Surveillance of viral zoonoses in Africa

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10th International Global Virus Network Meeting:
Eradication and Control of (Re-)Emerging Viruses
Les Pensieres Center for Global Health,
Veyrier du Lac (France)
November 28 - 30, 2018
Background

• Zoonoses are not eradicable infections

• Increased emergence and re-emergence of diseases such as Ebola virus disease, anthrax, trypanosomiasis and neglected tropical diseases (NTDs) in Africa including in new geographic areas

• High health and socio-economic impact, and pose serious biosafety and biosecurity challenges

• Ironically, Africa has least capacity for their risk assessment, prevention and control
Research activities in Zambia

School of Veterinary Medicine, University of Zambia was built in 1986.

Collaboration work between UNZA-Vet Med and Hokkaido University has continued for over 30 years.

Memorandum of Understanding Between UNZA and Research Center for Zoonosis Control Hokkaido University was concluded in February 6, 2007 and renewed in 2011.
Capacity for surveillance of viral zoonoses

UNZA - VETMED

BSL-3 Lab (negative pressure)

BSL-2 Lab (normal pressure)

Sample collection

BSL-3 (fixed and mobile on truck)
BSL-2 Lab.
Animal Biosafety level-2 facility

Capacity
- Serology-ELISA
- Molecular diagnosis (PCR, LAMP)
- Sequencing
- Isolation of pathogens
- Cell culture
- Storage (Deep Freezer, Dry ice, LN₂)
- Ultracentrifugation

Trapping rodents

Capturing mosquitoes

UNZA - VETMED
Outbreaks of haemorrhagic fever in Africa

- **Ebola**
  - (1976, 1979, 2004)
  - Sudan

- **Guinea, Liberia, Sierra Leone**
  - Ebola (2013-2014)

- **Congo, Gabon**

- **Angola**

- **Democratic Republic of Congo**

- **Uganda**

- **Kenya**

- **Novel Arena (Lujo) virus**
  - (2008) Zambia

Countries Red colored = Filovirus outbreaks
Potential pathogens in bats

Ebolavirus, Marburgvirus, Paramyxovirus, etc.
Hot zone

outbreak
Sero-surveillance of filovirus infection in bats

Filovirus-specific serum IgG detected in fruit bats

However, so far no filovirus genome RNA has been detected from fruit bats captured in Zambia.
QuickNavi-Ebola - lateral flow–based IC kit

- Detects multiple species of ebolavirus – EBOV, TAFV, BDBV
- SUDV mAbs have been produced and will be added – to detect all known African filoviruses

Yoshida et al, JID, 2016
QuickNavi™-Ebola field validation

10-20 min for diagnosis
Simple procedure
Stable at room temperature
No special instruments and training
Useful in remote areas
Uses blood, serum, plasma
Ebola diagnosis and biosafety training

Diagnosis of Ebola virus disease
BSL-3 facility at UNZA

Biosafety training programme at UNZA
When do birds arrive in Zambia?
September

When do they leave Zambia?
Between January and May

Where do they come from?
C&E Europe and W. Asia: Palaearctic
Sub-Saharan Africa: Intra-African

Route:
From Europe and Asia,
Palaearctic migrants follow a
Western route: over Liuwa Plains,
Zambezi, Western Province
Eastern Route: along Rift Valley

Risk of incursion of avian influenza through migratory birds into Zambia
Surveillance of avian influenza viruses in wild aquatic birds

- Establishment of diagnosis and surveillance systems in Zambia
- So far, H3, H4, H6, H9, H10, H11, H12 and H15 viruses, all of which are non-pathogenic, have been isolated.
Surveillance of animal influenza

<table>
<thead>
<tr>
<th>Year</th>
<th>Isolated</th>
<th>Total samples</th>
<th>Isolation Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1</td>
<td>1374</td>
<td>0.07%</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>1400</td>
<td>0.14%</td>
</tr>
<tr>
<td>2012</td>
<td>2</td>
<td>1400</td>
<td>0.14%</td>
</tr>
<tr>
<td>2013</td>
<td>13</td>
<td>1399</td>
<td>0.93%</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>5573</td>
<td>0.32%</td>
</tr>
</tbody>
</table>

Subtype | Strain | Date
--|------|----------
H3N6  | A/duck/Zambia/28/13 | September 2013
H6N2  | A/duck/Zambia/19/13 | June 2013
H6N2  | A/duck/Zambia/20/13 | June 2013
H6N2  | A/duck/Zambia/21/13 | June 2013
H6N2  | A/goose/Zambia/22/13 | July 2013
H6N2  | A/goose/Zambia/23/13 | July 2013
H6N2  | A/goose/Zambia/24/13 | July 2013
H6N2  | A/goose/Zambia/25/13 | July 2013
H6N2  | A/goose/Zambia/26/13 | August 2013
H9N2  | A/duck/Zambia/17/12 | October 2012
H10N7 | A/pelican/Zambia/15/11 | August 2011
H10N7 | A/pelican/Zambia/16/11 | August 2011
H11N1 | A/duck/Zambia/18/12 | November 2012
H11N2 | A/goose/Zambia/14/10 | August 2010
H11N6 | A/duck/Zambia/27/13 | September 2013
H11N6 | A/duck/Zambia/29/13 | September 2013
H11N6 | A/duck/Zambia/30/13 | September 2013
H11N9 | A/duck/Zambia/31/13 | September 2013
A patient suspected of hemorrhagic fever was reported in Zambia in September, 2008. She died at hospital in South Africa and other 3 people were infected and died.

We received blood samples of the first patient from the Ministry of Health, Zambia, and did not detect ebolavirus genome.

It was later reported that the latter 3 patients were infected by a new arenavirus designated as Lujo (Lusaka-Johannesburg) virus.
Surveillance of arenaviruses in rodents
In order to investigate the natural host animal of *Lujo virus* in Zambia, we collected 598 rodents in Lusaka, Mfuwe, Namwala, and Livingstone from 2009 to 2011.
We detected arenavirus in 23 out of 408 *Mastomys natalensis*. Arenaviruses in Zambia are similar to non-pathogenic Lassa virus-related viruses, but genetic identities are far from other arenaviruses. Thus, we suggested it as a novel arenavirus, *Luna* (*Lusaka-Namwala*) virus.

Lujo virus and related virus have not been detected yet.

We have expanded the surveillance of arenavirus to other animals and areas in Zambia.

Detection of novel pathogen in bats

Collection of samples from bats in caves
A nairovirus isolated from African bats causes haemorrhagic gastroenteritis and severe hepatic disease in mice.

Other symptoms
- thrombocytopenia
- leukopenia
- elevation of ALT and ALP values in blood

Summary
LPHV-inoculated mice demonstrated severe thrombocytopenia, leukopenia and liver dysfunction similar to human nairovirus disease, Crimean-Congo hemorrhagic fever.

This is the first nairovirus-induced hemorrhagic fever animal model in immunocompetent mice. This animal model is expected to be a good tool to understand Nairoviral diseases.
Paucity of knowledge on arboviral infections in Zambia

- Rift Valley fever (RVF) in Zambia was first reported in 1974 during an epizootic of cattle and sheep that occurred. In 1990, the disease was documented in 10 of the provinces of Zambia. In the last two decades, there have been no reports of RVF. The current occurrence of RVF in Zambia is unclear (Onderstepoort J Vet Res, 2012).

- Vector-borne virus infections were studied in 40 German overseas aid workers who had stayed in Zambia. One case was seropositive for anti-Dengue IgG and one case was positive for anti-Sindvis IgG by IFA (Infection 27, 1999).
Epidemiological research of Arboviruses

Over than 4,000 mosquitoes have been collected in 7 regions in Zambia and performed:

- RT-PCR to detect viral genes of Flaviviruses, Rift Valley fever virus, Chikungunya virus
- Virus isolation using mosquito and mammalian cells
- West Nile virus has been isolated in Culex mosquito spp. for the first time in Zambia
Going forward

- Collaboration/Partnerships with other research and training institutions for:
  
  - Development of new/novel and/or improvement of existing serologic and genomic-based assays
  
  - Risk assessment of the known/unknown/undiagnosed human diseases and novel zoonotic pathogens under the One Health Platform
  
  - Training of disease control experts (Short courses, MSc, PhD, Post-doctoral levels)
Eastern and Southern Africa Higher Education Centers of Excellence (ACE II)

Africa Center of Excellence for Infectious Diseases of Humans and Animals (ACEIDHA)

• Strengthening of research on infectious diseases
• MSc, PhD student training

Key partners: Hokkaido University Research Center for Zoonosis Control
University College Dublin

Funded by the World Bank Group
ACEIDHA is an Affiliate Member of the Global Virus Network

- ACEIDHA’s membership is sponsored by two GVN Centers of Excellence, Hokkaido University, Japan and University College Dublin

- Maximise synergies and mobility of scientists in Africa

- Better train virologists at MSc, PhD and post-doctoral levels.

- Facilitate interactions with partners in Africa, which is critical to GVN’s mission in preparing the world for future outbreaks of viral diseases.

www.gvn.org (12 Jan 2018)
Acknowledgements
Thank you for your attention