Key research needs to better predict future filovirus outbreaks

Vincent Munster, PhD
Rocky Mountain Laboratories, NIAID, NIH
Ebolavirus ecology: complex interplay between species

Modes of transmission
- Contact with feces of infected animal
- Contact with meat of infected animal consumed
- Contact with dead infected body
- Contact with infected medical equipment
- Contact with living infected entity
- Ingest fruit partially eaten by infected animal

V. ALTOUNIAN/SCIENCE
-Filoviruses and their outbreaks
Why is Ebola virus special?

- Reservoir → Transmission from reservoir → Human-to-human transmission

Most other viral zoonoses

Ebola virus disease

Reservoir

Transmission from reservoir

Human-to-human transmission

Matson et al, 2020 EMI
• Ecology between hosts
  – Host interactions
  – Ecological niches
  – Transmission

• Ecology within the host
  – Immune response
  – Virus mechanics
  – Persistence
Bats as Filovirus Hosts

Lloviu virus
Schreiber's bat
Miniopterus schreibersii

Mênlâ virus
Rousettus sp.

Marburg virus
Egyptian rousette
Rousettus aegyptiacus

Dehong virus
Leschenault's rousette
Rousettus leschenaultii

Bombali virus
Mops condylurus
Chaerephon pumilus

(Rohlf et al. 2022; doi: 10.1038/s41564-018-0328-

(He et al. 2019; doi: 10.1038/s41564-018-0328-4)
Ebolaviruses: Evidence for bats as the reservoir

*Mops condylurus* (Angolan free-tailed bat): host for Bombali virus – Sierra Leone and Kenya
Ebolaviruses: Evidence for bats as the reservoir
Ebola viruses: Evidence for bats as the reservoir

Mineopterus inflatus (Greater Long-fingered bat): 25% EBOV genome
Current DRC spillover

2013 West Africa spillover

2014-2018 spillovers

Guineo-Congolian rainforest

Approximate geographical spread per outbreak

1976-2012 spillovers

Matson et al, 2020 EMI
Pigott Elife 2014
Ecological niche mapping identifies putative bat host species for EBOV

Judson et al., PLoS Pathogens 2016
Marburg Rousettus host mapping shows clear spillover risk
Ebolavirus: changing spatial connectivity in Africa

![Graph showing correlation between road length and cases in first 100 days]

- Roads
- Current Out
- Recent Out
- Spillover Ev
- Photo Local


Munster et al., NEJM 2018
Gonzales et al., BioRxiv 2023
Ebola virus, bats as bushmeat, DRC 2017
Ebolavirus outbreak West Africa, Liberia
- Sexual transmission -

Sept. 29
S: First blood sample tests EBOV-negative

Sept. 23
S: Enters ETU

Sept. 9
S: Estimated EVD onset

Oct. 7
S: Exits ETU

Oct. 3
S: Second blood sample tests EBOV-negative

March 7
S and P engage in sexual intercourse

March 14
P: EVD onset

March 19
P: Enters ETU

March 20
P: Blood sample tests EBOV-positive

March 27
S: First semen sample tests EVD-positive; P: Dies from EVD

April 28
S: Second semen sample tests EBOV-negative

May 2
S: Third semen sample tests EBOV-negative

September 2014
October 2014
November 2014–February 2015
March 2015
April 2015
May 2015

179 Days

175 Days

155 Days

199 Days

Christie et al., MWWR 2015
Mate et al., NEJM 2015
Multiple origins of Ebola virus Disease outbreaks

Mate et al., NEJM 2015
Judson et al., JID 2023
Knowledge gaps and perspective

• The diversity of filoviruses in bats / reservoir hosts is still poorly understood
• The geographical “at risk” area increased dramatically over the last decade
• Multiple species are involved in the circulation of Ebolaviruses
• A better understanding of the drivers of Filovirus spillover are needed
• Human-animal interface is increasing
• Better understanding of human survivors as a spillover risk