

# High Consequence Pathogens: Outbreaks and What's Coming Next

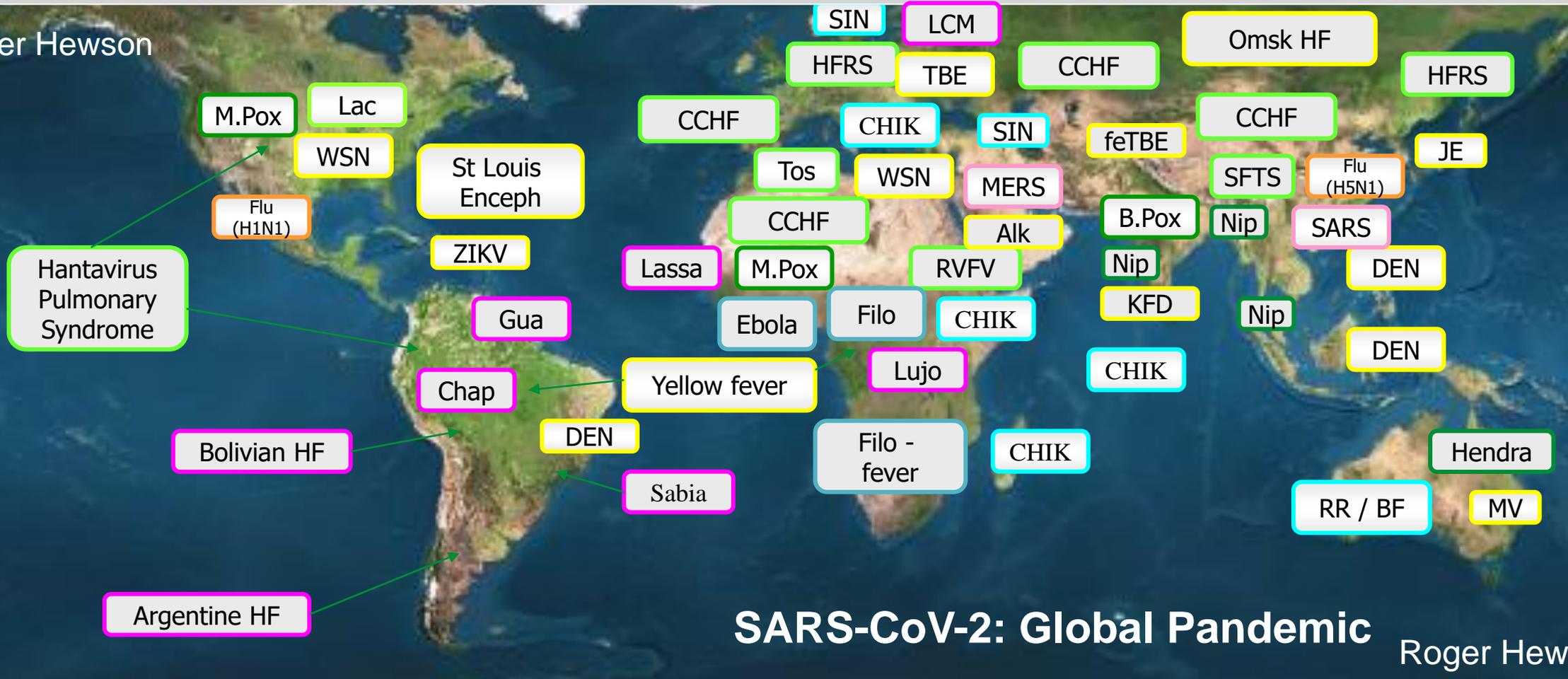
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6<sup>th</sup> Dec 2021



# Emerging and Re-emerging Pathogenic Viral Infections 2000-2020

Roger Hewson



## SARS-CoV-2: Global Pandemic

Roger Hewson

- Arenaviruses
- Bunyaviruses
- Coronaviruses
- Togaviruses
- Orthomyxoviruses
- Flaviviruses
- Filoviruses
- Henipaviruses
- Orthopoxviruses

# Viral Emergence...

- **>1.6 million** unknown virus species in mammalian and avian populations
- **>700,000** have the potential to cause disease in humans and livestock
- Only **0.1%** have been identified to date

Two general patterns

I. Almost all have RNA rather than DNA genomes

RNA viruses have mutation edge over DNA viruses

Genetic adaptability

II. Almost all have an animal reservoir  
Zoonosis - Cross species transmission

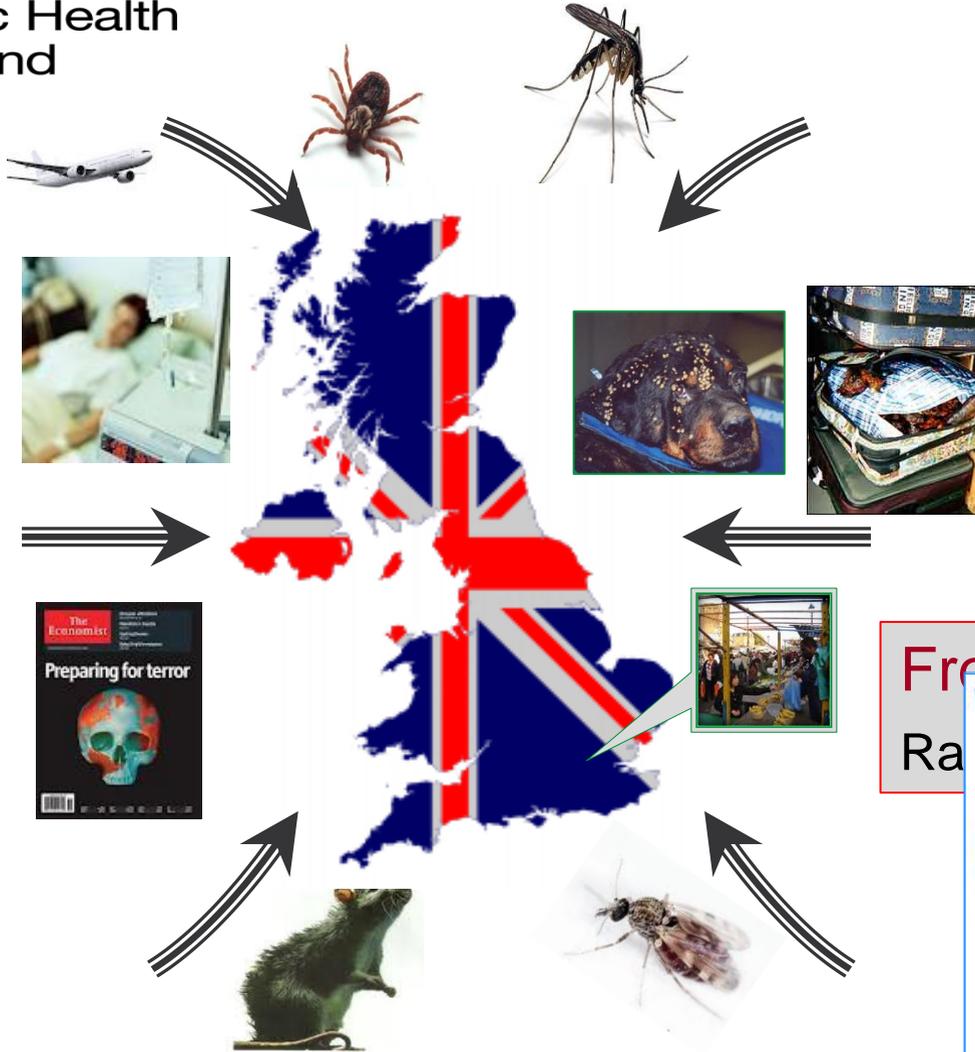
- HIV
- Influenza
- SARS-CoV-1/2
- Ebola / Marburg
- Lassa
- CHK
- CCHF
- ORO





Public Health England

# Threats to the UK:



- Imported disease. Travellers / patients returning from endemic disease areas of the world
- Changing patterns of disease vectors (climate change) **CCHF**
- Pet passport scheme / trade in livestock
- Accidental release - illegal trade (e.g. bush meat)
- New pathogens / re-emerging pathogens
- Deliberate release / malicious intent
  - FSU weapons programme (Ebola, Variola, CCHF etc)
  - Synthetic biology

Front line diagnostic service:  
Rat



# Ebola Virus Ecology and Transmission

Ebola virus disease is a zoonotic disease. Zoonotic diseases involve animals and humans.

## Animal-to-Animal Transmission

Evidence suggests that bats are the reservoir hosts for the Ebola virus. Bats carrying the virus can transmit it to other animals, like apes, monkeys, and duikers (antelopes), as well as to humans.

## Spillover Event

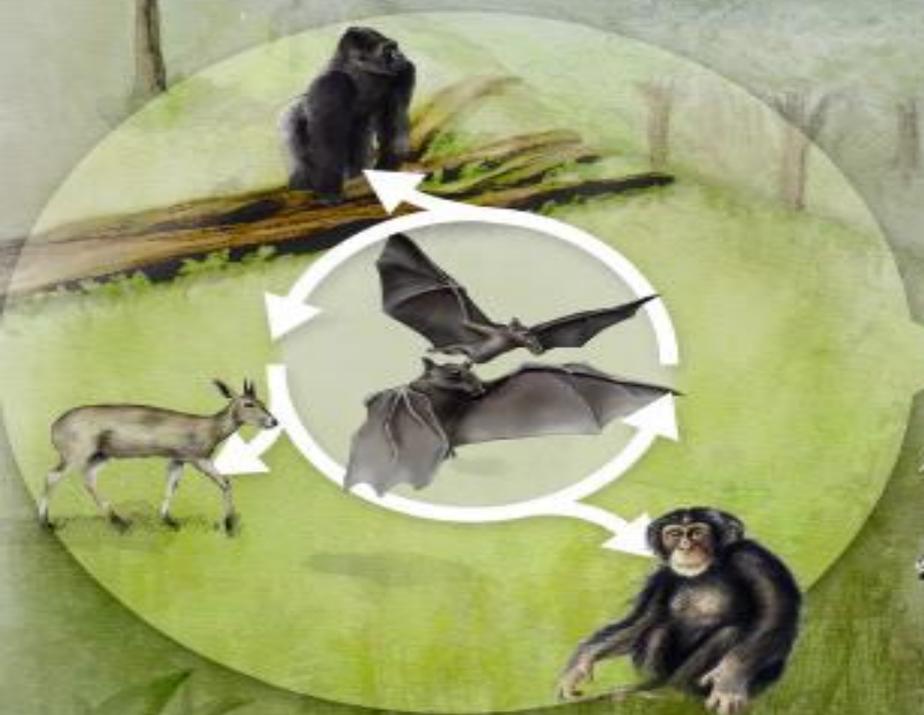
A "spillover event" occurs when an animal (bat, ape, monkey, duiker) or human becomes infected with Ebola virus through contact with the reservoir host. This contact could occur through hunting or preparing the animal's meat for eating.

## Human-to-Human Transmission

Once the Ebola virus has infected the first human, transmission of the virus from one human to another can occur through contact with the blood and body fluids of sick people or with the bodies of those who have died of Ebola.

## Survivor

Ebola survivors face new challenges after recovery. Some survivors report effects such as tiredness and muscle aches, and can face stigma as they re-enter their communities.



Traditional funeral practice



Unprotected healthcare worker



Unprotected contact with blood and body fluids



Survivor



# European Mobile Laboratory Guinea: 2013-2016 Epidemic

## Early Diagnostics are Essential



23.03.14



WHO

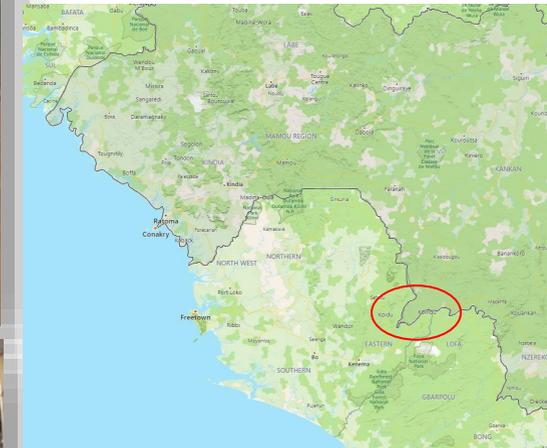
Global Outbreak Alert & Response Network

20.03.14



MEDECINS SANS FRONTIERES  
DOCTORS WITHOUT BORDERS

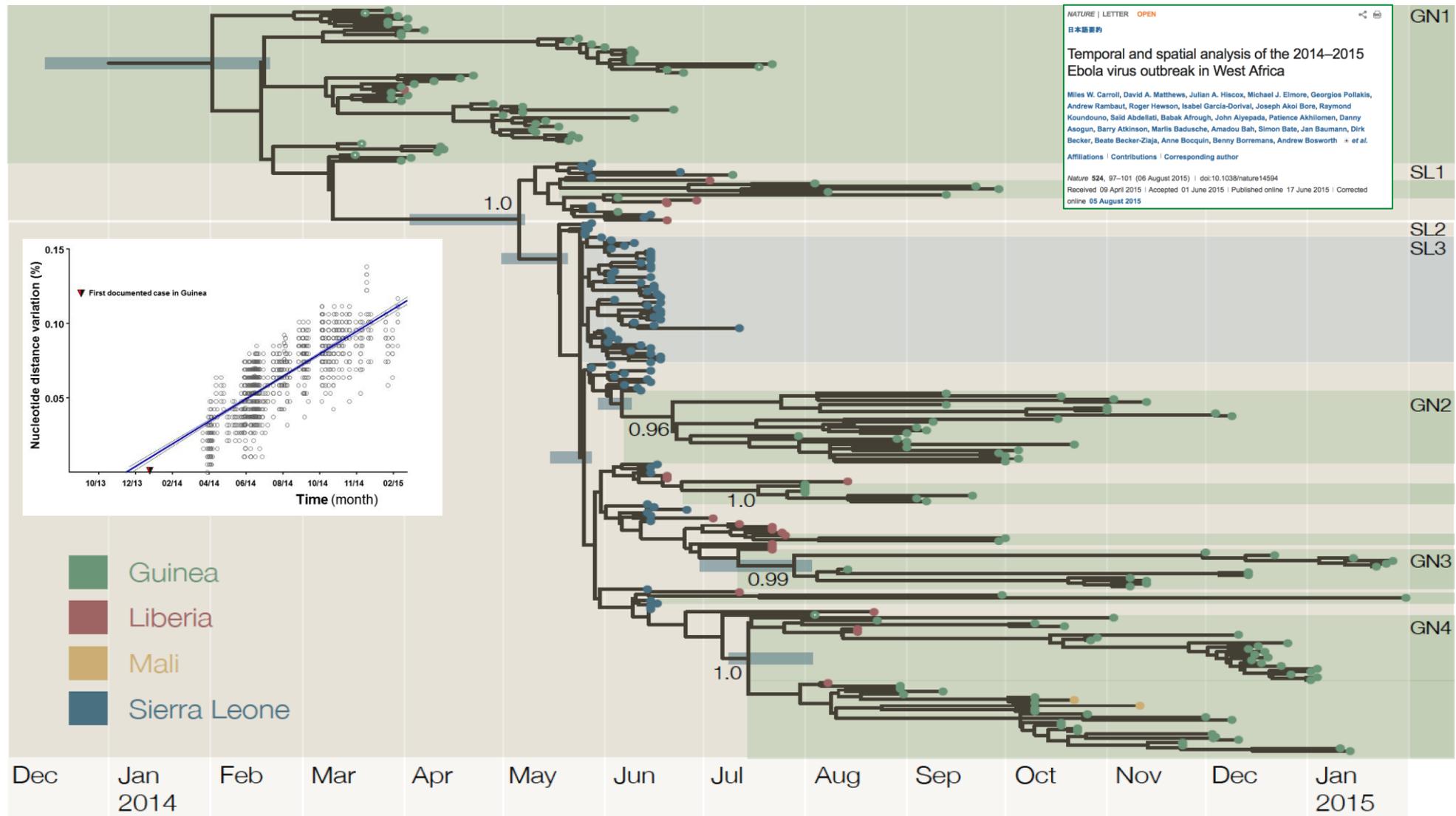
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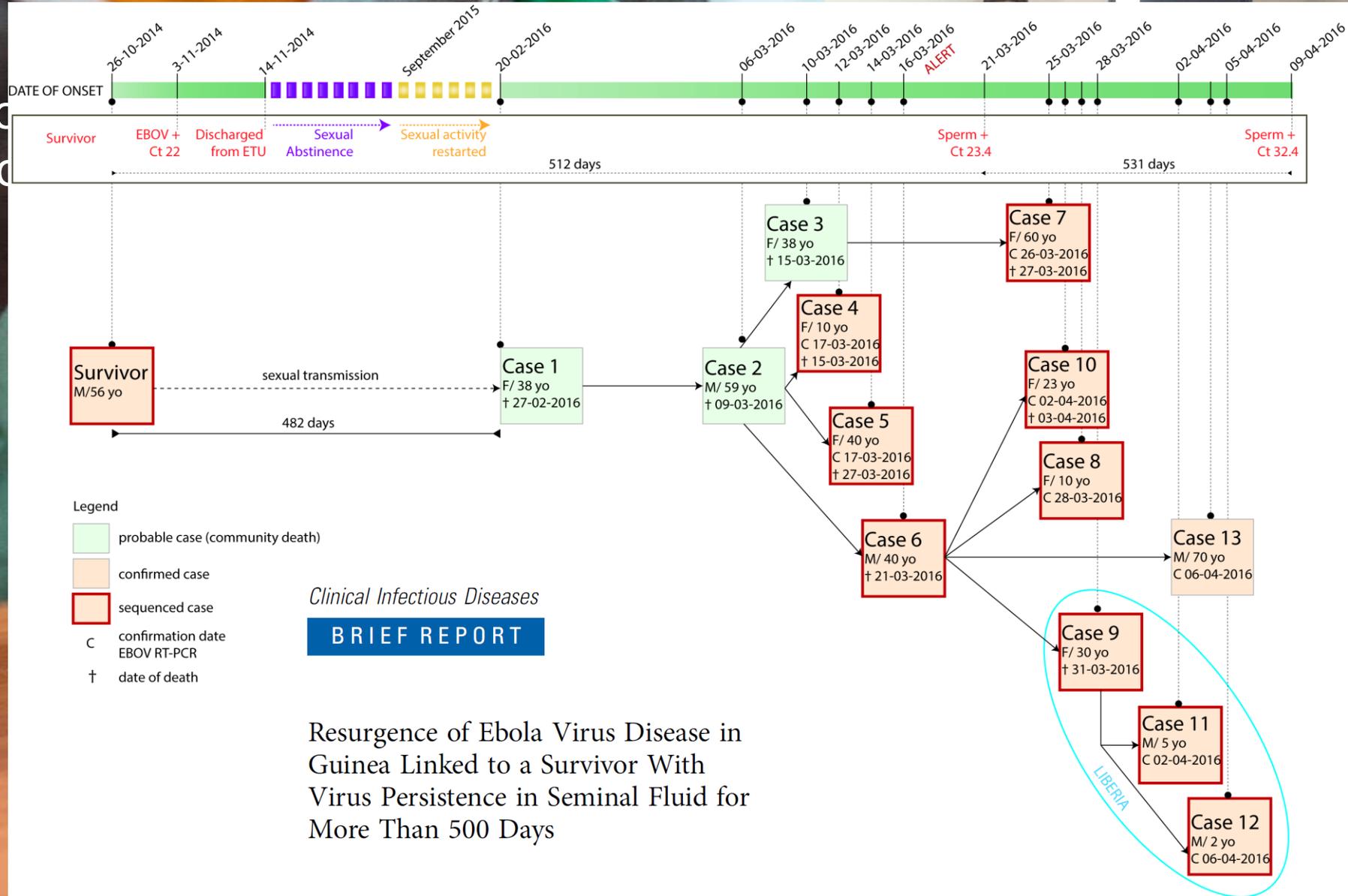
Kilian Stoecker

# Phylogenetics Over Time: Molecular Epidemiology

## Presented to WHO & Ebola Co-ordination Committee Conakry: March 2015



# EMLab May 2015 Co Molecular Epidemiolo



Quick et al Nature 2016

May 2015: EMLab Coyah ETC. Sequence turn around time 18-48 hours

# 2021 Guinea EBOV Outbreak: Persistence >5 years

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**Ebola**

## Man who survived Ebola five years ago may be source of Guinea outbreak

Finding raises questions about virus's ability to lurk long term in outwardly healthy bodies

**Lisa O'Carroll**  
@lisaocarroll  
Wed 17 Mar 2021 07:00 GMT



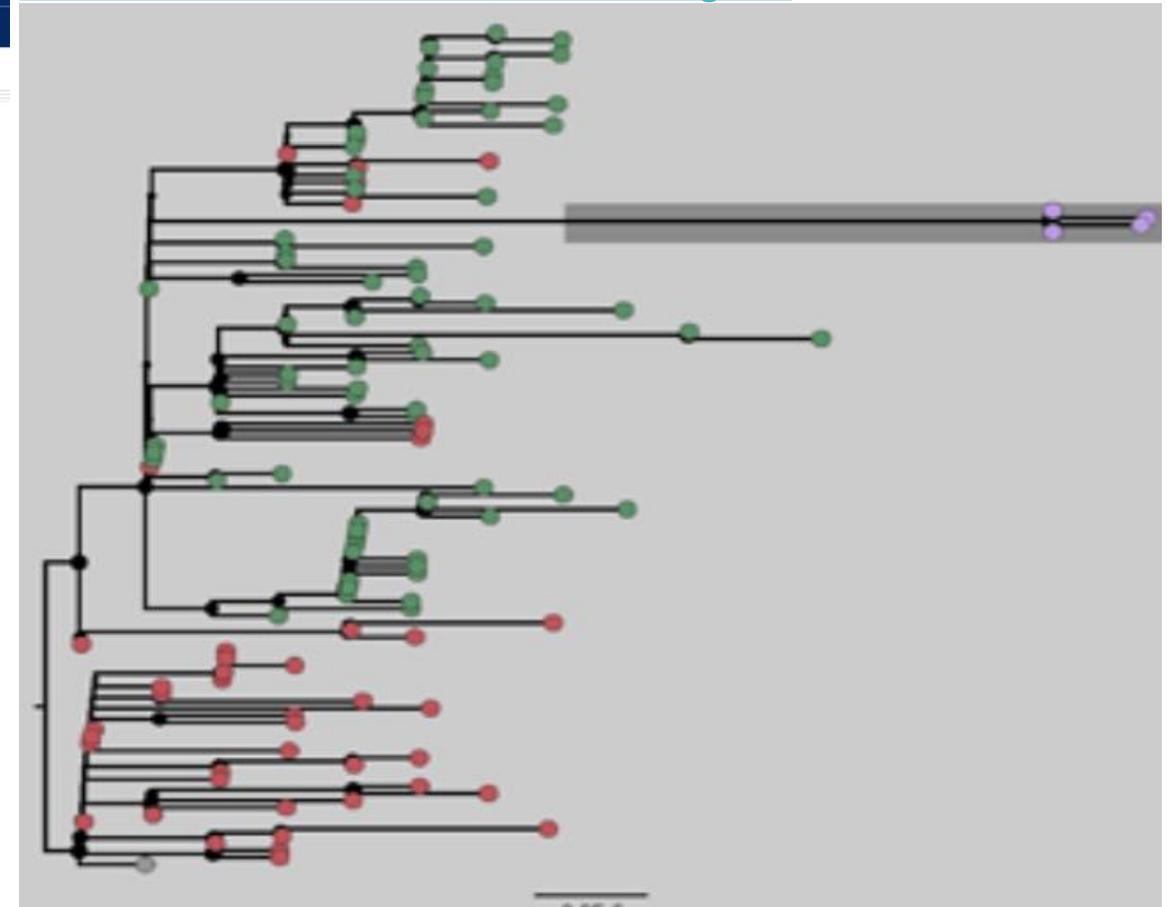
▲ The 2013-2016 Ebola outbreak in west Africa killed 11,000 people. Photograph: Ahmed Jallanzo/EPA

An Ebola survivor is likely to have triggered the current outbreak in **Guinea**, scientists have said, in a shock discovery that means the virus may remain dormant for five years.

The finding, which comes after 29 cases and 13 deaths, raises fresh questions about the ability of **Ebola** to lurk in the body long term even while the survivor remains outwardly healthy.

“This is pretty shocking,” virologist Angela Rasmussen of Georgetown University told *Science magazine*. “Ebolaviruses aren’t herpesviruses (which are known to cause long-lasting infections) and generally RNA viruses don’t just hang around not replicating at all.”

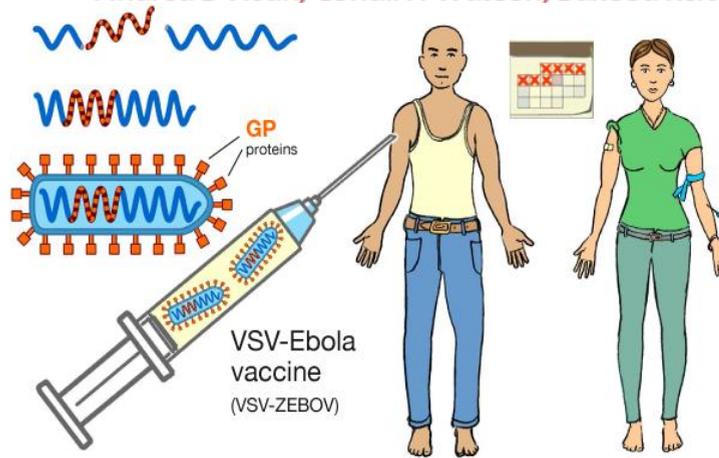
[Release - 4 EBOV genomes from Guinea 2021 outbreak - Ebolavirus / Guinea 2021 - Virological](#)



# Rapid Vaccine Development

## Efficacy and effectiveness of an rVSV-vectored vaccine expressing Ebola surface glycoprotein: interim results from the Guinea ring vaccination cluster-randomised trial

Ana Maria Henao-Restrepo, Ira M Longini, Matthias Egger, Natalie E Dean, W John Edmunds, Anton Camacho, Miles W Carroll, Moussa Doumbia, Bertrand Draguez, Sophie Duraffour, Godwin Enwere, Rebecca Grais, Stephan Gunther, Stefanie Hossmann, Mandy Kader Kondé, Souleymane Kone, Eeva Kuisma, Myron M Levine, Sema Mandal, Gunnstein Norheim, Ximena Riveros, Aboubacar Soumah, Sven Trelle, Andrea S Vicari, Conall H Watson, Sakoba Kéïta, Marie Paule Kieny\*, John-Arne Røttingen\*

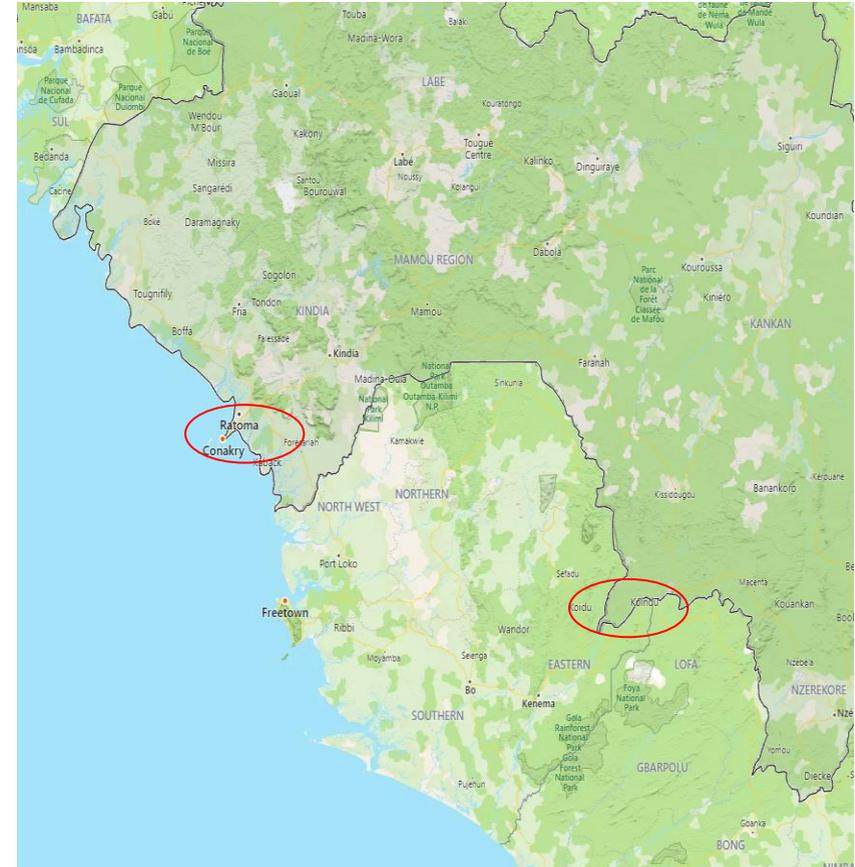


Phase I trials started late 2014. Phase III March 2015

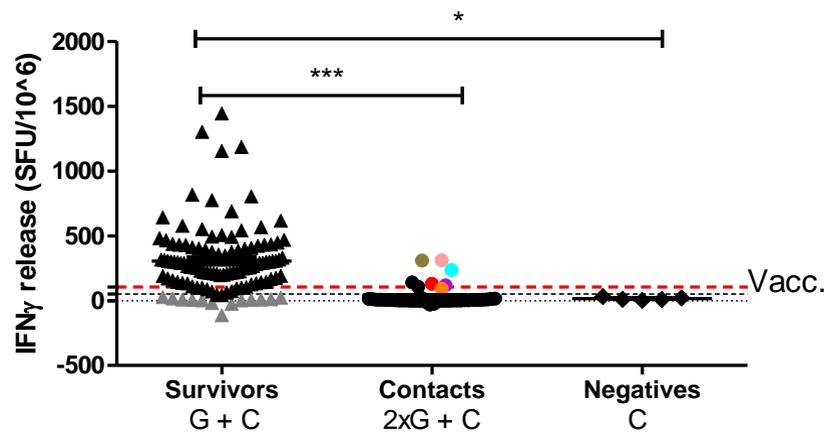
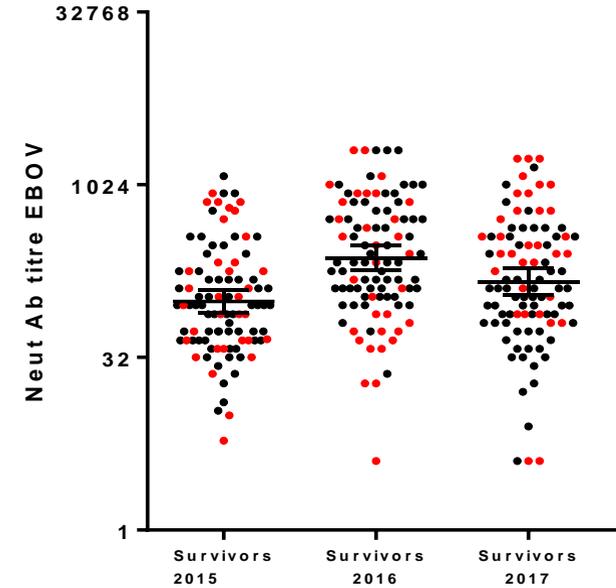
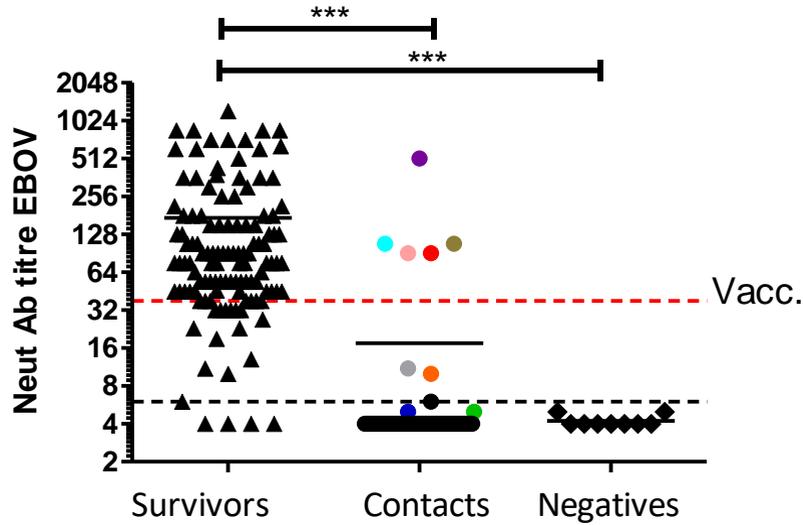
# Understanding Naturally Acquired Immunity



# Learning from Survivors and Contacts

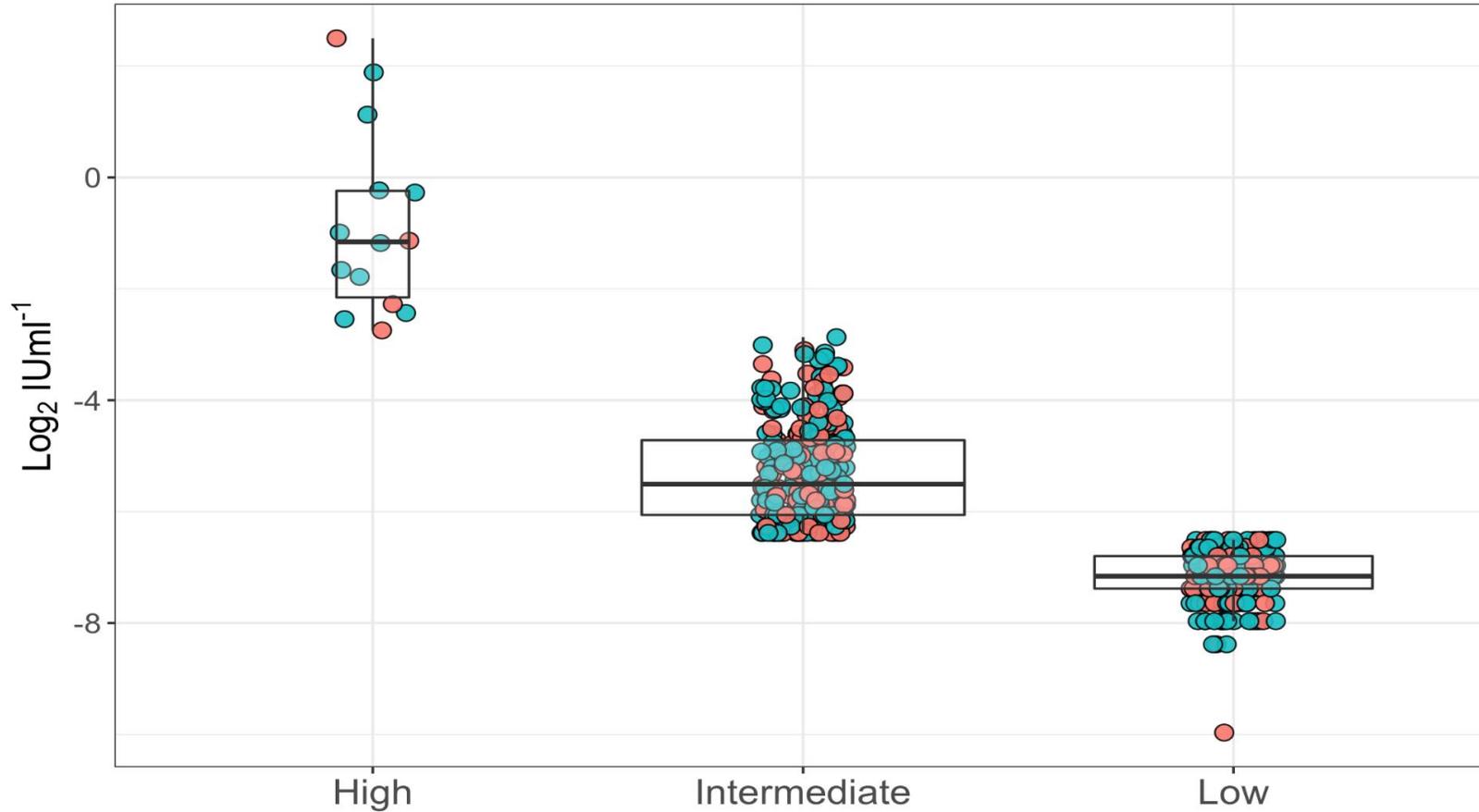


# Antibody & T Cell Responses In EVD Survivors & Contacts



- Naturally acquired immunity approx. 10-fold higher than vaccination
- No detectable circulating Ab or T cell response in some individuals
- A symptomatic infections do occur
- Long term “protective” immunity

# Evidence of Prior Filovirus Spill-over Events: Looking for Pathogen Footprints



# WHO 2018 Panel Conclusions

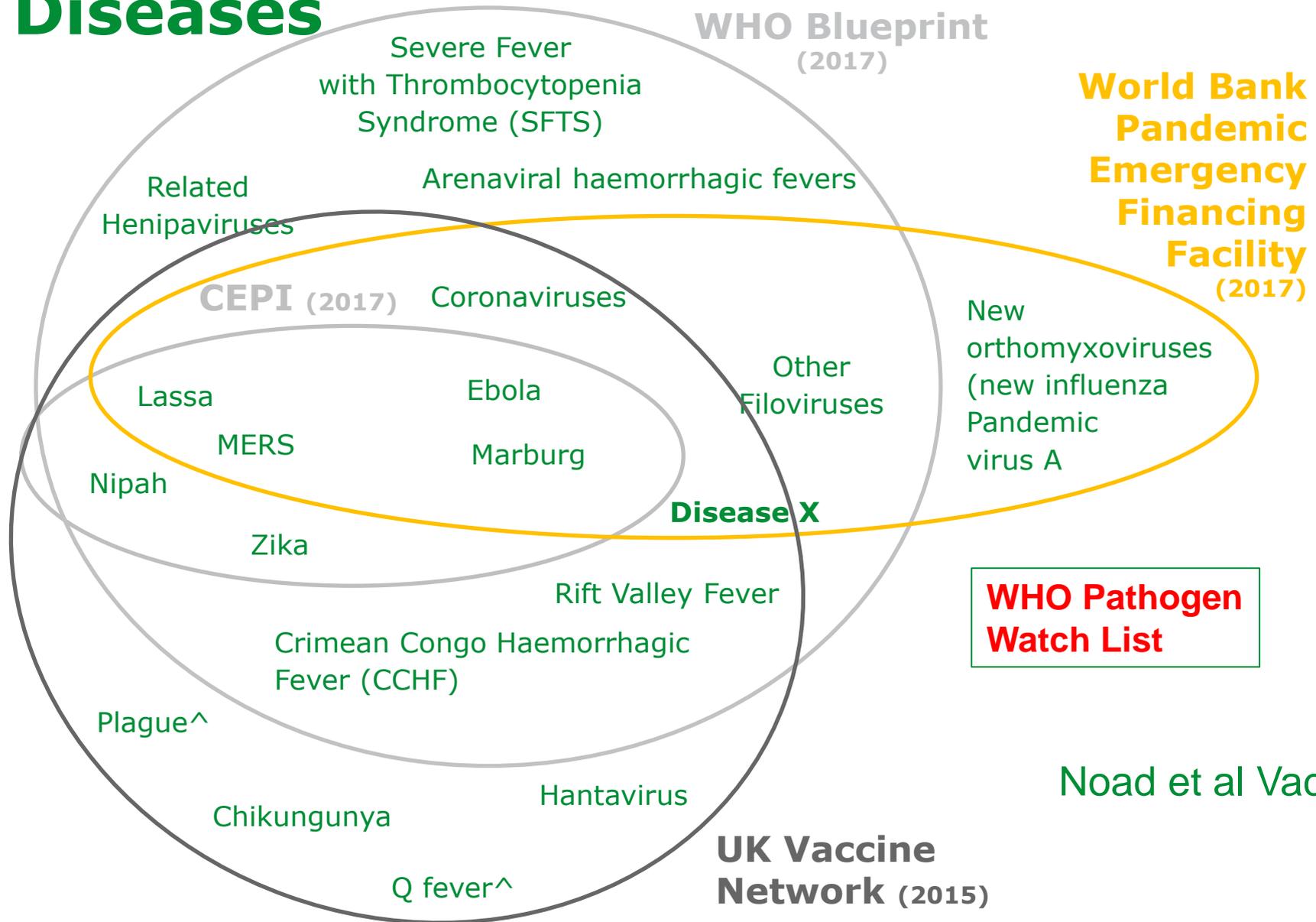
The 2018 annual review determined that given their potential to cause a public health emergency and the absence of efficacious drugs and/or vaccines, there is an urgent need for accelerated research and development for:<sup>4</sup>

- Crimean-Congo Hemorrhagic Fever (CCHF)
- Ebola Viral Disease and Marburg Viral Disease
- Lassa Fever
- Middle East respiratory syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS)
- Nipah and henipaviral diseases
- Rift Valley Fever (RVF)
- Zika disease
- Disease X

**2018 Panel concluded that the next pan/epidemic will most likely be caused by a pathogenic respiratory coronavirus**



# Priority Diseases



^bacteria

# Developing Vaccines to Priority Emerging Diseases



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## New vaccines for a safer world

The Coalition for Epidemic Preparedness Innovations (CEPI) is a global partnership launched in 2017 to develop vaccines to stop future epidemics.

FIND OUT MORE

<https://cepi.net/about/whyweexist/>

# Summary

- Viruses are emerging continually: Most are RNA and zoonotic
- Human behaviour/climate change: increases the incidence of spill over & transmission
- We only see a fraction of the spill over events
- Paucity of epidemiological/surveillance data: we need improved Ab detection platforms to understand the pathogen footprints
- Early diagnostics are vital for outbreak response
- Never believe anyone who says asymptomatic infections don't occur and pathogens can't transmit person-to-person!
- **What's coming next? Pathogen X. You can never be too prepared!**

# THANK YOU

@Carroll\_Lab\_Ox

