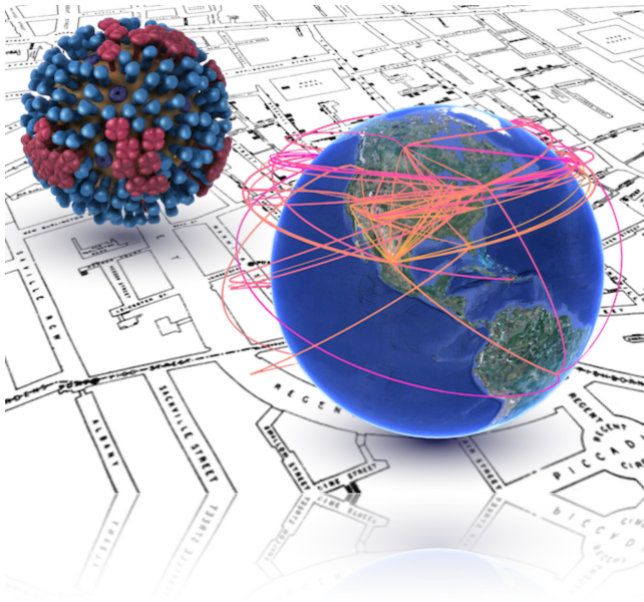


Molecular Epidemiology and Transmission of Two Deadly Human Viruses – The Ebola Virus and Lassa Virus



Kirsty Kwok

Study Program:
MPhil in Microbiology

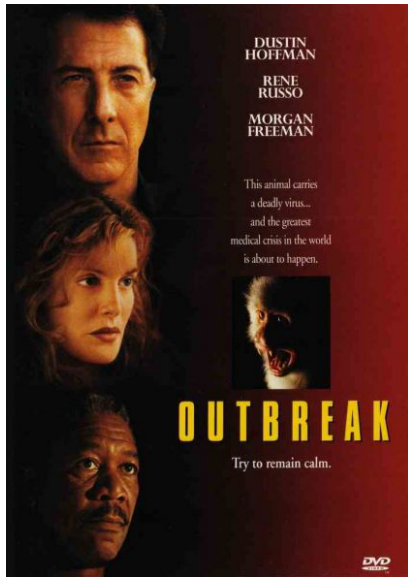
Supervisor: Dr. Martin Chan
Department of Microbiology
Friday, December 9, 2016

Lassa Endemic Zone and the 2014 Ebola outbreak



Andersen, K. *et al.* (Cell, 2015)

1995



1996



2016





Ebola virus (EBOV)

Natural reservoirs:
Likely to be bats

Average Case fatality rate:
~50%

WEST AFRICA **Ebola Outbreak**

Likely host = bats

2 in 5
people who got
Ebola in this
outbreak died.

Largest Ebola outbreak in history

Single-stranded
RNA virus

Biosafety level: 4

African viruses



Lassa virus (LASV)

Natural reservoirs:
Mastomys natalensis

80% infections: asymptotic

1 in 5 infections → severe outcome
(CFR → 15 to 20%)

CFR can be >50% in outbreaks
e.g. 2016 Nigeria outbreak
189 cases, 89 deaths
→ CFR 53.9%

Overview of EBOV and LASV **genome** sequencing studies performed during 2014–2016

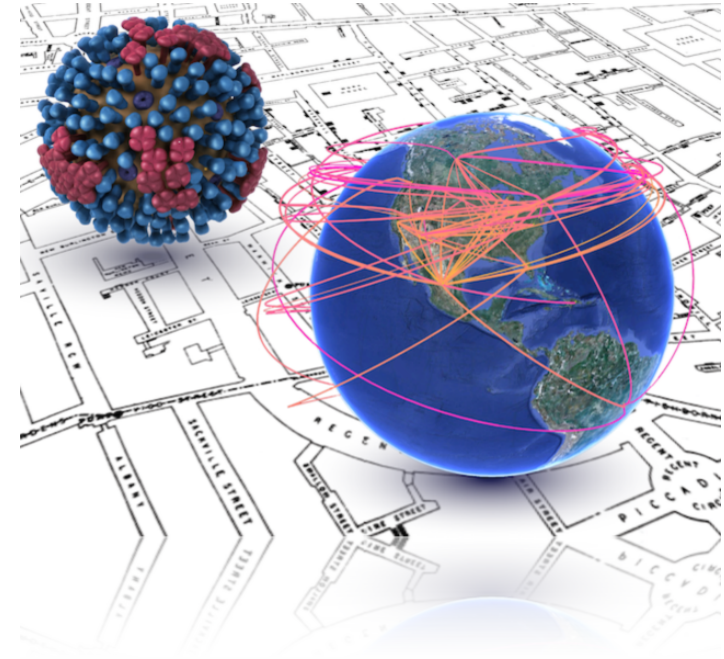
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Overview of EBOV and LASV **genome** sequencing studies performed during 2014–2016

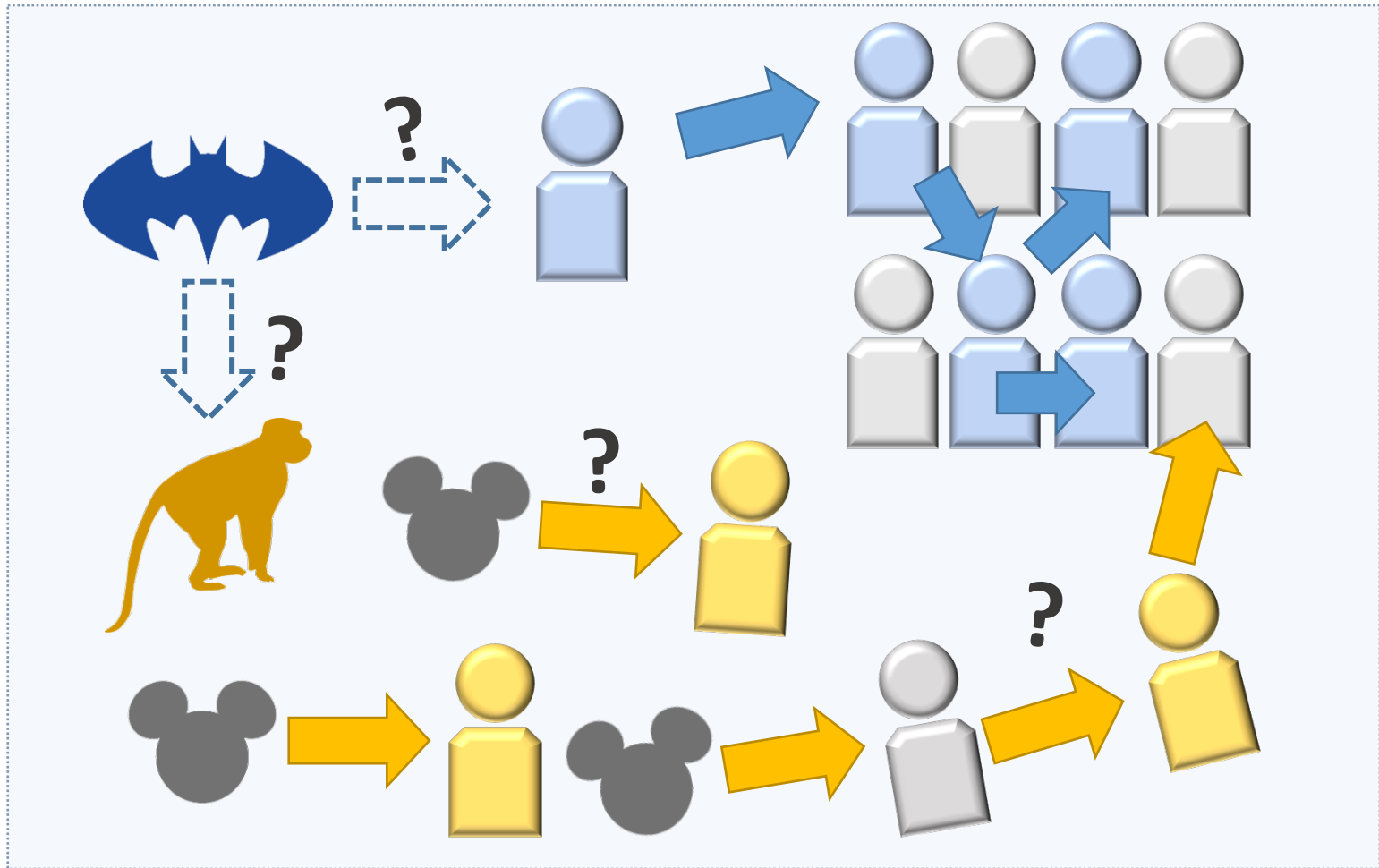
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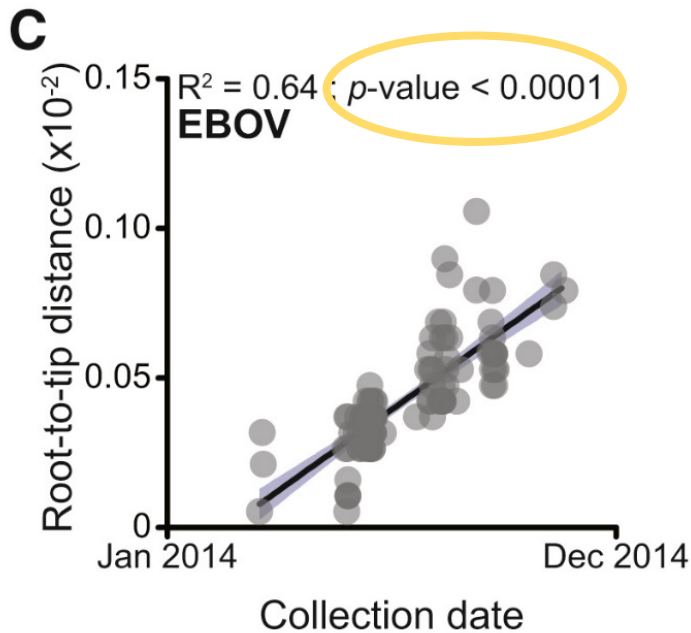
What can **genomic** molecular epidemiology studies tell us about the virus?

→ It can help us to find the transmission pattern of EBOV/LASV

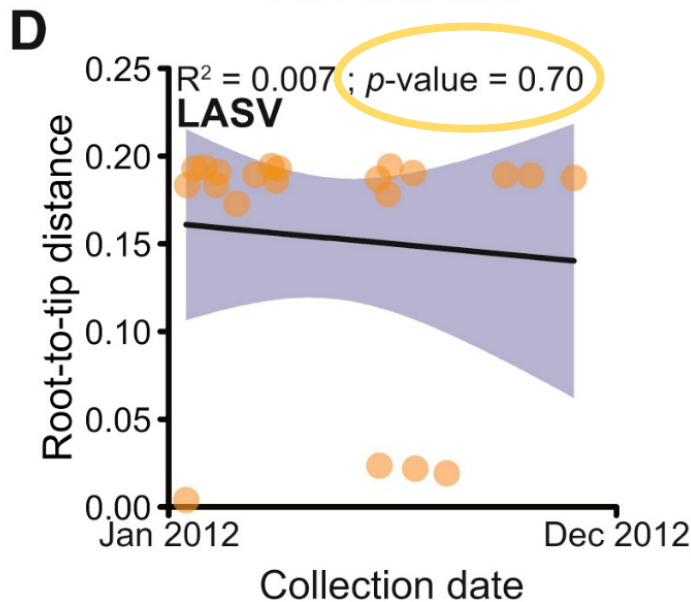


Repeated spillover from reservoirs or sustained human-to-human transmission?

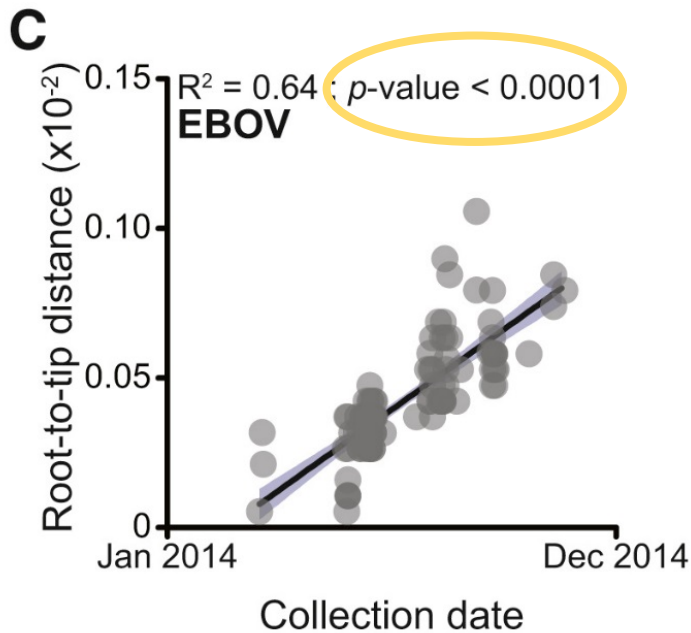




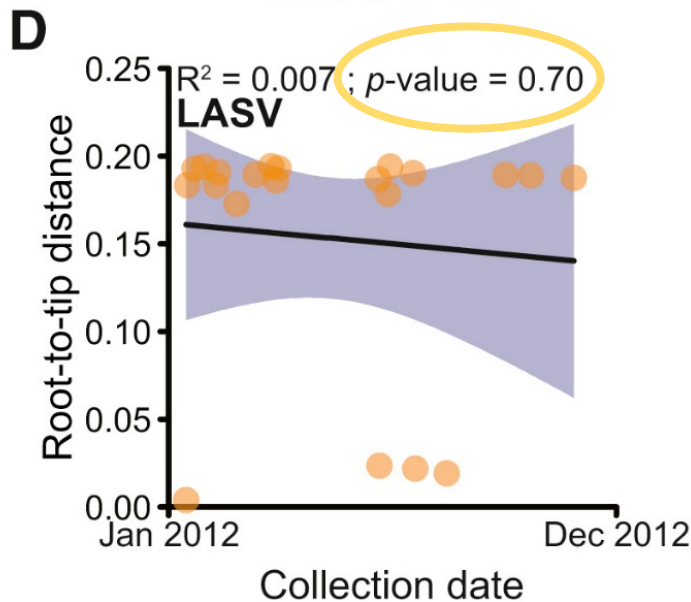
EBOV: Samples' collection date **is strongly correlated** with root-to-tip distance



LASV: **No correlation** between collection date and root-to-tip distance

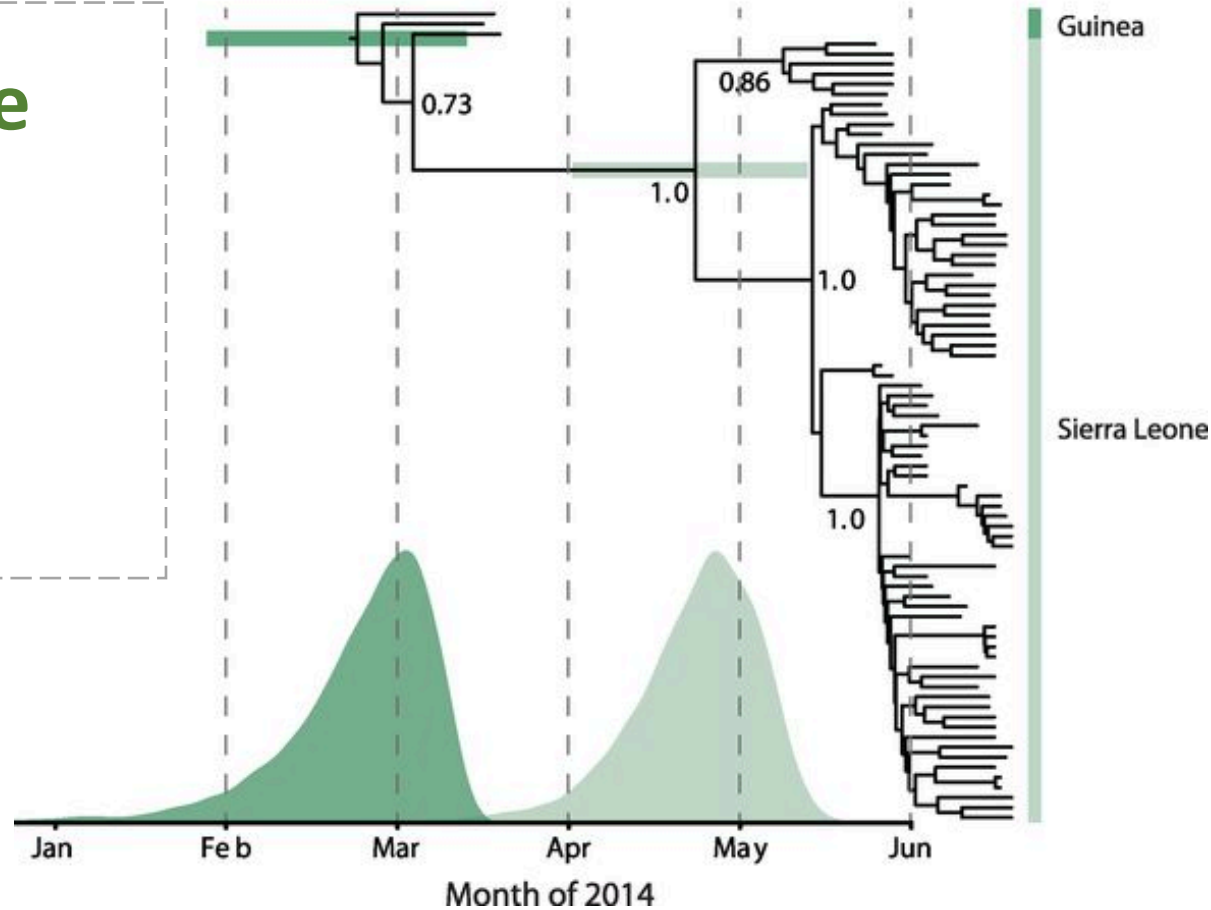


EBOV: Human-to-human transmission is compatible with this correlation

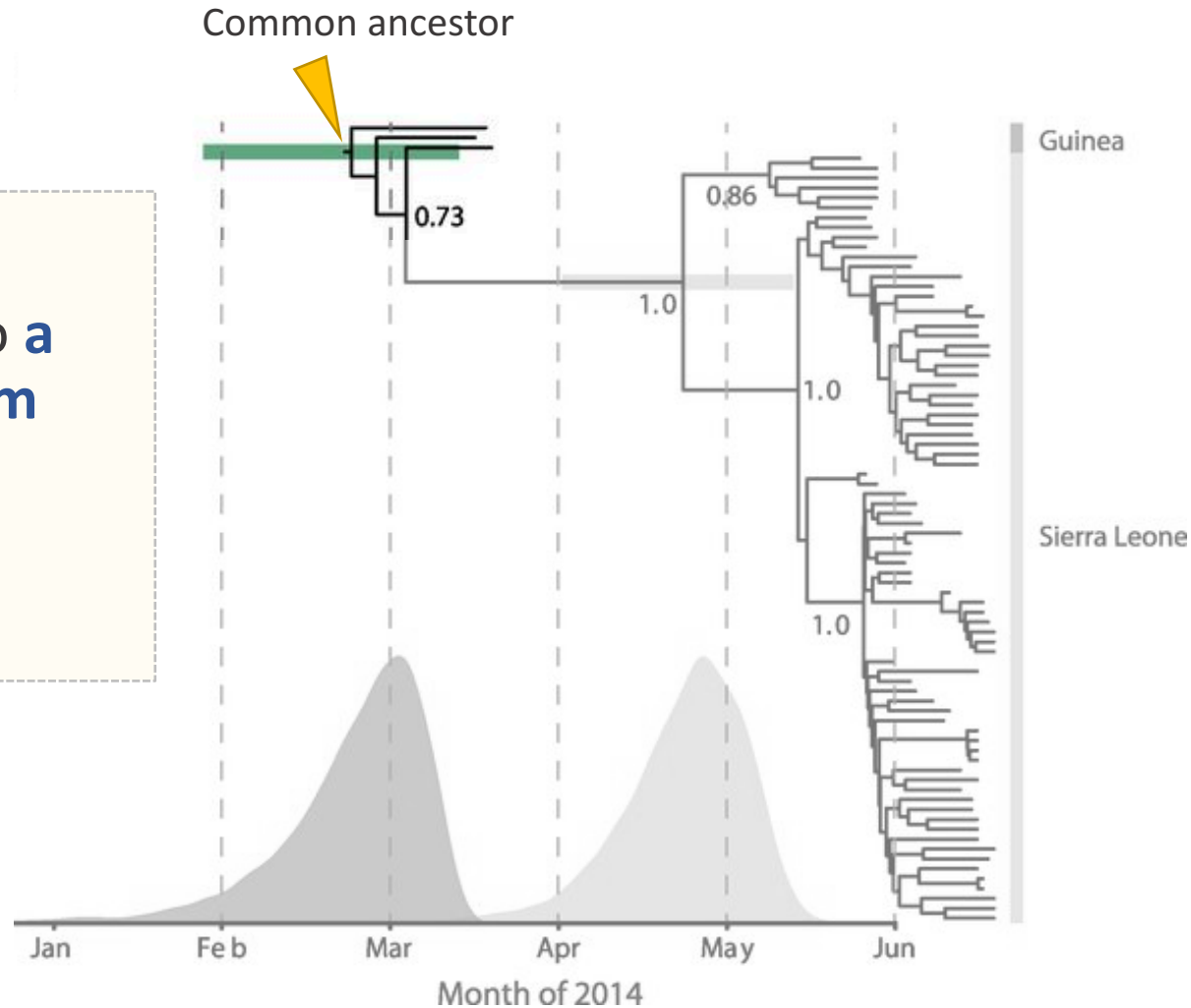


LASV: Transmission is likely from a common source of infection i.e. natural reservoirs

What can **genome sequencing** tell us about the most recent EBOV outbreak?



The most recent Ebola Epidemic is likely due to a **single transmission from the natural reservoir, followed by human-to-human transmission!**



Patient zero

An 18-month-old boy

Location: **Meliandou, Guinea**

Date of onset of symptoms:

26 December 2013

Symptoms: Fever, black stools, and vomiting

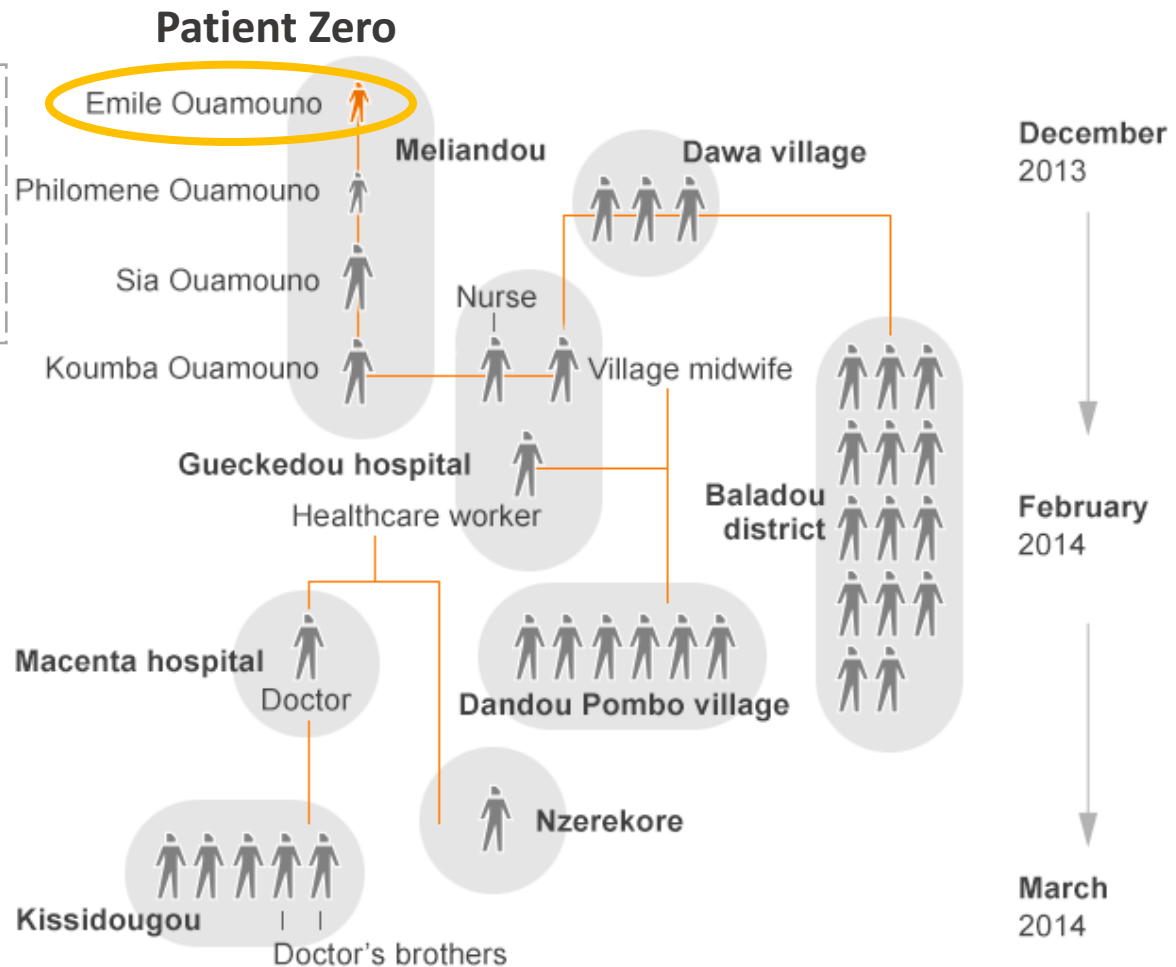
Results: Died two days later

Possible source of infection:

The child was seen playing in his backyard near **a hollow tree heavily infested with bats**

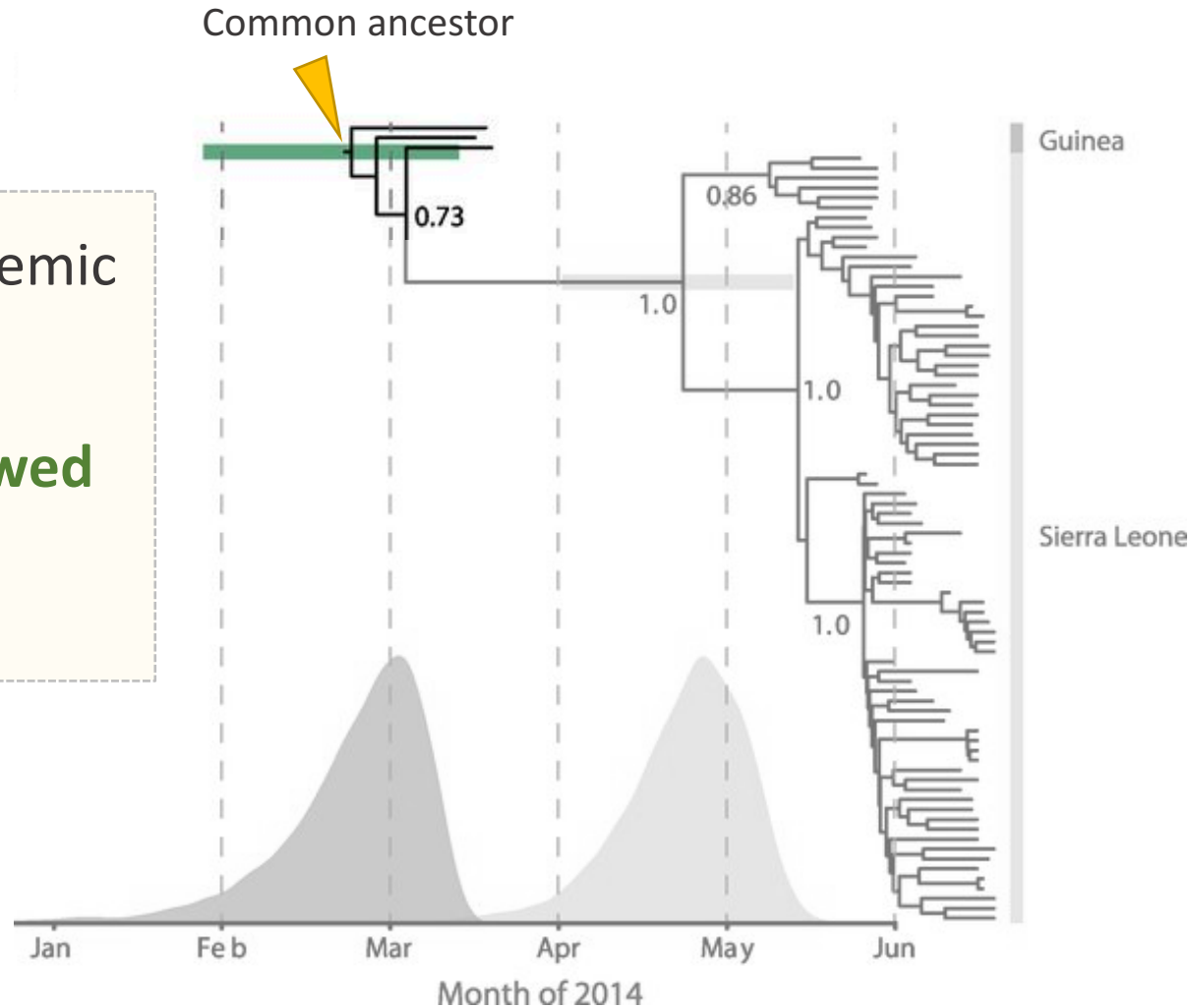


How did the outbreak start?



Source: New England Journal of Medicine

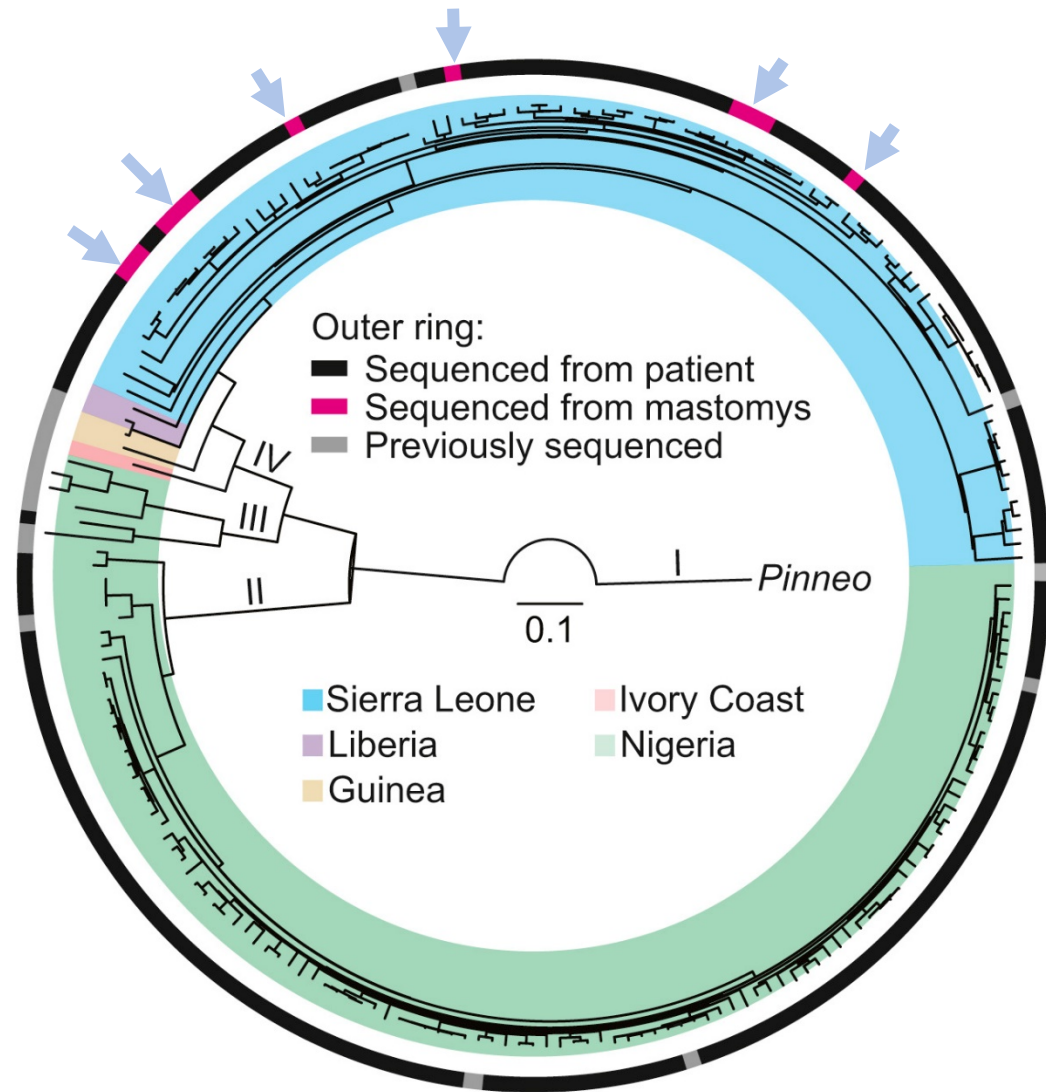
2013 – 2015 Ebola Epidemic is likely due to a **single transmission from the natural reservoir, followed by human-to-human transmission!**



What about LASV?

LASV: Rodent strains are **interspersed** with human strains

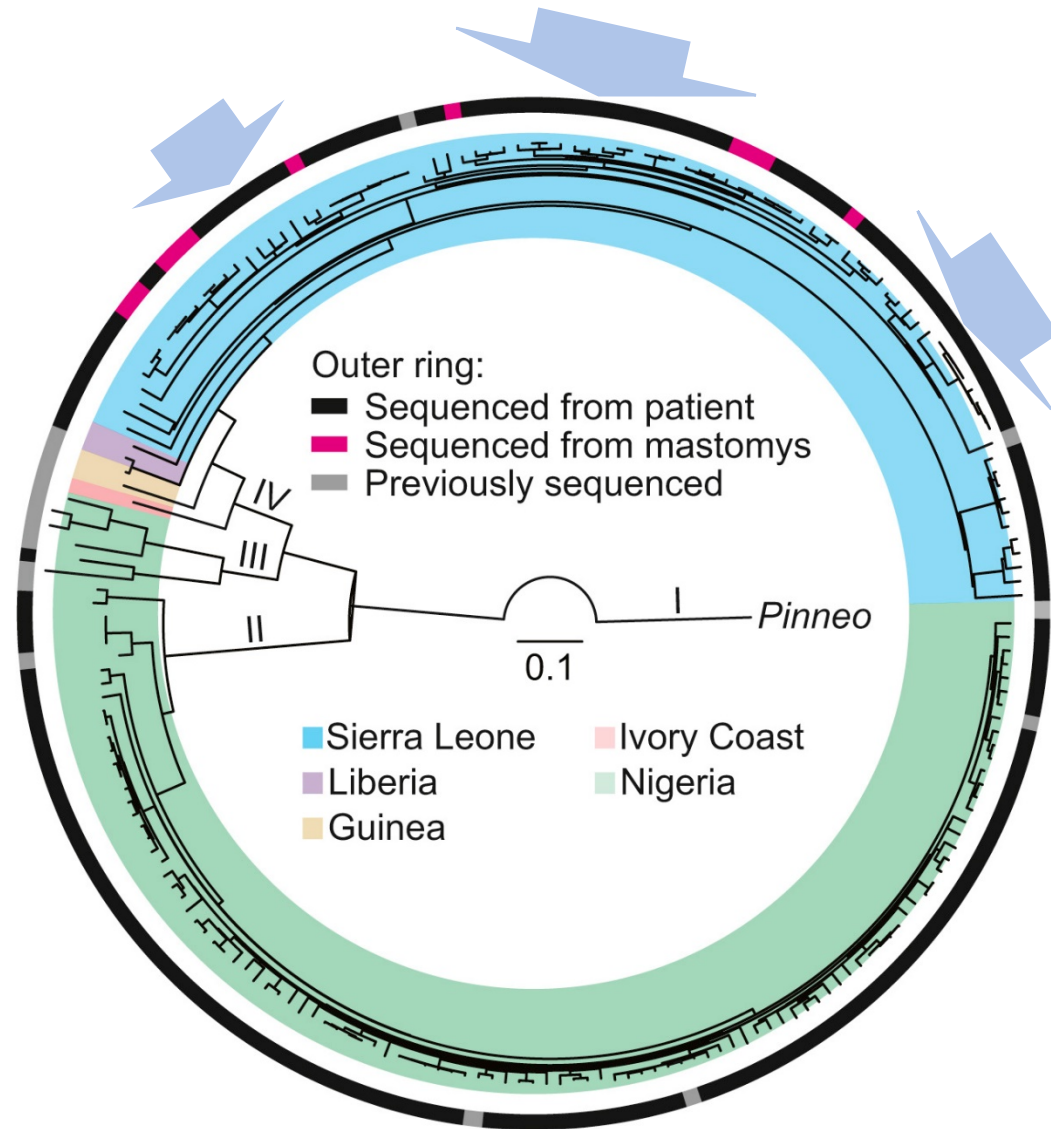
LASV: **Multiple reservoirs-to-human** transmission events in LASV infections



What about LASV?

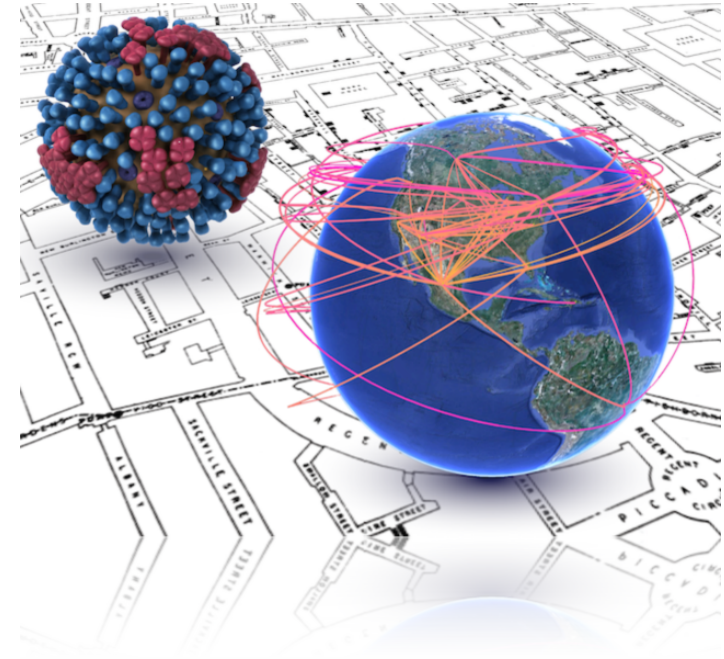
LASV: Branches developing in patients' strains

LASV: **Human-to-human** transmission events do sometimes occur in LASV infections too



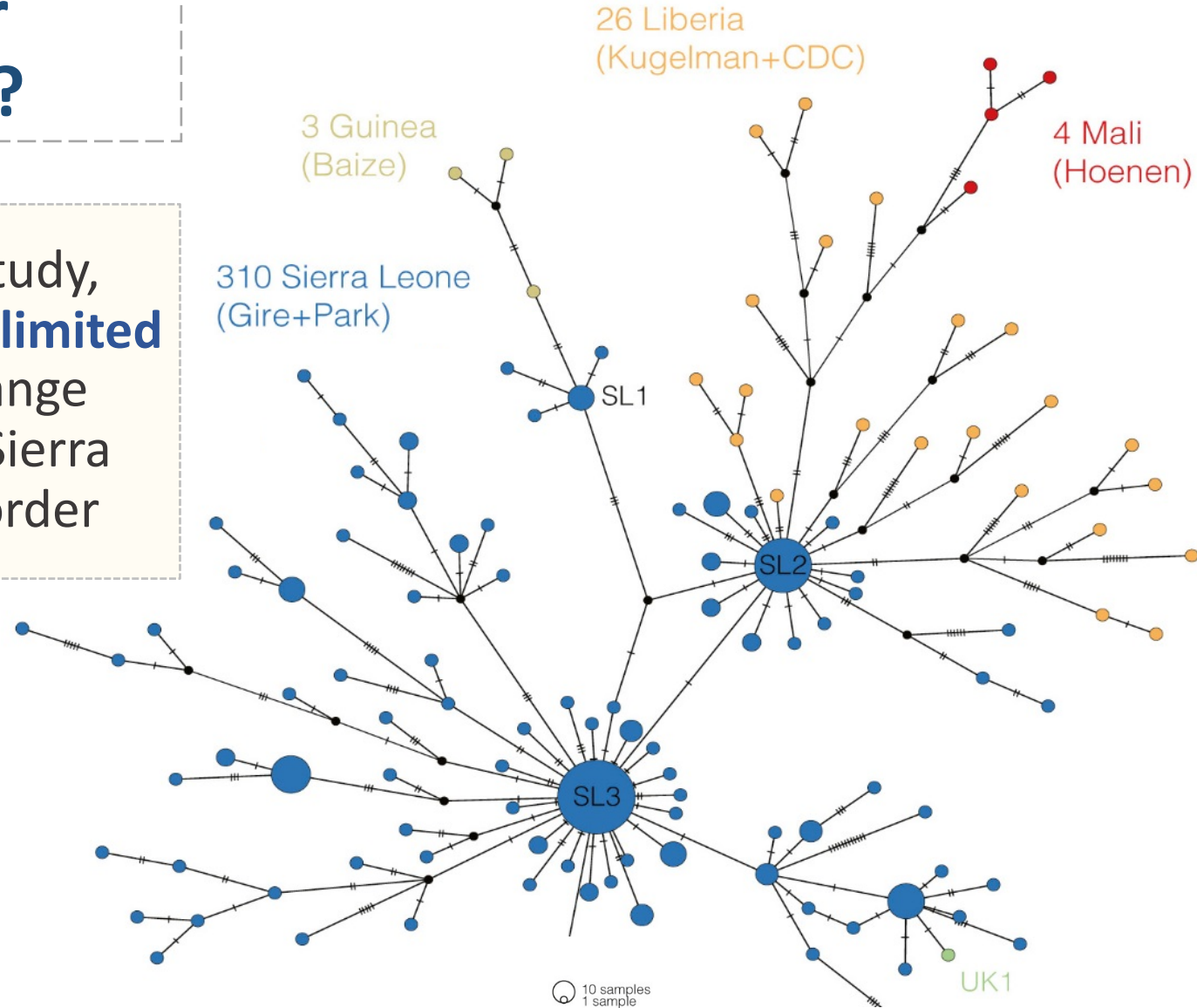
What can **genomic** molecular epidemiology studies tell us about the virus?

→ It can help us to monitor the transmissions of EBOV across borders

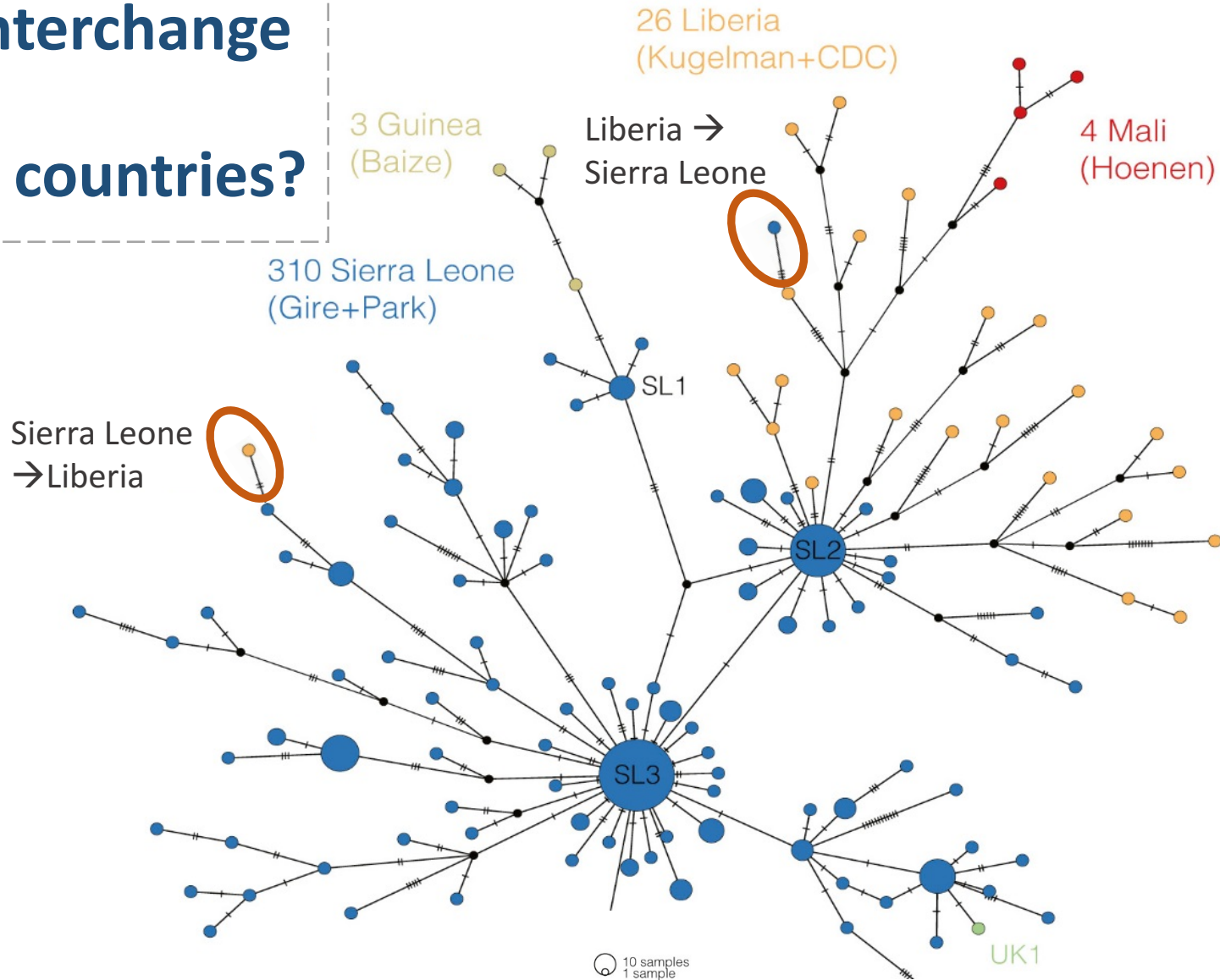


Does transmission of EBOV occur across border?

EBOV: From **this** study, we can see **limited** EBOV exchange across the Sierra Leonean Border

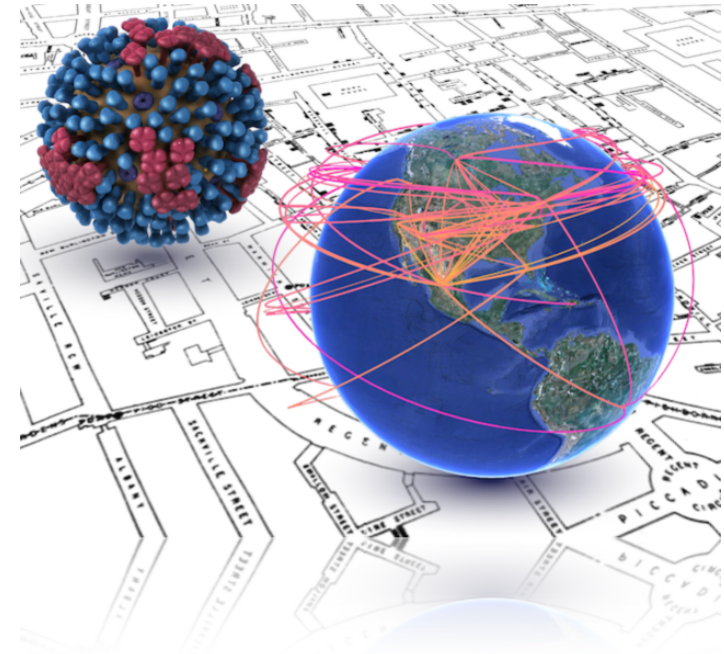


What will we see if
free EBOV interchange
occurs with
neighboring countries?



Can **genomic** molecular epidemiology studies help us to contain an outbreak?

What are the **public health** usefulness of **genomic** molecular epidemiology?



Genomic Epidemiology X Public Health

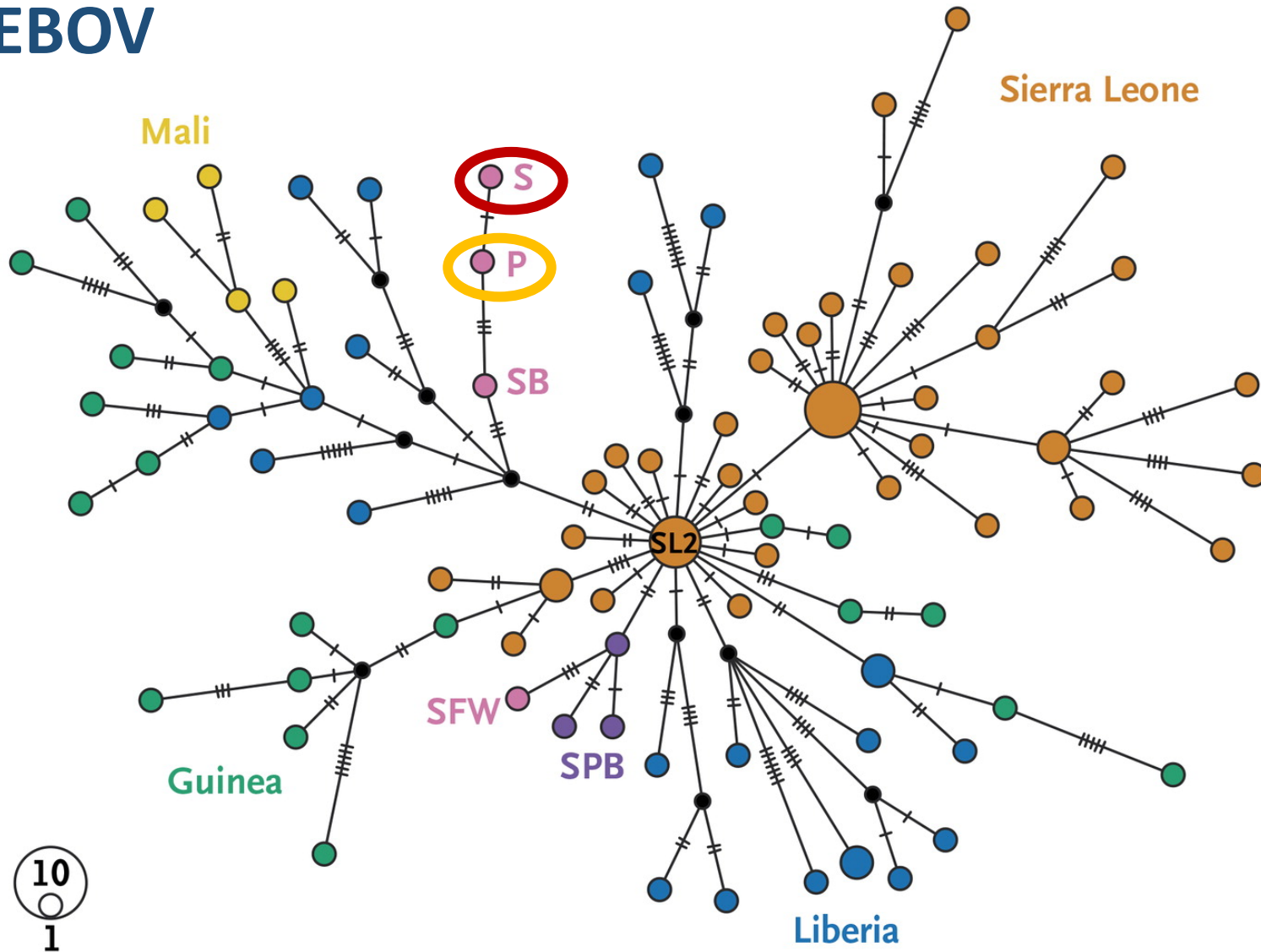
Identify possible
transmission routes

**Genomic
Epidemiology**

Reconstruct EBOV
transmission chain and
spread in the epidemic

Monitor virus
evolution

Molecular evidence of sexual transmission of EBOV



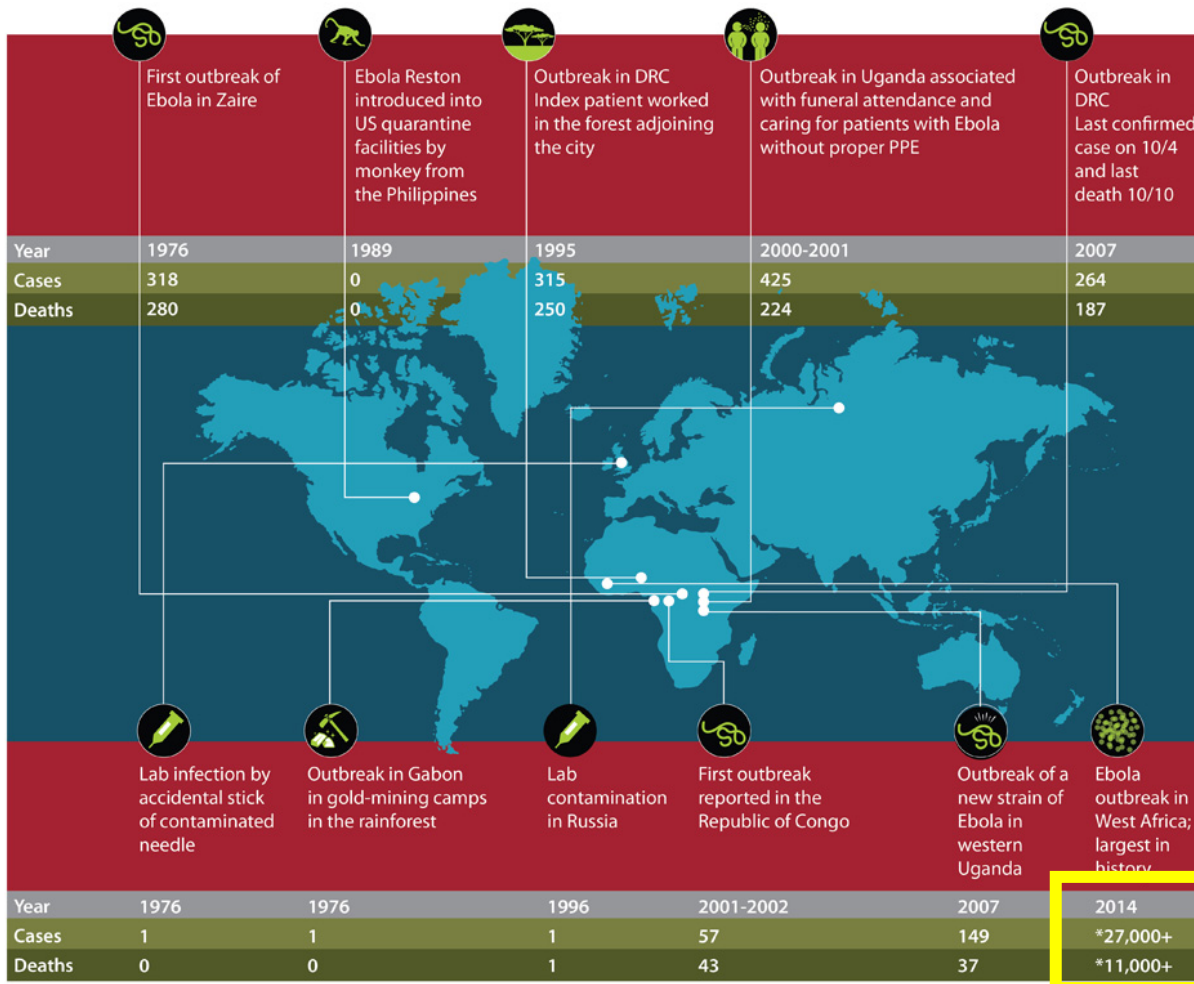
The power of whole genome molecular epidemiology

Video:

<https://vimeo.com/156668942>



Outbreaks chronology: Ebola virus disease



WEST AFRICA Ebola Outbreak

Likely host = bats

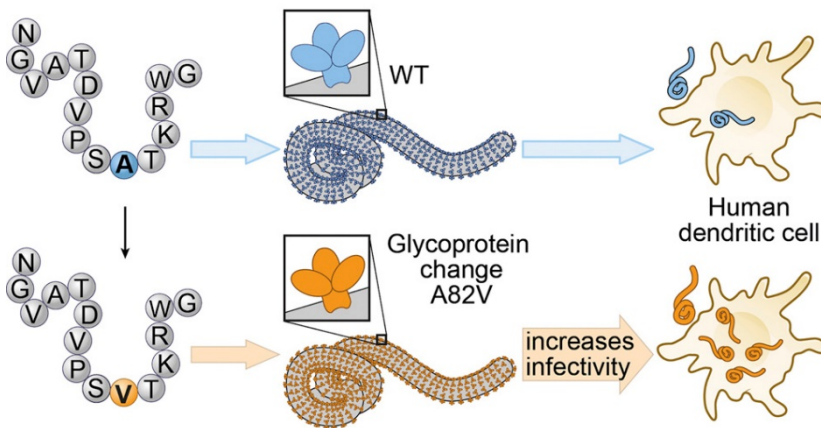
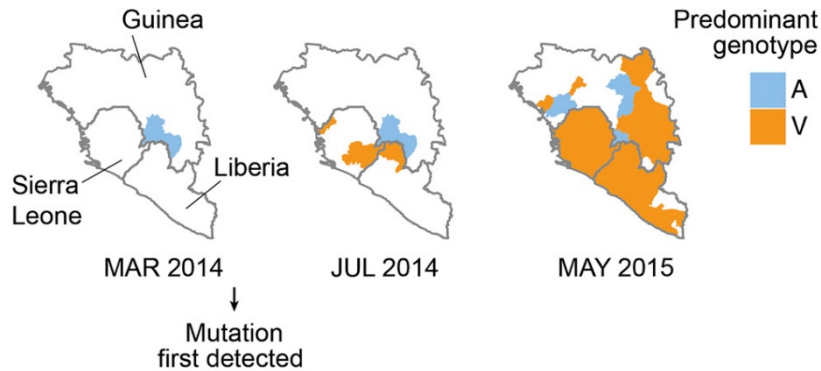
Largest Ebola outbreak in history

2 in 5 people who got Ebola in this outbreak died.

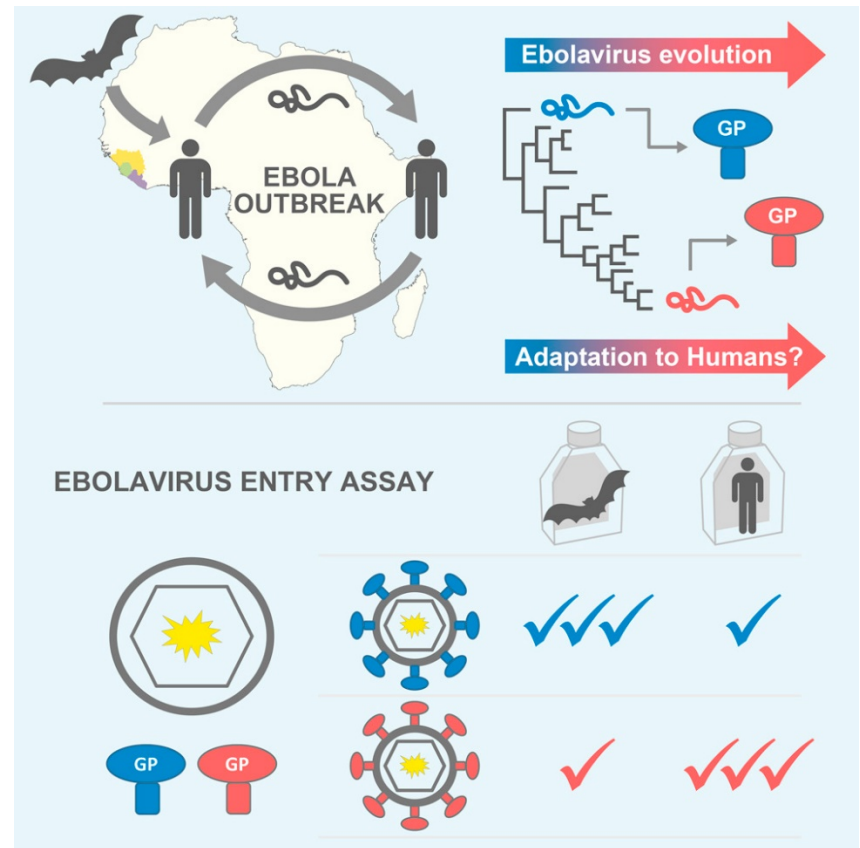
CS 252971

* As of July 18, 2015

Why the 2013–2016 EBOV outbreak was so much larger than previous outbreaks?



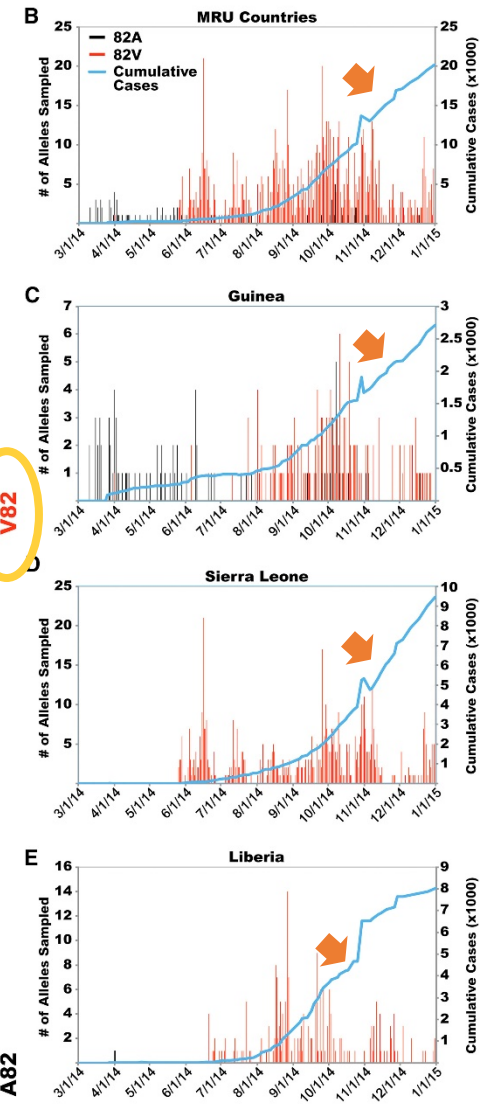
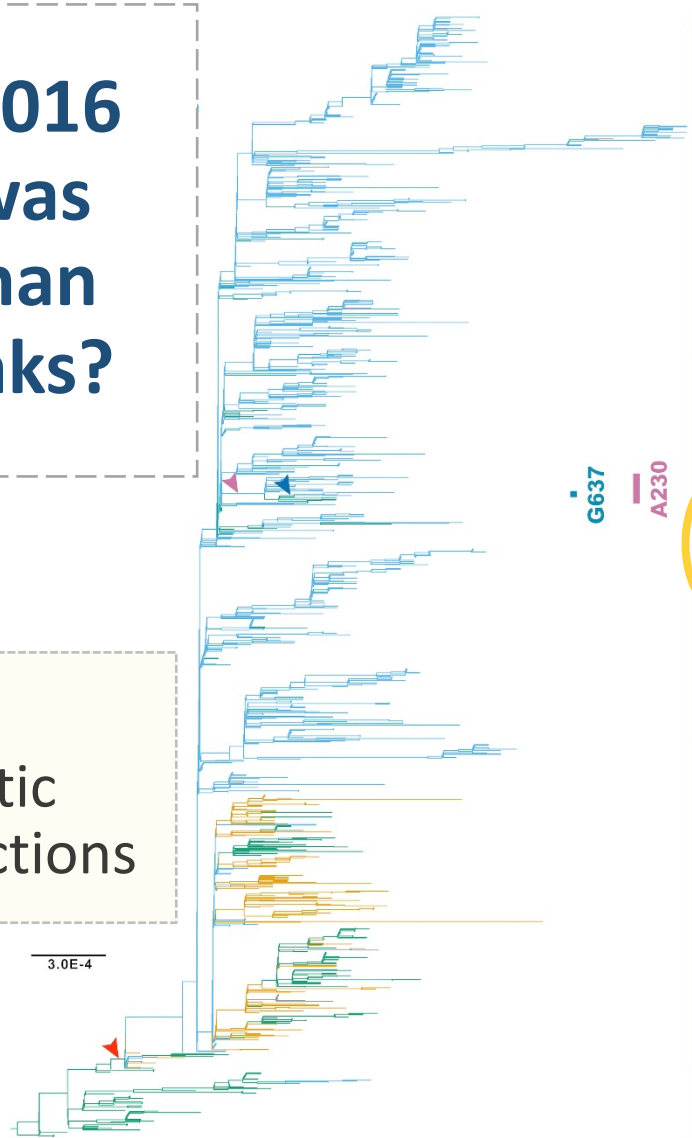
William, E.D. *et al.* (Cell, 2016)



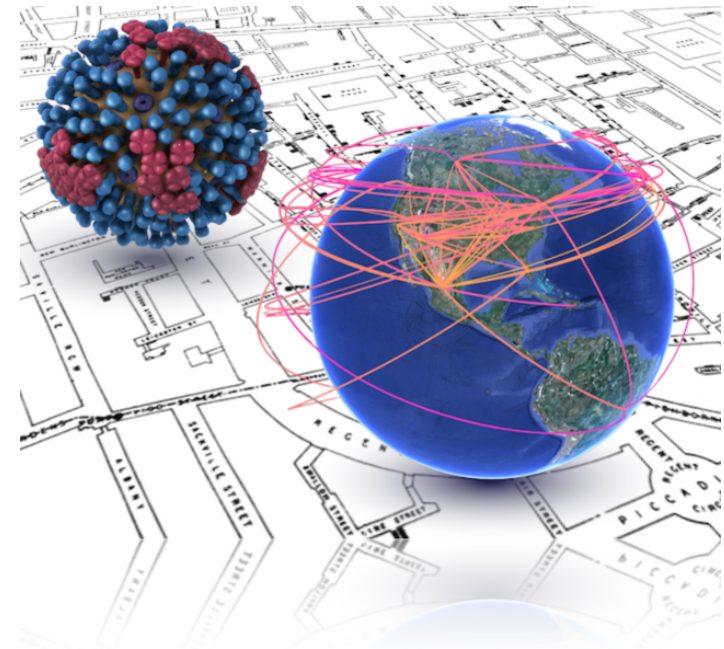
Richard, A.U. *et al.* (Cell, 2016)

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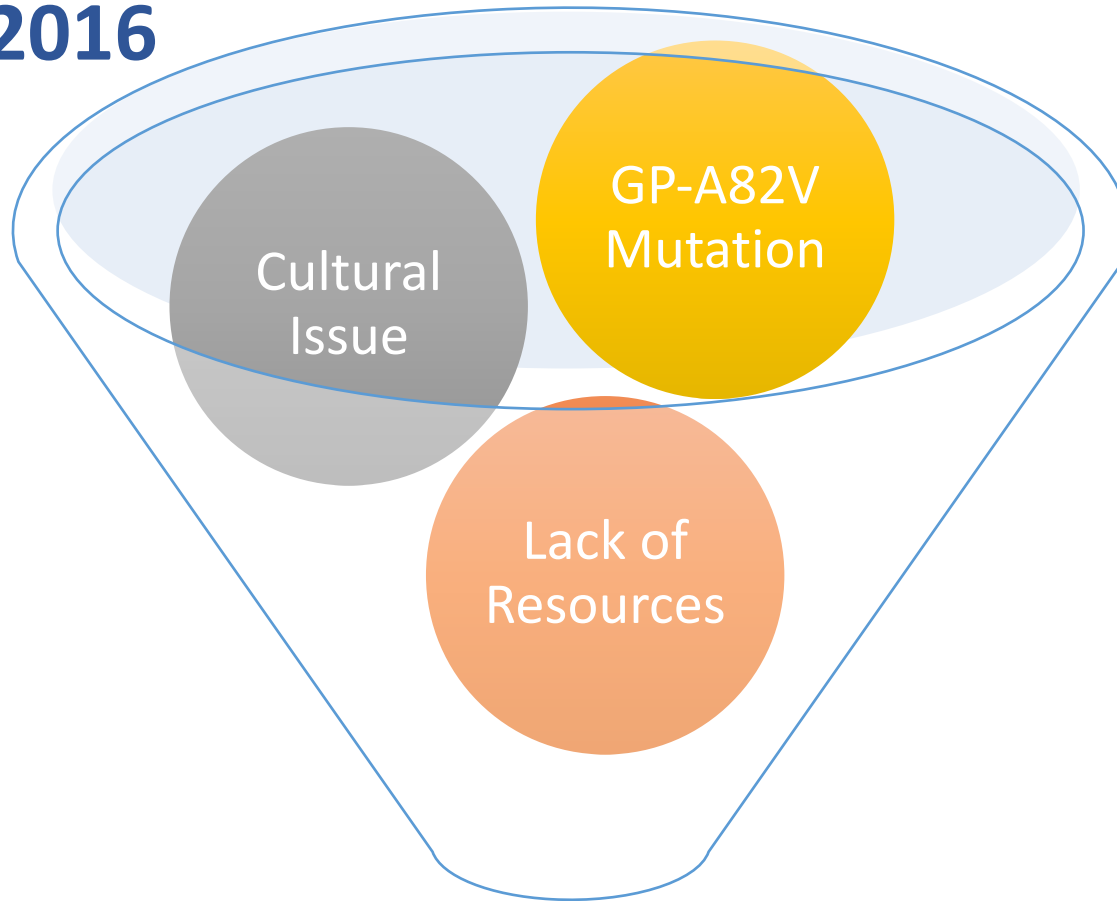
Evolution of GP-A82V
Coincides with Dramatic Increase in EBOV Infections



Lessons learned and future directions in outbreak response



Multiple factors contribute to EBOV epidemic 2013 – 2016



Largest EBOV Outbreak in History

WHO One year report

*“A “mysterious” disease began silently spreading in a small village in Guinea on **26 December 2013** but was not identified as Ebola until **21 March 2014**”*

Delayed diagnosis

- Delayed alert**
- Delayed infection control**
- EBOV Outbreak!**

Lack of sequencing capacity in Africa

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What are needed for future outbreak responses in the affected countries?



European Mobile Laboratory Project

[Background](#) | [Concept](#) | [Activities](#) | [Units](#) | [Partners](#) | [News & Events](#)

- ✓ Healthcare infrastructure
- ✓ Healthcare training of local staff
- ✓ Local laboratory capacity
- ✓ Shared sequences database
- ✓ Portable sequencing technologies



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HAVE YOU CONSIDERED



USING A MinION?

Image References

Slide #	Url
1	http://tree.bio.ed.ac.uk/research/molepi.png https://www.usaid.gov/sites/default/files/nodeimage/Power-Africa-map-rev.png
2	https://upload.wikimedia.org/wikipedia/en/0/08/Outbreak_movie.JPG http://4.bp.blogspot.com/JJ466EDrFA/Ub8yqkGN5OI/AAAAAAAHMg/98wqYnz0NUY/s1600/Ebola+Syndrome+1.jpg http://93daysmovie.com/wp-content/uploads/2014/11/93DaysWebPoster1.jpg
3	http://farm3.staticflickr.com/2237/2044987545_0e36ef42d7.jpg
6,17,20,27	http://tree.bio.ed.ac.uk/research/molepi.png https://www.aacc.org/~media/images/cln/articles/2012/april/dnasequencing.jpg?la=en
7	http://images.clipartpanda.com/batman-clipart-black-and-white-batman-20clip-20art--batman-clipart-8.png http://images.clipartpanda.com/mickey-mouse-head-clipart-13555293131641649437untitled-hi.png
12	https://upload.wikimedia.org/wikipedia/commons/e/ed/Flag_of_Guinea.svg http://www.unmultimedia.org/radio/english/wp-content/uploads/2014/10/meliandou1.jpg
27	https://thumbs.dreamstime.com/x/stop-ebola-modified-sign-virus-45915586.jpg
31,32	http://ngs-expert.com/wp-content/uploads/2014/06/4130_mini_ion_lab-copy.png https://upload.wikimedia.org/wikipedia/commons/thumb/f/fa/Flag_of_the_People's_Republic_of_China.svg/2000px-Flag_of_the_People's_Republic_of_China.svg.png http://az616578.vo.msecnd.net/files/2016/03/15/635936094413774872601650525_share.jpg https://europa.eu/european-union/sites/europa.eu/files/docs/body/flag_yellow_high.jpg https://upload.wikimedia.org/wikipedia/en/thumb/a/a4/Flag_of_the_United_States.svg/300px-Flag_of_the_United_States.svg.png http://plusquotes.com/images/quotes-img/Minion.jpg
34	http://flusolution.net/wp-content/uploads/2014/08/Photo-Ebola-Map-of-Africa.jpg

Thank you

