lodging, other subsistence, and incidental expenses, may be considered reasonable and allowable only to the extent such costs do not exceed reasonable charges normally allowed by the recipient in its regular operations as the result of the recipient organization's written travel policy and are within the limits established by the applicable cost principles.

In the absence of a reasonable written policy regarding international travel costs, the standard for determining the reasonableness of reimbursement for international travel costs will be the Standardized Regulations (Government Civilians, Foreign Areas), published by the U.S. Department of State, as from time to time amended. The most current Standardized Regulations on international travel costs may be obtained from the AO. In the event that the cost for air fare exceeds the customary standard commercial airfare (coach or equivalent) or the lowest commercial discount airfare, the recipient must document one of the allowable exceptions from the applicable cost principles.

b. FLY AMERICA ACT RESTRICTIONS

(1) The recipient must use U.S. Flag Air Carriers for all international air transportation (including personal effects) funded by this award pursuant to the Fly America Act and its implementing regulations to the extent service by such carriers is available.

(2) In the event that the recipient selects a carrier other than a U.S. Flag Air Carrier for international air transportation, in order for the costs of such international air transportation to be allowable, the recipient must document such transportation in accordance with this provision and maintain such documentation pursuant to the Standard Provision, "Accounting, Audit and Records." The documentation must use one of the following reasons or other exception under the Fly America Act:

(i) The recipient uses a European Union (EU) flag air carrier, which is an airline operating from an EU country that has signed the US-EU "Open Skies" agreement (http://www.state.gov/e/eb/rls/othr/ata/i/ic/170684.htm).

(ii) Travel to or from one of the following countries on an airline of that country when no city pair fare is in effect for that leg (see http://apps.fas.gsa.gov/citypairs/search/):

a. Australia on an Australian airline,
b. Switzerland on a Swiss airline, or
c. Japan on a Japanese airline;

(iii) Only for a particular leg of a route on which no US Flag Air Carrier provides service on that route;

(iv) For a trip of 3 hours or less, the use of a US Flag Air Carrier at least doubles the travel time;

(v) If the US Flag Air Carrier offers direct service, use of the US Flag Air Carrier would increase the travel time by more than 24 hours; or

(vi) If the US Flag Air Carrier does not offer direct service,

a. Use of the US Flag Air Carrier increases the number of aircraft changes by 2 or more,

b. Use of the US Flag Air Carrier extends travel time by 6 hours or more, or

c. Use of the US Flag Air Carrier requires a layover at an overseas interchange of 4 hours or more.

c. DEFINITIONS

The terms used in this provision have the following meanings:

(1) "Travel costs" means expenses for transportation, lodging, subsistence (meals and incidentals), and related expenses incurred by employees who are on travel status on official business of the recipient for any travel outside the country in which the organization is located. "Travel costs" do not include expenses incurred by employees who are not on official business of the recipient, such as rest and recuperation (R&R) travel offered as part of an employee's benefits package that are consistent with the recipient's personnel and travel policies and procedures.

(2) "International air transportation" means international air travel by individuals (and their personal effects) or transportation of cargo by air between a place in the United States and a place outside thereof, or between two places both of which are outside the United States.

(3) "U.S. Flag Air Carrier" means an air carrier on the list issued by the U.S. Department of Transportation at http://ostpxweb.dot.gov/aviation/certific/certlist.htm. U.S. Flag Air Carrier service also includes service provided under a code share agreement with another air carrier when the ticket, or documentation for an electronic ticket, identifies the U.S. flag air carrier's designator code and flight number.

(4) For this provision, the term "United States" includes the fifty states, Commonwealth of Puerto Rico, possessions of the United States, and the District of Columbia.

d. SUBAWARDS AND CONTRACTS

This provision must be included in all subawards and contracts under which this award will finance international air transportation.

[END OF PROVISION]

M18. OCEAN SHIPMENT OF GOODS (JUNE 2012)

a. Prior to contracting for ocean transportation to ship goods purchased or financed with USAID funds under this award, the recipient must contact the office below to determine the flag and class of vessel to be used for shipment:

U.S. Agency for International Development,
Bureau for Management
Office of Acquisition and Assistance, Transportation Division
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Email: oceantransportation@usaid.gov

b. This provision must be included in all subawards and contracts.

[END OF PROVISION]

M20. TRAFFICKING IN PERSONS (JULY 2015)

a. The recipient, subawardee, or contractor, at any tier, or their employees, labor recruiters, brokers or other agents, must not engage in:

(1) Trafficking in persons (as defined in the Protocol to Prevent, Suppress, and Punish Trafficking in Persons, especially Women and Children, supplementing the UN Convention against Transnational Organized Crime) during the period of this award;

(2) Procurement of a commercial sex act during the period of this award; or

(3) Use of forced labor in the performance of this award.

(4) Acts that directly support or advance trafficking in persons, including the following acts:

i. Destroying, concealing, confiscating, or otherwise denying an employee access to that employee's identity or immigration documents;

ii. Failing to provide return transportation or pay for return transportation costs to an employee from a country outside the United States to the country from which the employee was recruited upon the end of employment if requested by the employee, unless:

a) exempted from the requirement to provide or pay for such return transportation by USAID under this award; or

b) the employee is a victim of human trafficking seeking victim services or legal redress in the country of employment or a witness in a human trafficking enforcement action;

iii. Soliciting a person for the purpose of employment, or offering employment, by means of materially false or fraudulent pretenses, representations, or promises regarding that employment;

iv. Charging employees recruitment fees ; or

v. Providing or arranging housing that fails to meet the host country housing and safety standards.

b. In the event of a violation of section (a) of this provision, USAID is authorized to terminate this award, without penalty, and is also authorized to pursue any other remedial actions authorized as stated in section 1704(c) of the National Defense Authorization Act for Fiscal Year 2013 (Pub. L. 112-239, enacted January 2, 2013).

c. For awards that exceed an estimated value of $500,000, the recipient must submit to the Agreement Officer, the annual "Certification regarding Trafficking in Persons, Implementing Title XVII of the National Defense Authorization Act for Fiscal Year 2013" as required prior to this award, and must implement a compliance plan to prevent the activities described above in section (a) of this provision. The recipient must provide a copy of the compliance plan to the Agreement Officer upon request and must post the useful and relevant contents of the plan or related materials on its website (if one is maintained) and at the workplace.

d. The recipient's compliance plan must be appropriate to the size and complexity of the award and to the nature and scope of the activities to be performed. The plan must include, at a minimum, the following:

(1) An awareness program to inform employees about the trafficking related prohibitions included in this provision, the activities prohibited and the action that will be taken against the employee for violations.

(2) A reporting process for employees to report, without fear of retaliation, activity inconsistent with the policy prohibiting trafficking, including a means to make available to all employees the Global Human Trafficking Hotline at 1-844-888-FREE and its e-mail address at **help@befree.org**.

(3) A recruitment and wage plan that only permits the use of recruitment companies with trained employees, prohibits charging of recruitment fees to the employee, and ensures that wages meet applicable host-country legal requirements or explains any variance.

(4)) A housing plan, if the recipient or any subawardee intends to provide or arrange housing. The housing plan is required to meet any host-country housing and safety standards.

(5) Procedures for the recipient to prevent any agents or subawardee at any tier and at any dollar value from engaging in trafficking in persons activities described in section a of this provision. The recipient must also have procedures to monitor, detect, and terminate any agents or subawardee or subawardee employees that have engaged in such activities.

e. If the Recipient receives any credible information from any source that alleges that the recipient, contractor, subawardee, or agent has engaged in any of the prohibited activities identified in this provision, the recipient must immediately notify the cognizant Agreement Officer and the USAID Office of the Inspector General; and must fully cooperate with any Federal agencies responsible for audits, investigations, or corrective actions relating to trafficking in persons.

f. The Agreement Officer may direct the Recipient to take specific steps to abate an alleged violation or enforce the requirements of a compliance plan.

g. For purposes of this provision, "employee" means an individual who is engaged in the performance of this award as a direct employee, consultant, or volunteer of the recipient or any subrecipient.

[END OF PROVISION]

M22. LIMITING CONSTRUCTION ACTIVITIES (AUGUST 2013)

a) Construction is not eligible for reimbursement under this award unless specifically identified in paragraph d) below.

b) Construction means —construction, alteration, or repair (including dredging and excavation) of buildings, structures, or other real property and includes, without limitation, improvements, renovation, alteration and refurbishment. The term includes, without limitation, roads, power plants, buildings, bridges, water treatment facilities, and vertical structures.

c) Agreement Officers will not approve any subawards or procurements by recipients for construction activities that are not listed in paragraph d) below. USAID will reimburse allowable costs for only the construction activities listed in this provision not to exceed the amount specified in the construction line item of the award budget. The recipient must receive prior written approval from the AO to transfer funds allotted for construction activities to other cost categories, or vice versa.

d) Description
Construction is not eligible for reimbursement under this award.

e) The recipient must include this provision in all subawards and procurements and make vendors providing services under this award and subrecipients aware of the restrictions of this provision.

[END OF PROVISION]

M24. PILOT PROGRAM FOR ENHANCEMENT OF GRANTEE EMPLOYEE WHISTLEBLOWER PROTECTIONS (SEPTEMBER 2014)

The requirement to comply with and inform all employees of the "Pilot Program for Enhancement of Contractor Employee Whistleblower Protections" is retroactively effective for all assistance awards and subawards (including subcontracts) issued beginning July 1, 2013.

The Grantee must:

1. Inform its employees working under this award in the predominant native language of the workforce that they are afforded the employee whistleblower rights and protections provided under 41 U.S.C. § 4712; and

2. Include such requirement in any subaward or subcontract made under this award.

41 U.S.C. § 4712 states that an employee of a Grantee may not be discharged, demoted, or otherwise discriminated against as a reprisal for "whistleblowing." In addition, whistleblower protections cannot be waived by any agreement, policy, form, or condition of employment.

Whistleblowing is defined as making a disclosure "that the employee reasonably believes" is evidence of any of the following:

- Gross mismanagement of a Federal contract or grant;
- A gross waste of Federal funds;
- An abuse of authority relating to a Federal contract or grant;
- A substantial and specific danger to public health or safety; or
- A violation of law, rule, or regulation related to a Federal contract or grant (including the competition for, or negotiation of, a contract or grant).

To qualify under the statute, the employee's disclosure must be made to:

- A Member of the U.S. Congress, or a representative of a U.S. Congressional Committee;
- A cognizant U.S. Inspector General;
- The U.S. Government Accountability Office;
- A Federal employee responsible for contract or grant oversight or management at the relevant agency;
- A U.S. court or grand jury; or,
- A management official or other employee of the Grantee who has the responsibility to investigate, discover, or address misconduct.

[End of Provision]

M28. MANDATORY DISCLOSURES (July 2015)

Consistent with 2 CFR §200.113, applicants and recipients must disclose, in a timely manner, in writing to the USAID Office of the Inspector General, with a copy to the cognizant Agreement Officer, all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award. Subrecipients must disclose, in a timely manner, in writing to the USAID Office of the Inspector General and to the prime recipient (pass through entity) all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award.

Disclosures must be sent to:
U.S. Agency for International Development
Office of the Inspector General
P.O. Box 657 Washington, DC 20044-0657
Phone: 1-800-230-6539 or 202-712-1023
Email: ig.hotline@usaid.gov
URL: https://oig.usaid.gov/content/usaid-contractor-reporting-form.

Failure to make required disclosures can result in any of the remedies described in 2 CFR §200.338 Remedies for noncompliance, including suspension or debarment (See 2 CFR 180, 2 CFR 780 and 31 U.S.C. 3321).

The recipient must include this mandatory disclosure requirement in all subawards and contracts under this award.

[End of Provision]

[END OF MANDATORY PROVISIONS]

REQUIRED AS APPLICABLE STANDARD PROVISIONS FOR U.S. NONGOVERNMENTAL ORGANIZATIONS

RAA11. INVESTMENT PROMOTION (NOVEMBER 2003)

a. Except as specifically set forth in this award or otherwise authorized by USAID in writing, no funds or other support provided hereunder may be used for any activity that involves investment promotion in a foreign country.

b. In the event the recipient is requested or wishes to provide assistance in the above area or requires clarification from USAID as to whether the activity would be consistent with the limitation set forth above, the recipient must notify the Agreement Officer and provide a detailed description of the proposed activity. The recipient must not proceed with the activity until advised by USAID that it may do so.

c. The recipient must ensure that its employees and subrecipients and contractors providing investment promotion services hereunder are made aware of the restrictions set forth in this clause and must include this clause in all contracts and other subawards and contracts entered into hereunder.

[END OF PROVISION]

RAA12. REPORTING HOST GOVERNMENT TAXES (DECEMBER 2014)

a. By April 16 of each year, the recipient must submit a report containing:

(1) Contractor/recipient name.

(2) Contact name with phone, fax and e-mail.

(3) Agreement number(s).

(4) The total amount of value-added taxes and customs duties (but not sales taxes) assessed by the host government (or any entity thereof) on purchases in excess of
$500 per transaction of supplies, materials, goods or equipment, during the 12 months ending on the preceding September 30, using funds provided under this contract/agreement.

(5) Any reimbursements received by April 1 of the current year on value-added taxes and customs duties reported in (iv).

(6) Reports are required even if the recipient did not pay any taxes or receive any reimbursements during the reporting period.

(7) Cumulative reports may be provided if the recipient is implementing more than one program in a foreign country.

b. Submit the reports to: Harish Ramroop via email at hramroop@usaid.gov or via snail mail at:

Harish Ramroom
USAID
M/CFO/CMP, Room 435-I, SA-44
1300 Pennsylvania Avenue, N.W.
Washington, DC 20523

c. Host government taxes are not allowable where the Agreement Officer provides the necessary means to the recipient to obtain an exemption or refund of such taxes, and the recipient fails to take reasonable steps to obtain such exemption or refund. Otherwise, taxes are allowable in accordance with the Standard Provision, "Allowable Costs," and must be reported as required in this provision.

d. The recipient must include this reporting requirement in all applicable subawards and contracts.

[END OF PROVISION]

**Any references to "this award" in this Appendix shall be understood to refer to the cooperative agreement (AID-OAA-A-14-00102) received by the University of California, Davis from the US Agency for International Development (USAID) for the PREDICT-2 project. Any questions regarding the terms and conditions or information included in the prime agreement should be directed to the Purchaser.*

M6. SUBAWARDS AND CONTRACTS (DECEMBER 2014)

a. Subawardees and contractors have no relationship with USAID under the terms of this award. All required USAID approvals must be directed through the recipient to USAID.

b. Notwithstanding any other term of this award, subawardees and contractors have no right to submit claims directly to USAID and USAID assumes no liability for any third party claims against the recipient.

[END OF PROVISION]

M8. USAID ELIGIBILITY RULES FOR GOODS AND SERVICES (JUNE 2012)

a. This provision is not applicable to commodities or services that the recipient provides with private funds as part of a cost-sharing requirement, or with Program Income generated under this award.

b. Ineligible and Restricted Commodities and Services:

(1) Ineligible Commodities and Services. The recipient must not, under any circumstances, procure any of the following under this award:

(i) Military equipment,
(ii) Surveillance equipment,
(iii) Commodities and services for support of police or other law enforcement activities,
(iv) Abortion equipment and services,
(v) Luxury goods and gambling equipment, or
(vi) Weather modification equipment.

(2) Ineligible Suppliers. Any firms or individuals that do not comply with the requirements in Standard Provision, "Debarment, Suspension and Other Responsibility Matters" and Standard Provision, "Preventing Terrorist Financing" must not be used to provide any commodities or services funded under this award.

(3) Restricted Commodities. The recipient must obtain prior written approval

of the Agreement Officer (AO) or comply with required procedures under an applicable waiver, as provided by the AO when procuring any of the following commodities:

(i) Agricultural commodities,
(ii) Motor vehicles,
(iii) Pharmaceuticals,
(iv) Pesticides,
(v) Used equipment,
(vi) U.S. Government-owned excess property, or
(vii) Fertilizer.

c. Source and Nationality:
Except as may be specifically approved in advance by the AO, all commodities and services that will be reimbursed by USAID under this award must be from the authorized geographic code specified in this award and must meet the source and nationality requirements set forth in 22 CFR 228. If the geographic code is not specified, the authorized geographic code is 937. When the total value of procurement for commodities and services during the life of this award is valued at $250,000 or less, the authorized geographic code for procurement of all goods and services to be reimbursed under this award is code 935. For a current list of countries within each geographic code, see: **http://www.usaid.gov/ads/policy/300/310**.

d. Guidance on the eligibility of specific commodities and services may be obtained from the AO. If USAID determines that the recipient has procured any commodities or services under this award contrary to the requirements of this provision, and has received payment for such purposes, the AO may require the recipient to refund the entire amount of the purchase.

e. This provision must be included in all subawards and contracts which include procurement of commodities or services.

[END OF PROVISION]

M12. PREVENTING TERRORIST FINANCING -- IMPLEMENTATION OF E.O. 13224 (AUGUST 2013)

a. The recipient must not engage in transactions with, or provide resources or support to, individuals and organizations associated with terrorism, including those individuals or entities that appear on the Specially Designated Nationals and Blocked Persons List maintained by the U.S. Treasury (online at: **http://www.treasury.gov/resource-center/sanctions/SDN-List/Pages/default.aspx**) or the United Nations Security designation list (online at: **http://www.un.org/sc/committees/1267/aq_sanctions_list.shtml**).

b. This provision must be included in all subawards and contracts issued under this

award.

[END OF PROVISION]

M17. TRAVEL AND INTERNATIONAL AIR TRANSPORTATION (DECEMBER 2014)

a. TRAVEL COSTS

All travel costs must comply with the applicable cost principles and must be consistent with those normally allowed in like circumstances in the recipient's non-USAID-funded activities. Costs incurred by employees and officers for travel, including air fare, costs of lodging, other subsistence, and incidental expenses, may be considered reasonable and allowable only to the extent such costs do not exceed reasonable charges normally allowed by the recipient in its regular operations as the result of the recipient organization's written travel policy and are within the limits established by the applicable cost principles.

In the absence of a reasonable written policy regarding international travel costs, the standard for determining the reasonableness of reimbursement for international travel costs will be the Standardized Regulations (Government Civilians, Foreign Areas), published by the U.S. Department of State, as from time to time amended. The most current Standardized Regulations on international travel costs may be obtained from the AO. In the event that the cost for air fare exceeds the customary standard commercial airfare (coach or equivalent) or the lowest commercial discount airfare, the recipient must document one of the allowable exceptions from the applicable cost principles.

b. FLY AMERICA ACT RESTRICTIONS

(1) The recipient must use U.S. Flag Air Carriers for all international air transportation (including personal effects) funded by this award pursuant to the Fly America Act and its implementing regulations to the extent service by such carriers is available.

(2) In the event that the recipient selects a carrier other than a U.S. Flag Air Carrier for international air transportation, in order for the costs of such international air transportation to be allowable, the recipient must document such transportation in accordance with this provision and maintain such documentation pursuant to the Standard Provision, "Accounting, Audit and Records." The documentation must use one of the following reasons or other exception under the Fly America Act:

(i) The recipient uses a European Union (EU) flag air carrier, which is an airline operating from an EU country that has signed the US-EU "Open Skies" agreement (http://www.state.gov/e/eb/rls/othr/ata/i/ic/170684.htm).

(ii) Travel to or from one of the following countries on an airline of that

country when no city pair fare is in effect for that leg (see http://apps.fas.gsa.gov/citypairs/search/):

a. Australia on an Australian airline,
b. Switzerland on a Swiss airline, or
c. Japan on a Japanese airline;

(iii) Only for a particular leg of a route on which no US Flag Air Carrier provides service on that route;

(iv) For a trip of 3 hours or less, the use of a US Flag Air Carrier at least doubles the travel time;

(v) If the US Flag Air Carrier offers direct service, use of the US Flag Air Carrier would increase the travel time by more than 24 hours; or

(vi) If the US Flag Air Carrier does not offer direct service,

a. Use of the US Flag Air Carrier increases the number of aircraft changes by 2 or more,

b. Use of the US Flag Air Carrier extends travel time by 6 hours or more, or

c. Use of the US Flag Air Carrier requires a layover at an overseas interchange of 4 hours or more.

c. DEFINITIONS

The terms used in this provision have the following meanings:

(1) "Travel costs" means expenses for transportation, lodging, subsistence (meals and incidentals), and related expenses incurred by employees who are on travel status on official business of the recipient for any travel outside the country in which the organization is located. "Travel costs" do not include expenses incurred by employees who are not on official business of the recipient, such as rest and recuperation (R&R) travel offered as part of an employee's benefits package that are consistent with the recipient's personnel and travel policies and procedures.

(2) "International air transportation" means international air travel by individuals (and their personal effects) or transportation of cargo by air between a place in the United States and a place outside thereof, or between two places both of which are outside the United States.

(3) "U.S. Flag Air Carrier" means an air carrier on the list issued by the U.S. Department of Transportation at http://ostpxweb.dot.gov/aviation/certific/certlist.htm. U.S. Flag Air Carrier

service also includes service provided under a code share agreement with another air carrier when the ticket, or documentation for an electronic ticket, identifies the U.S. flag air carrier's designator code and flight number.

(4) For this provision, the term "United States" includes the fifty states, Commonwealth of Puerto Rico, possessions of the United States, and the District of Columbia.

d. SUBAWARDS AND CONTRACTS

This provision must be included in all subawards and contracts under which this award will finance international air transportation.

[END OF PROVISION]

M18. OCEAN SHIPMENT OF GOODS (JUNE 2012)

APPLICABILITY: *This provision is applicable for awards and subawards for which the recipient contracts for ocean transportation for goods purchased or financed with USAID funds. In accordance with 22 CFR 228.21, ocean transportation shipments are subject to the provisions of 46 CFR Part 381.*

OCEAN SHIPMENT OF GOODS (JUNE 2012)

a. Prior to contracting for ocean transportation to ship goods purchased or financed with USAID funds under this award, the recipient must contact the office below to determine the flag and class of vessel to be used for shipment:

U.S. Agency for International Development,
Bureau for Management
Office of Acquisition and Assistance, Transportation Division
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Email: **oceantransportation@usaid.gov**

b. This provision must be included in all subawards and contracts.

[END OF PROVISION]

M20. TRAFFICKING IN PERSONS (April 2016)

a. The recipient, subawardee, or contractor, at any tier, or their employees, labor recruiters, brokers or other agents, must not engage in:

(1) Trafficking in persons (as defined in the Protocol to Prevent, Suppress,

and Punish Trafficking in Persons, especially Women and Children, supplementing the UN Convention against Transnational Organized Crime) during the period of this award;

(2) Procurement of a commercial sex act during the period of this award;

(3) Use of forced labor in the performance of this award;

(4) Acts that directly support or advance trafficking in persons, including the following acts:

i. Destroying, concealing, confiscating, or otherwise denying an employee access to that employee's identity or immigration documents;

ii. Failing to provide return transportation or pay for return transportation costs to an employee from a country outside the United States to the country from which the employee was recruited upon the end of employment if requested by the employee, unless:

a) exempted from the requirement to provide or pay for such return transportation by USAID under this award; or

b) the employee is a victim of human trafficking seeking victim services or legal redress in the country of employment or a witness in a human trafficking enforcement action;

iii. Soliciting a person for the purpose of employment, or offering employment, by means of materially false or fraudulent pretenses, representations, or promises regarding that employment;

iv. Charging employees recruitment fees; or

v. Providing or arranging housing that fails to meet the host country housing and safety standards.

b. In the event of a violation of section (a) of this provision, USAID is authorized to terminate this award, without penalty, and is also authorized to pursue any other remedial actions authorized as stated in section 1704(c) of the National Defense Authorization Act for Fiscal Year 2013 (Pub. L. 112-239, enacted January 2, 2013).

c. If the estimated value of services required to be performed under the award outside the United States exceeds $500,000, the recipient must submit to the Agreement Officer, the annual "Certification regarding Trafficking in Persons, Implementing Title XVII of the National Defense Authorization Act for Fiscal Year 2013" as required prior to this award, and must implement a compliance plan to prevent the activities described above in section (a) of this provision. The recipient must provide a copy of the compliance plan to the Agreement Officer upon request and must post the useful and relevant contents of the plan or related materials on its website

(if one is maintained) and at the workplace.

d. The recipient's compliance plan must be appropriate to the size and complexity of the award and to the nature and scope of the activities, including the number of non-United States citizens expected to be employed. The plan must include, at a minimum, the following:

(1) An awareness program to inform employees about the trafficking related prohibitions included in this provision, the activities prohibited and the action that will be taken against the employee for violations.

(2) A reporting process for employees to report, without fear of retaliation, activity inconsistent with the policy prohibiting trafficking, including a means to make available to all employees the Global Human Trafficking Hotline at 1-844-888-FREE and its e-mail address at help@befree.org.

(3) A recruitment and wage plan that only permits the use of recruitment companies with trained employees, prohibits charging of recruitment fees to the employee, and ensures that wages meet applicable host-country legal requirements or explains any variance.

(4) A housing plan, if the recipient or any subawardee intends to provide or arrange housing. The housing plan is required to meet any host-country housing and safety standards.

(5) Procedures for the recipient to prevent any agents or subawardee at any tier and at any dollar value from engaging in trafficking in persons activities described in section a of this provision. The recipient must also have procedures to monitor, detect, and terminate any agents or subawardee or subawardee employees that have engaged in such activities.

e. If the Recipient receives any credible information regarding a violation listed in section a(1)-(4) of this provision, the recipient must immediately notify the cognizant Agreement Officer and the USAID Office of the Inspector General; and must fully cooperate with any Federal agencies responsible for audits, investigations, or corrective actions relating to trafficking in persons.

f. The Agreement Officer may direct the Recipient to take specific steps to abate an alleged violation or enforce the requirements of a compliance plan.

g. For purposes of this provision, "employee" means an individual who is engaged in the performance of this award as a direct employee, consultant, or volunteer of the recipient or any subrecipient.

h. The recipient must include in all subawards and contracts a provision prohibiting the conduct described in section a(1)-(4) by the subrecipient, contractor, or any of their employees, or any agents. The recipient must also include a provision authorizing the recipient to terminate the award as described in section b of this

provision.

[END OF PROVISION]

M22. LIMITING CONSTRUCTION ACTIVITIES (AUGUST 2013)

APPLICABILITY: *In accordance with the policy at ADS 303.3.30, AOs must include this provision in all solicitations and awards. When no construction activities are contemplated under the award, the AO must insert "*Construction is not eligible for reimbursement under this award*" in section d) of this provision. If the award permits construction activities based on the policy above (or as authorized by waiver), the AO must insert the description and location(s) of the specific construction activities in section d) of this provision. The AO must not make a general reference to the Program Description. The AO must also ensure that there is a specific line item for construction activities in the award budget.*

LIMITING CONSTRUCTION ACTIVITIES (AUGUST 2013)

a) Construction is not eligible for reimbursement under this award unless specifically identified in paragraph d) below.

b) Construction means —construction, alteration, or repair (including dredging and excavation) of buildings, structures, or other real property and includes, without limitation, improvements, renovation, alteration and refurbishment. The term includes, without limitation, roads, power plants, buildings, bridges, water treatment facilities, and vertical structures.

c) Agreement Officers will not approve any subawards or procurements by recipients for construction activities that are not listed in paragraph d) below. USAID will reimburse allowable costs for only the construction activities listed in this provision not to exceed the amount specified in the construction line item of the award budget. The recipient must receive prior written approval from the AO to transfer funds allotted for construction activities to other cost categories, or vice versa.

d) Description
Construction is not eligible under this award.

e) The recipient must include this provision in all subawards and procurements and make vendors providing services under this award and subrecipients aware of the restrictions of this provision.

[END OF PROVISION]

M24. PILOT PROGRAM FOR ENHANCEMENT OF GRANTEE EMPLOYEE WHISTLEBLOWER PROTECTIONS (SEPTEMBER

2014)

The requirement to comply with and inform all employees of the "Pilot Program for Enhancement of Contractor Employee Whistleblower Protections" is retroactively effective for all assistance awards and subawards (including subcontracts) issued beginning July 1, 2013.

The Grantee must:

1. Inform its employees working under this award in the predominant native language of the workforce that they are afforded the employee whistleblower rights and protections provided under 41 U.S.C. § 4712; and

2. Include such requirement in any subaward or subcontract made under this award.

41 U.S.C. § 4712 states that an employee of a Grantee may not be discharged, demoted, or otherwise discriminated against as a reprisal for "whistleblowing." In addition, whistleblower protections cannot be waived by any agreement, policy, form, or condition of employment.

Whistleblowing is defined as making a disclosure "that the employee reasonably believes" is evidence of any of the following:

- Gross mismanagement of a Federal contract or grant;
- A gross waste of Federal funds;
- An abuse of authority relating to a Federal contract or grant;
- A substantial and specific danger to public health or safety; or
- A violation of law, rule, or regulation related to a Federal contract or grant (including the competition for, or negotiation of, a contract or grant).

To qualify under the statute, the employee's disclosure must be made to:

- A Member of the U.S. Congress, or a representative of a U.S. Congressional Committee;
- A cognizant U.S. Inspector General;
- The U.S. Government Accountability Office;
- A Federal employee responsible for contract or grant oversight or management at the relevant agency;
- A U.S. court or grand jury; or,
- A management official or other employee of the Grantee who has the responsibility to investigate, discover, or address misconduct.

[End of Provision]

M26. PROHIBITION ON PROVIDING FEDERAL ASSISTANCE TO ENTITIES THAT REQUIRE CERTAIN INTERNAL

CONFIDENTIALITY AGREEMENTS (APRIL 2015)

(a) The recipient must not require employees, subawardees, or contractors seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting such employees, subawardees, or contractor from lawfully reporting such waste, fraud, or abuse to a designated Investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

(b) The recipient must notify employees that the prohibitions and restrictions of any internal confidentiality agreements covered by this provision are no longer in effect.

(c) The prohibition in paragraph (a) of this clause does not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

(d) (1) In accordance with section 7 43 of Division E, Title VI I, of the Consolidated and Further Continuing Resolution Appropriations Act, 2015 (Pub. L. 113-235), use of funds appropriated (or otherwise made available) under that or any other Act may be prohibited, if the Government determines that the recipient is not in compliance with the requirements of this provision.

(2) The Government may seek any available remedies in the event the recipient fails to comply with the requirements of this provision.

[End of Provision]

M28. MANDATORY DISCLOSURES (July 2015)

Consistent with 2 CFR §200.113, applicants and recipients must disclose, in a timely manner, in writing to the USAID Office of the Inspector General, with a copy to the cognizant Agreement Officer, all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award. Subrecipients must disclose, in a timely manner, in writing to the USAID Office of the Inspector General and to the prime recipient (pass through entity) all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award.

Disclosures must be sent to:

U.S. Agency for International Development
Office of the Inspector General
P.O. Box 657
Washington, DC 20044-0657
Phone: 1-800-230-6539 or 202-712-1023
Email: ig.hotline@usaid.gov

URL: https://oig.usaid.gov/content/usaid-contractor-reporting-form.

Failure to make required disclosures can result in any of the remedies described in 2 CFR §200.338 Remedies for noncompliance, including suspension or debarment (See 2 CFR 180, 2 CFR 780 and 31 U.S.C. 3321).

The recipient must include this mandatory disclosure requirement in all subawards and contracts under this award.

[End of Provision]

M27. NONDISCRIMINATION AGAINST BENEFICIARIES (November 2016).

(a) USAID policy requires that the recipient not discriminate against any beneficiaries in implementation of this award, such as, but not limited to, by withholding, adversely impacting, or denying equitable access to the benefits provided through this award on the basis of any factor not expressly stated in the award. This includes, for example, race, color, religion, sex (including gender identity, sexual orientation, and pregnancy), national origin, disability, age, genetic information, marital status, parental status, political affiliation, or veteran's status. Nothing in this provision is intended to limit the ability of the recipient to target activities toward the assistance needs of certain populations as defined in the award.

(b) The recipient must insert this provision, including this paragraph, in all subawards and contracts under this award.

[End of Provision]

[END OF MANDATORY PROVISIONS]

RAA12. REPORTING HOST GOVERNMENT TAXES (DECEMBER 2014)

***APPLICABILITY**: This provision is applicable to all USAID agreements that obligate or subobligate FY 2003 or later funds except for agreements funded with Operating Expense, Pub. L. 480 funds, or trust funds, or agreements where there will be no commodity transactions in a foreign country over the amount of $500. Please insert address and point of contact at the Embassy, Mission, or M/CFO/CMP as appropriate under section (b) of this provision.*

REPORTING HOST GOVERNMENT TAXES (JUNE 2012)

a. By April 16 of each year, the recipient must submit a report containing:

(1) Contractor/recipient name.

(2) Contact name with phone, fax and e-mail.

(3) Agreement number(s).

(4) The total amount of value-added taxes and customs duties (but not sales taxes) assessed by the host government (or any entity thereof) on purchases in excess of $500 per transaction of supplies, materials, goods or equipment, during the 12 months ending on the preceding September 30, using funds provided under this contract/agreement.

(5) Any reimbursements received by April 1 of the current year on value-added taxes and customs duties reported in (iv).

(6) Reports are required even if the recipient did not pay any taxes or receive any reimbursements during the reporting period.

(7) Cumulative reports may be provided if the recipient is implementing more than one program in a foreign country.

b. Submit the reports to: [insert address and point of contact at the Embassy, Mission, or M/CFO/CMP as appropriate, may include an optional “with a copy to”].

c. Host government taxes are not allowable where the Agreement Officer provides the necessary means to the recipient to obtain an exemption or refund of such taxes, and the recipient fails to take reasonable steps to obtain such exemption or refund. Otherwise, taxes are allowable in accordance with the Standard Provision, “Allowable Costs,” and must be reported as required in this provision.

d. The recipient must include this reporting requirement in all applicable subawards and contracts.

[END OF PROVISION]

RAA26. CONTRACT PROVISION FOR DBA INSURANCE UNDER RECIPIENT PROCUREMENTS (DECEMBER 2014)

APPLICABILITY: *The following provision is required when the recipient is expected to procure services to be performed overseas.*

DEFENSE BASE ACT (DBA) WORKERS' COMPENSATION INSURANCE FOR PROCUREMENT CONTRACT (DECEMBER 2014)

All contracts made by the recipient under this award for services to be performed overseas must contain the following provision, as applicable.

Workers' Compensation Insurance (Defense Base Act)

(a) The Contractor must--

(1) Before commencing performance under this contract, establish provisions to provide for the payment of disability compensation and medical benefits to covered employees and death benefits to their eligible survivors, by purchasing Defense Base Act (DBA) insurance pursuant to the terms of the contract between USAID and USAID's DBA insurance carrier unless the Contractor qualifies as a self-insurer under the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 932) as extended by the Defense Base Act (42 U.S.C. 1651, et seq.), or has an approved retrospective rating agreement for DBA. The Contractor must continue to maintain these provisions to provide such Defense Base Act benefits until contract performance is completed.

(2) If USAID or the Contractor has secured a waiver of DBA coverage in accordance with AIDAR 728.305-70(a) for contractor's employees who are not citizens of, residents of, or hired in the United States, the contractor agrees to provide such employees with worker's compensation benefits as required by the laws of the country in which the employees are working, or by the laws of the employee's native country, whichever offers greater benefits. The Department of Labor has granted partial blanket waivers of DBA coverage applicable to USAID-financed contracts performed in countries listed in the DEFENSE BASE ACT (DBA) WAIVER LIST.

(3) Within ten days of an employee's injury or death or from the date the Contractor has knowledge of the injury or death, submit Form LS-202 (Employee's First Report of Injury or Occupational Illness) to the Department of Labor in accordance with the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 930(a), 20 CFR 702.201 to 702.203).

(4) Pay all compensation due for disability or death within the timeframes required by

the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 914, 20 CFR 702.231 and 703.232).

(5) Provide for medical care as required by the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 907, 20 CFR 702.402 and 702.419).

(6) If controverting the right to compensation, submit Form LS-207 (Notice of Controversion of Right to Compensation) to the Department of Labor in accordance with the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 914(d), 20 CFR 702.251).

(7) Immediately upon making the first payment of compensation in any case, submit Form LS-206 (Payment of Compensation Without Award) to the Department of Labor in accordance with the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 914(c), 20 CFR 702.234).

(8) When payments are suspended or when making the final payment, submit Form LS-208 (Notice of Final Payment or Suspension of Compensation Payments) to the Department of Labor in accordance with the Longshore and Harbor Workers' Compensation Act (33 U.S.C. 914 (c) and (g), 20 CFR 702.234 and 702.235).

(9) Adhere to all other provisions of the Longshore and Harbor Workers' Compensation Act as extended by the Defense Base Act, and Department of Labor regulations at 20 CFR Parts 701 to 704.

For additional information on the Longshore and Harbor Workers' Compensation Act requirements see http://www.dol.gov/owcp/dlhwc/lsdba.htm.

The Contractor must insert the substance of this clause including this paragraph (c), in all subcontracts to which the Defense Base Act applies.

[END OF PROVISION]

[END OF REQUIRED AS APPLICABLE PROVISIONS]

EXHIBIT G

PROHIBITION OF SALARY SUPPLEMENTS WITH PREDICT-2 FUNDS

Though a commonly-accepted practice in many countries, salary supplements or "top ups" for staff of foreign governmental entities or parastatals are **NOT ALLOWED**. Supplementing or "topping up" existing salaries by paying a salary rate above the individual's pre-project pay rate or by receiving compensation from the project above and beyond their established 100% level of effort (LOE) compensation is prohibited. If governmental/parastatal employees are to be engaged in PREDICT activities, the Consortium partner managing the in-country activities must secure written permission from the supervising ministry acknowledging that their employee(s) is participating in the project and that the ministry or department is supportive of the employee spending time on the project. If payment for government/parastatal employees is to be provided by PREDICT, a subaward or subcontract detailing the financial relationship with the ministry should be put in place to facilitate payment and document that written permission was obtained. **Government/parastatal employees should not be paid through individual contracts or agreements.**

From:	Andrew Clements <aclements@usaid.gov>
To:	Katherine Leasure <kaleasure@ucdavis.edu>
CC:	PREDICTMGT <predictmgt@usaid.gov>;predict@ucdavis.edu <predict@ucdavis.edu>;Jonna Mazet <jkmazet@ucdavis.edu>
Sent:	3/20/2018 12:27:49 AM
Subject:	Re: Change to Approved ITA - H. Li (China)

Thanks, Katie. I will let the Mission know.

Andrew P. Clements, Ph.D.
Senior Scientific Advisor
Emerging Threats Division/Office of Infectious Diseases/Bureau for Global Health
U.S. Agency for International Development
Mobile phone: 1-571-345-4253
Email: aclements@usaid.gov

On Mar 20, 2018, at 2:22 AM, Katherine Leasure <kaleasure@ucdavis.edu> wrote:

Hi Andrew. EcoHealth Alliance has submitted an amendment to the previously approved ITA for Hongying Li. Her dates of travel have been revised to April 8 through May 5, 2018. This extended travel will accommodate all activities outlined in the original ITA, as well as an EEID Workshop in early April. A copy of the previously approved ITA is below, with changes highlighted in yellow. Please let me know if you have any questions. Thank you!

EcoHealth Alliance would like to request travel approval for Hongying Li to travel from New York, NY, USA to Beijing, Kunming, Guangzhou, Wuhan, and Shenzhen, China from ~~March 26 to April 16, 2018~~ April 8 to May 5, 2018 for field coordination work and meetings with in-country partners in China, and to attend the US-China Ecology and Evolution Infectious Disease (EEID) Workshop.

Trip purpose: Hongying Li will be meeting with partners in Beijing for PREDICT surveillance laboratory work, and to work with local field coordinator, Dr. Guangjian Zhu, to assist the field work in Yunnan and Guangdong provinces. She will also meet with China Country Coordinator, Dr. Zhengli Shi, at Wuhan Institute of Virology for laboratory work and projects updates. Hongying will attend the US-China Ecology and Evolution Infectious Disease (EEID) Workshop hosted by the National Science Foundation in Shenzhen, China from April 9-13, to present PREDICT work in China and join the discussion for US-China collaborations on EEID research. In addition, she will meet with the USAID Mission in Beijing, China to give a brief on PREDICT work in China on April 10, and May 4 [per diem for Shenzhen is $399].

Katherine Leasure
HR/Payroll/Financial Assistant
One Health Institute
University of California, Davis
530-752-7526
530-752-3318 FAX
kaleasure@ucdavis.edu

From: morel <[redacted]>
Subject: Re: GVP paper published on WHO Bulletin
Sent: Mon, 2 Apr 2018 17:18:30 -0300
Cc: Dennis Carroll <dcarroll@usaid.gov>, Brooke Watson <watson@ecohealthalliance.org>, Peter Daszak <daszak@ecohealthalliance.org>, Jonna Mazet <jkmazet@ucdavis.edu>, Cara Chrisman <cchrisman@usaid.gov>, "Eddy Rubin" <erubin@metabiota.com>, Nathan Wolfe <nwolfe@metabiota.com>, gaof <gaof@im.ac.cn>, Gian Luca Burci <gian-luca.burci@graduateinstitute.ch>, Keiji Fukuda <kfukuda@hku.hk>, Prasert Auewarakul <prasert.aue@mahidol.ac.th>, Oyewale Tomori [redacted]
To: [redacted]

Dear [redacted]
Fantastic, congratulations! And thanks for all your work which made this possible!

Following Peter's suggestion, I also tweeted it!:

Best regards,

Carlos

Em 2 de abr de 2018, à(s) 12:58, [redacted] escreveu:

Hi everyone,

Our GVP paper has been published on the April issue of the WHO Bulletin.
http://www.who.int/bulletin/volumes/96/4/17-205005.pdf

Congratulations to all!

Best,
[redacted]

[redacted]
Fellow
One Health Institute
School of Veterinary Medicine
University of California, Davis

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