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

GLOBAL VIRUS NETWORK

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)

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

Capacity

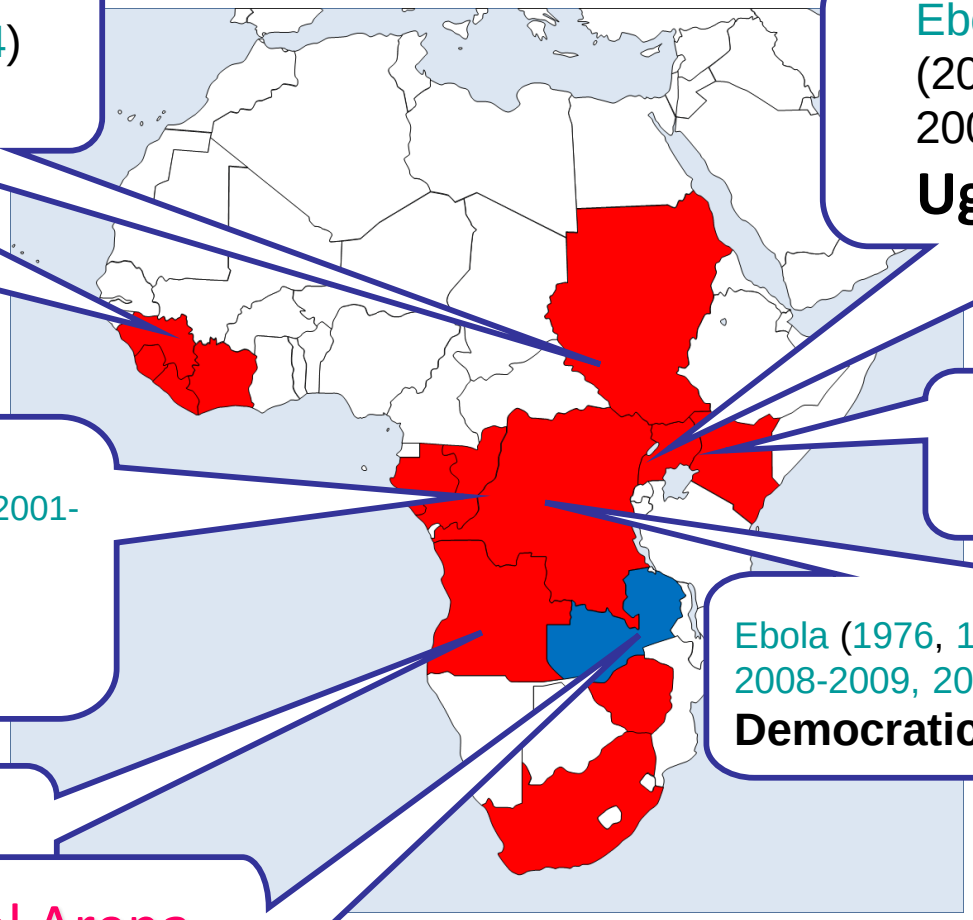
- **Serology-ELISA**
- **Molecular diagnosis (PCR, LAMP)**
- **Sequencing**
- **Isolation of pathogens**
- **Cell culture**
- **Storage (Deep Freezer, Dry ice, LN_2)**
- **Ultracentrifugation**

Trapping rodents

Sample collection

Capturing mosquitoes

Outbreaks of haemorrhagic fever in Africa



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

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

Ebola (1994,1996,1996-1997, 2001-2002, 2002-2003, 2005) **Congo, Gabon**

Marburg (2004-2005) **Angola**

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

Ebola · Marburg (2000-2001, 2007, 2007-2008, 2012, 2012) **Uganda**

Marburg (1980,1987) **Kenya**

Ebola (1976, 1977,1995, 1998-2000, 2007, 2008-2009, 2012, 2014, 2018) **Democratic Republic of Congo**

Countries Red colored = Filovirus outbreaks

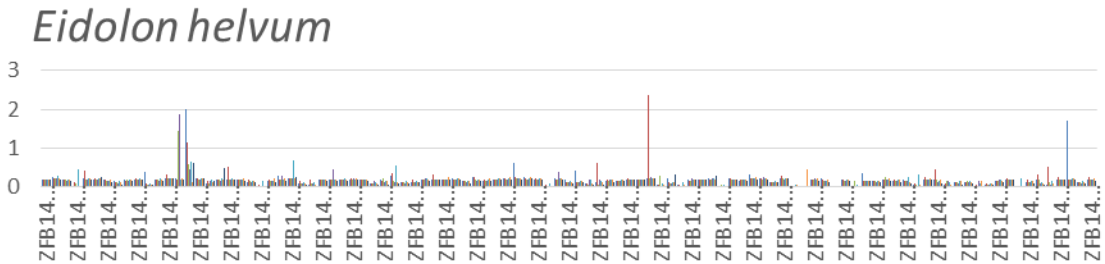
Potential pathogens in bats

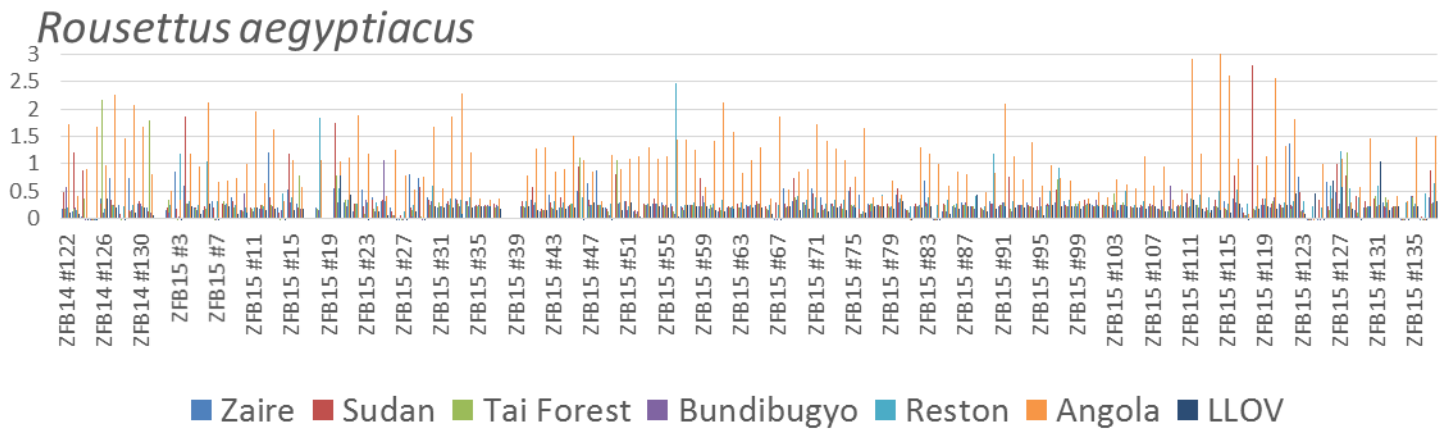
Ebolavirus, Marburgvirus, Paramyxovirus, etc.

Hot zone

outbreak

Sero-surveillance of filovirus infection in bats

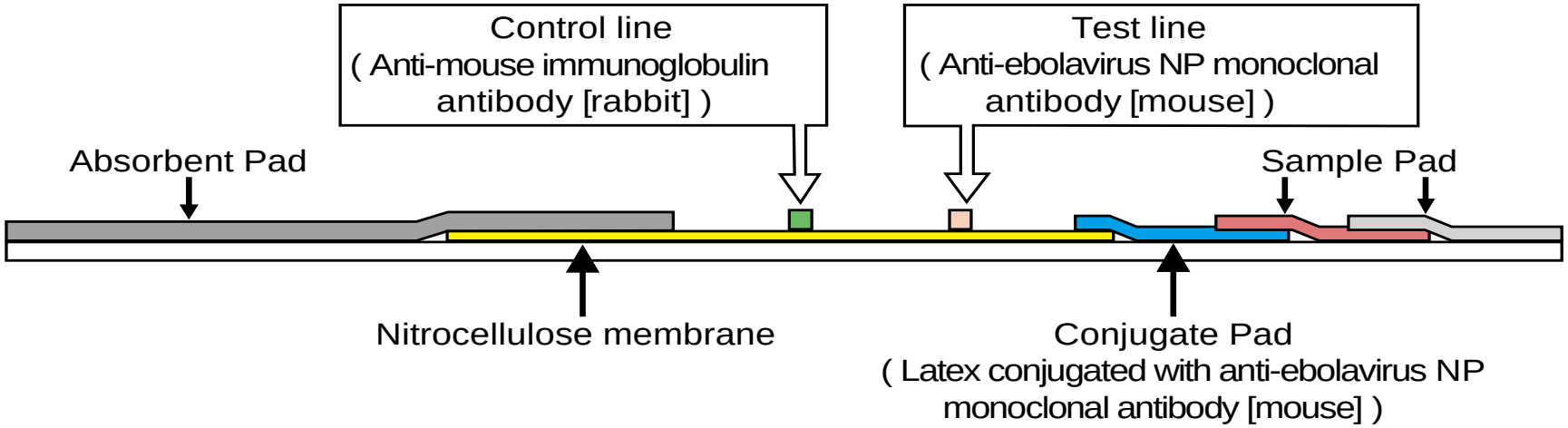




Filovirus-specific serum IgG detected in fruit bats

However, so far no filovirus genome RNA has been detected from fruit bats captured in Zambia.

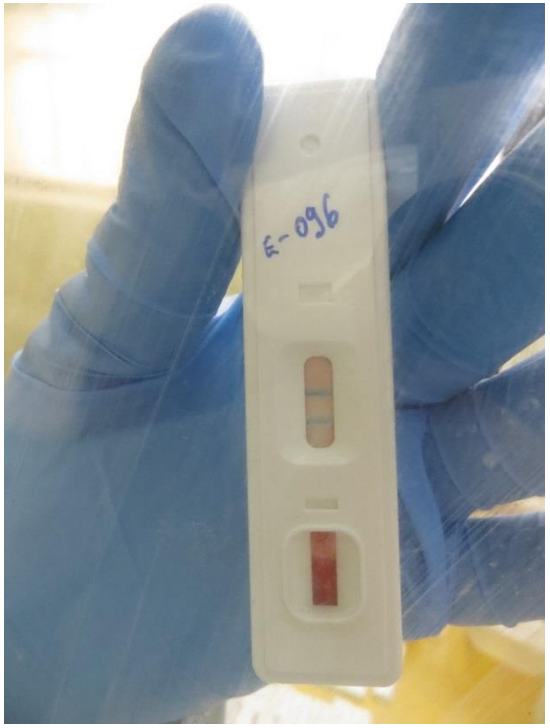
QuickNavi-Ebola - lateral flow–based IC kit



- **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^{TM}-Ebola field validation



10-20 min for diagnosis

- **Simple procedure**
- **Stable at room temperature**
- **No special instructions 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

Risk of incursion of avian influenza through migratory birds into Zambia

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:

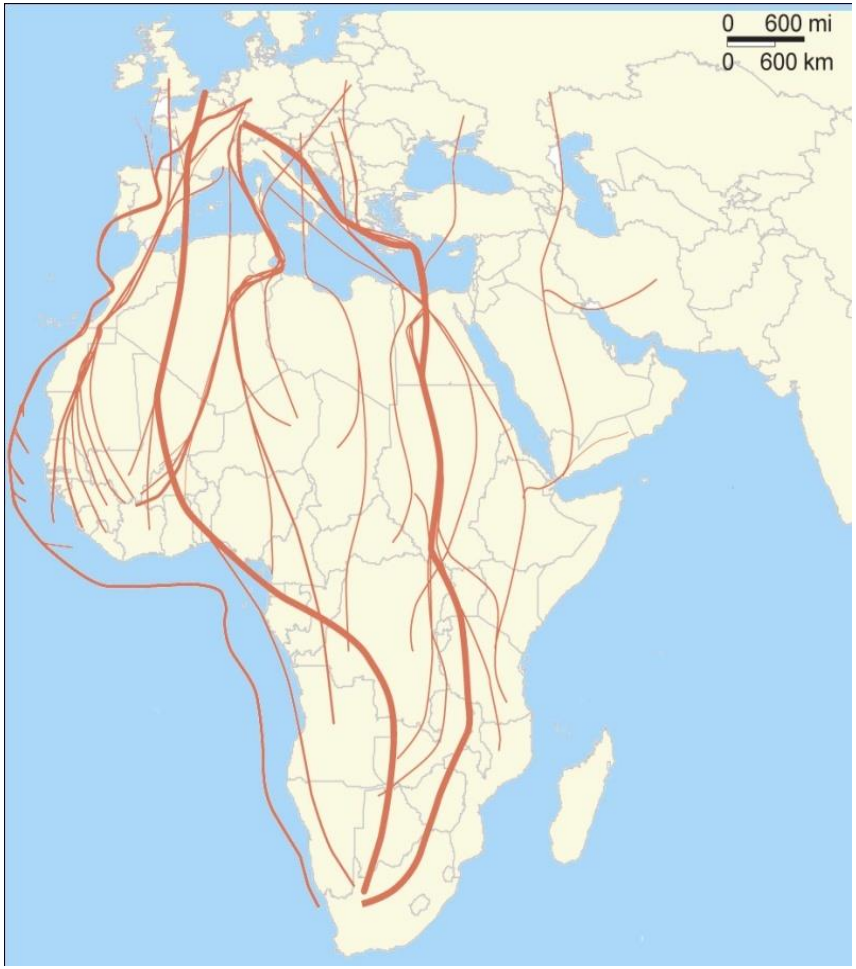
From Europe and Asia,

Palaearctic migrants follow a

Western route : over Liuwa Plains,

Zambezi, Western Province

Eastern Route: along Rift Valley



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 nonpathogenic, have been isolated.

Surveillance of animal influenza

Year	Isolated	Total samples	Isolation Rates
2010	1	1374	0.07%
2011	2	1400	0.14%
2012	2	1400	0.14%
2013	13	1399	0.93%
Total	18	5573	0.32%

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
H10N1	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

Case of mysterious disease in 2008

- 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.

T E POST, Thursday October 16, 2008 HOME NEWS • 11

WHO confirms fourth case of mysterious disease

y Masuzyo Chakwe

THE World Health Organisation (WHO) has stated that a fourth case of the mysterious disease has been confirmed, with a nurse who had close contact with one of the earlier cases being admitted to hospital in South Africa.

According to a news update released by WHO, analysis was continuing at laboratories in South Africa and the United States to learn more about the virus believed to be from the Arenaviridae family.

It stated that preliminary tests indicate that a mysterious disease in Zambia and South Africa that has killed three people in the past month is caused by a virus from the family that includes Lassa fever.

It stated that WHO was working with its partners in the Global Outbreak Alert and Response Network to help the health ministries in South Africa and Zambia investigate the outbreak, conduct laboratory diagnosis and become involved in case monitoring and the follow-up with anyone who may have been in contact with sufferers of the disease.

On Friday, the UN agency said there was no indication yet of any need to restrict travel to or from Zambia or South Africa and no special measures required for passengers arriving from these countries.

At least 121 known contacts of the fatal cases are being traced in South Africa and 23 in Zambia.

The Arenaviridae family contains a wide range of viruses, including that which causes Lassa fever, an acute viral haemorrhagic illness that occurs widely across West Africa. Humans become infected from contact with the urine or faeces of rodents.

Investigations began after an office employee at a safari tour company in Zambia died on September 14 in a hospital in Johannesburg, South Africa, two days after undergoing a medical evacuation from Zambia.

A paramedic who cared for that patient was later admitted to hospital in Johannesburg and died on October 2, and a nurse who was also involved in the care of the first patient died on October 5.

The three patients experienced fever, headaches, diarrhoea and myalgia that developed into rash and hepatic dysfunction, followed by rapid deterioration and death, WHO reported.

nze police nab

ZIB ZAMBIAN BREWERIES GROUP

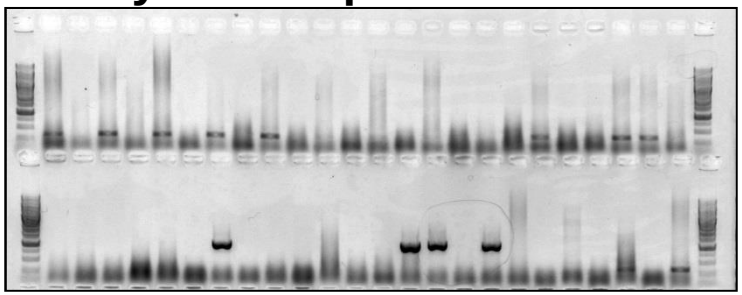
EXECUTIVE APPOINTMENTS

Surveillance of arenaviruses in rodents

Surveillance of arenaviruses con't

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.

Screening of Arenavirus by one-step RT-PCR



Sharman and cage traps

↓

euthanize the rodents

↓

extract total RNA from kidney

↓

1-step RT-PCR

viral RNA → Screening of arenavirus RNA

cytochrome b → Species identification of rodent

Surveillance of arenaviruses con't

Mastomys natalensis

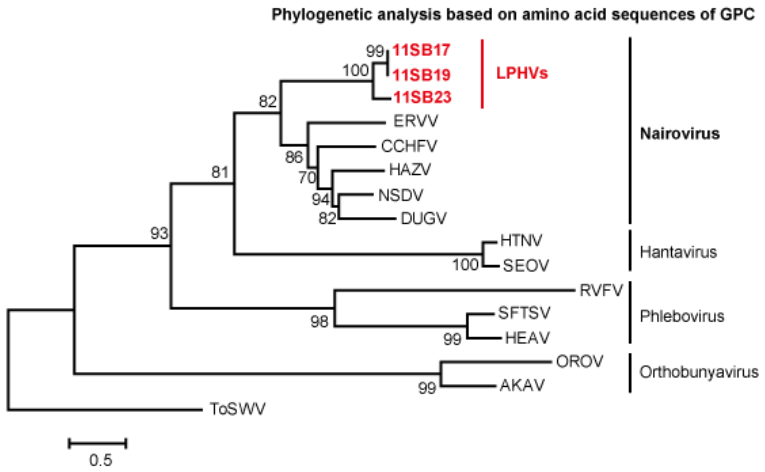
- **We detected arenavirus in 23 out of 408 *Mastomys natalensis*.**
- **Arenaviruses in Zambia are similar to non-pathogenic Lassa virus-related viruses, but genetic identities are far from other arenaviruses.**
- **Thus, we suggested it as a novel arenavirus, Luna (Lusaka-Namwala) virus.**
- **Lujo virus and related virus have not been detected yet.**
- **We have expanded the surveillance of arenavirus to other animals and areas in Zambia.**

Ishii A et al. ***J Gen Virol***, 2012
Ishii A et al***. Emerg Infect Dis***, 2011

Detection of novel pathogen in bats

Collection of samples from bats in caves

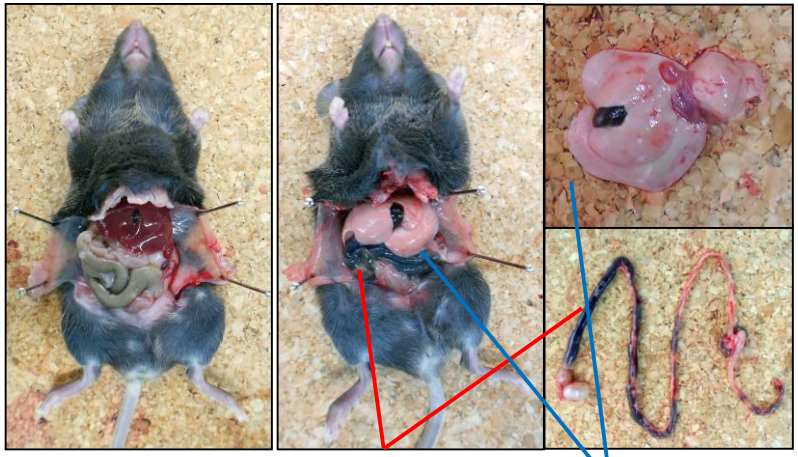
Characterization of isolated novel nairovirus



Whole genome sequence of newly isolated nairovirus was determined. **According to the phylogenetical analyses, the viruses belonged to novel nairovirus and designates as "Leopards Hill virus (LPHV)".**

LPHV caused acute and lethal hemorrhagic fever-like symptoms to mice (C57BL/6J) .

non-infection **LPHV-infected**



Hemorrhagic gastroenteritis

whitened liver

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

nature COMMUNICATIONS

ARTICLE

Received 22 May 2014 | Accepted 23 Oct 2014 | Published 2 Dec 2014 DOI: 10.1038/ncomms6651 OPEN

A nairovirus isolated from African bats causes haemorrhagic gastroenteritis and severe hepatic disease in mice

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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.

GVN
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725 W Lombard St. | Baltimore, MD 21201-1009 | 410.706.1966
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12 January, 2018

Professor Aaron S. Mweene, PhD., MSc, BVM
Center Leader-African Center of Excellence of Infectious Diseases in Humans and Animals, (ACEIDHA)
Department of Disease Control, School of Veterinarian Medicine, University of Zambia
P.O. Box 32379, Lusaka 10101 Zambia

Dear Dr. Mweene,

It is with great pleasure that I convey to you the news that, the Scientific Leadership Board of the Global Virus Network has approved the application from the University of Zambia, School of Veterinarian Medicine, as Affiliate member of the Global Virus Network.

It is clear that your Institute's strong relations with Hokkaido, Japan, programs and research involving emerging and re-emerging virus epidemic threats, BL-3 tissue culture and virus isolation, identification and control of zoonotic agents, and a presence in Africa, is vital to GVN's mission of working to prevent and treat viral infections, and to prepare for still undiscovered viruses with pandemic potential.

We are eager to join with our Zambian colleagues; furthering the work of the GVN, and we are certain that the Africa Center of Excellence for Infectious Diseases of Humans and Animals (ACEIDHA) will become an integral part of the GVN under your leadership. As you know, Affiliates support the GVN through their conduct of research studies, training programs, and outreach efforts worldwide. Upon joining the Network, Affiliates pledge to uphold the core values of the organization, including collaborating with other GVN centers, and institutional capacity-building not yet a part of the GVN.

We both look forward to working with you, and other ACEIDHA members.

Sincerely,

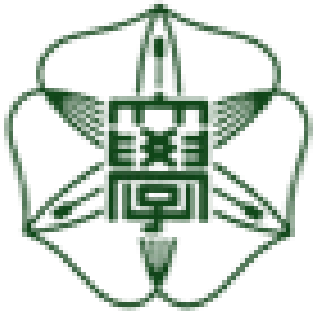
Robert C. Gallo, MD
Global Virus Network
Scientific Director & Co-founder

www.gvn.org (12 Jan 2018)

Acknowledgements

Zambia

University of Zambia



Thank you for your attention