



# Potential impact of sexual transmission on Ebola virus epidemiology: Sierra Leone as a case study

---

International Meeting on Emerging Diseases and Surveillance (IMED)  
6 November 2016, Vienna, Austria

Jessie L. Abbate<sup>1,2,3</sup>, Carmen Lia Murall<sup>4</sup>, Heinz Richner<sup>1</sup>, Christian L. Althaus<sup>5</sup>

<sup>1</sup> Institute for Ecology and Evolution, University of Bern, Switzerland

<sup>2</sup> UMR MIVEGEC (UMR CNRS 5290, IRD 224, UM), Montpellier, France

<sup>3</sup> UMR UMMISCO (UMI 209 IRD-UPMC), Bondy, France

<sup>4</sup> Max-Planck Institute for Dynamics and Self-Organization, Göttingen

<sup>5</sup> Institute of Social and Preventive Medicine (ISPM), University of Bern

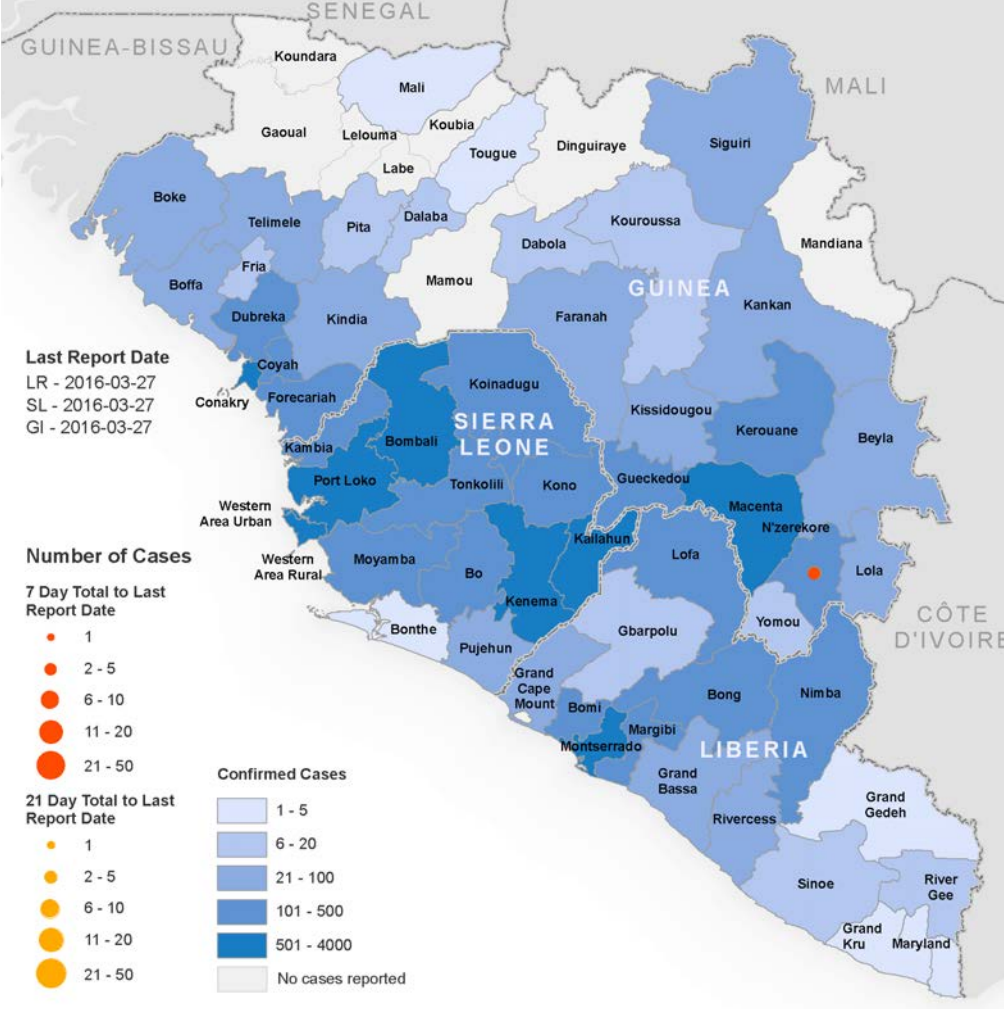
**u<sup>b</sup>**

---

**UNIVERSITÄT  
BERN**

*Image: United Nations Population Fund (UNFPA)*

Source: World Health Organization (WHO)  
 Image: Michaeleen Doucleff and Alyson Hurt/NPR



★ Declared 'ebola-free'      # Flareups (number of cases)

March 2015      May 2015      July 2015      Sept. 2015      Nov. 2015      Jan. 2016      March 2016

	March 2015	April 2015	May 2015	June 2015	July 2015	Aug. 2015	Sept. 2015	Oct. 2015	Nov. 2015	Dec. 2015	Jan. 2016	Feb. 2016	March 2016
Liberia	1		★	7					3				
Sierra Leone									★		2		
Guinea										★			13

# (Sexual) transmission of Ebola virus

- Transmission from symptomatic patients through **body fluids** (sweat, saliva, blood)
- **Molecular evidence** of sexual transmission of Ebola virus (*Mate et al, 2015, NEJM*)
- Average duration of **RNA persistence in semen** of convalescent survivors: **5.9 months** (95% CI: 5.1-6.9 months) (*Deen et al, 2015, NEJM; Eggo et al, 2015, Euro Surveill*)

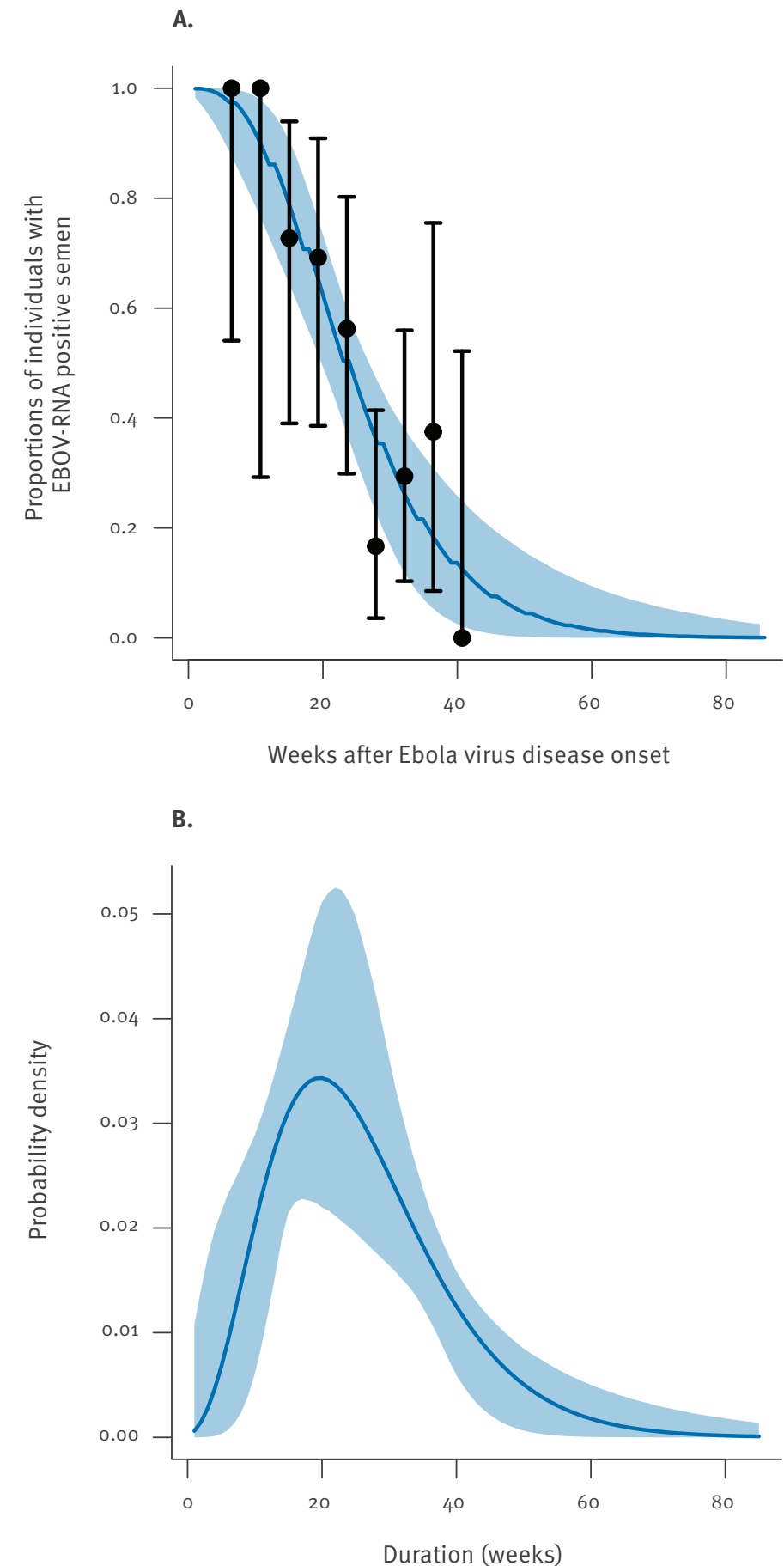
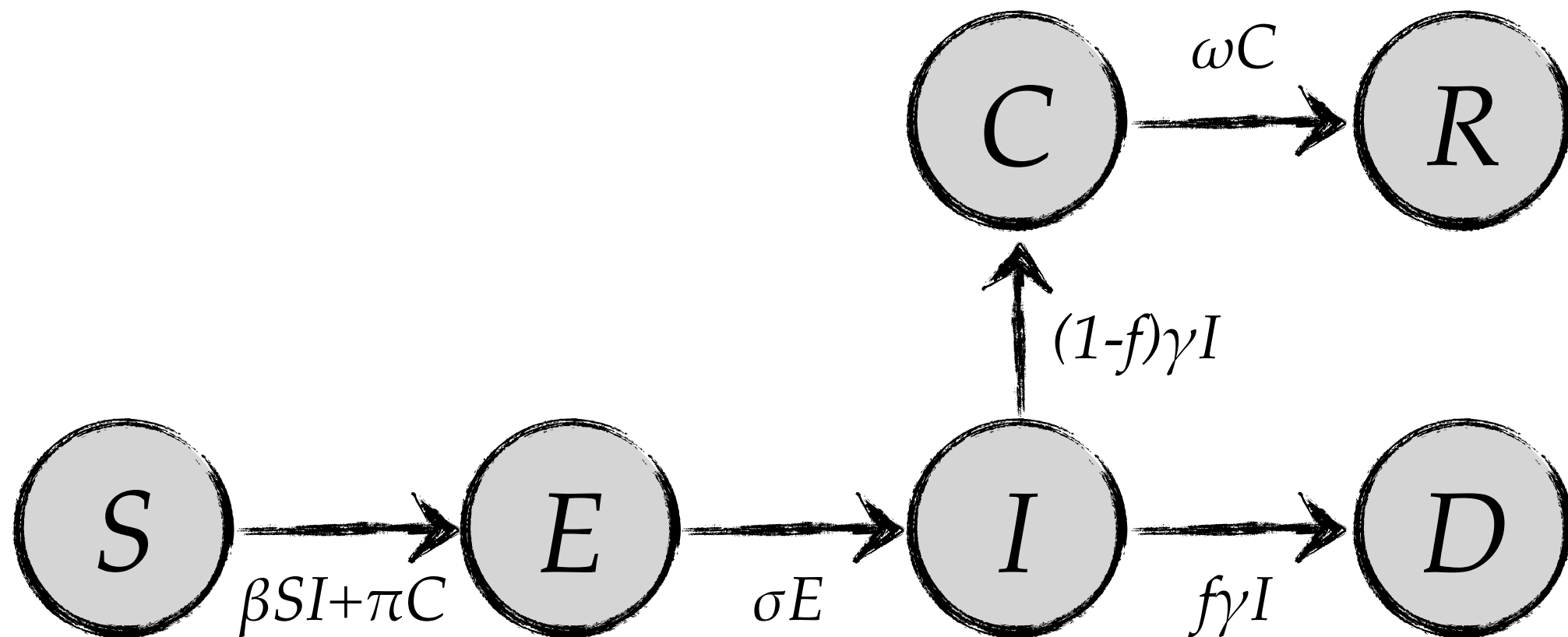


Figure: Eggo et al (2015, Euro Surveill)



# Ebola transmission model including sexual transmission through convalescent survivors

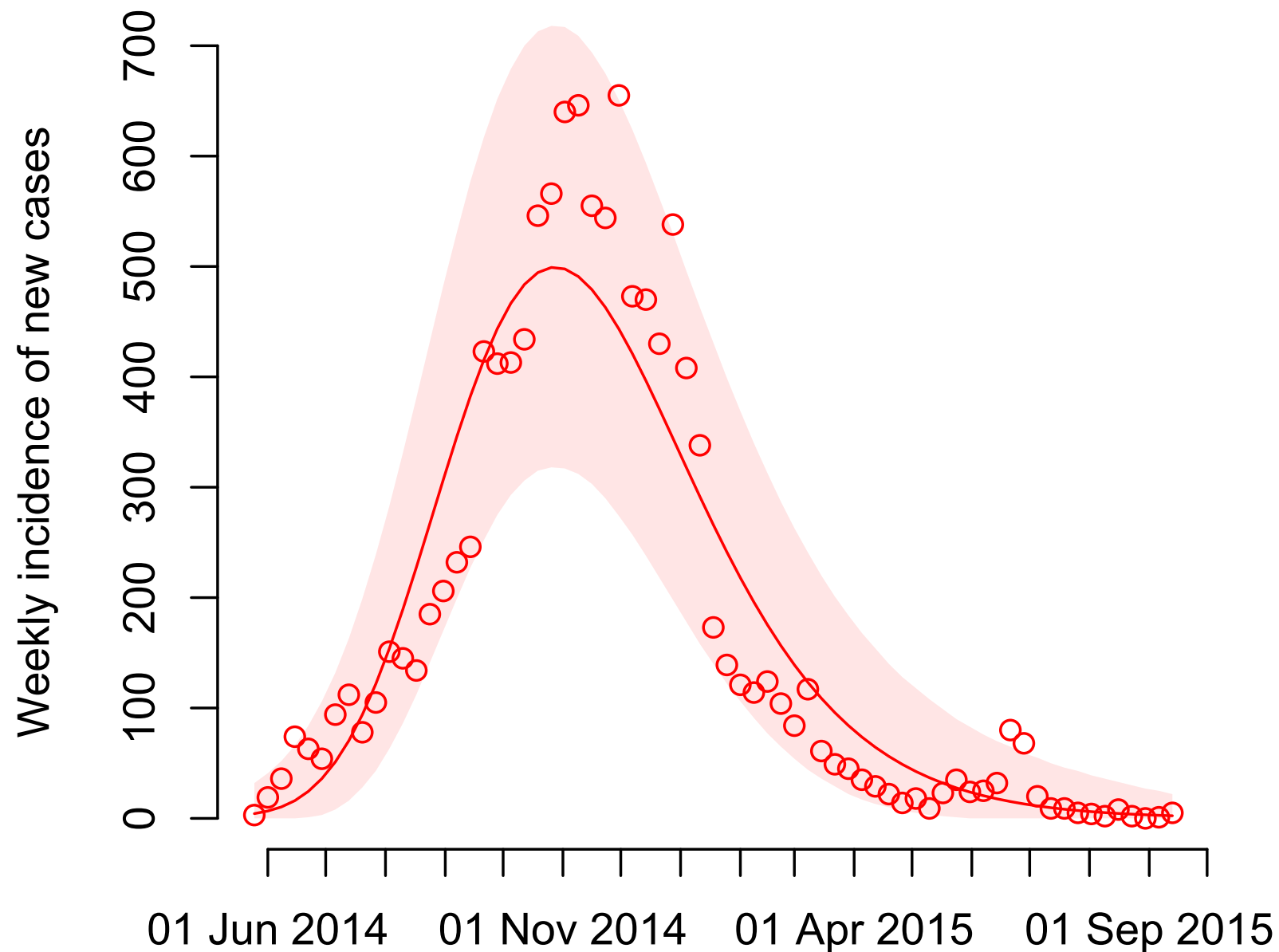
- **Compartmentalization:** Reducing the population diversity to a few key characteristics that are relevant to the infection



- After transmission, **susceptible individuals  $S$**  enter the **exposed** class  $E$  before they become **infectious individuals  $I$**  that can become **convalescent** survivors ( $C$ ) and **recover** ( $R$ ) or **die** ( $D$ ).

# Dynamics of Ebola epidemic in Sierra Leone

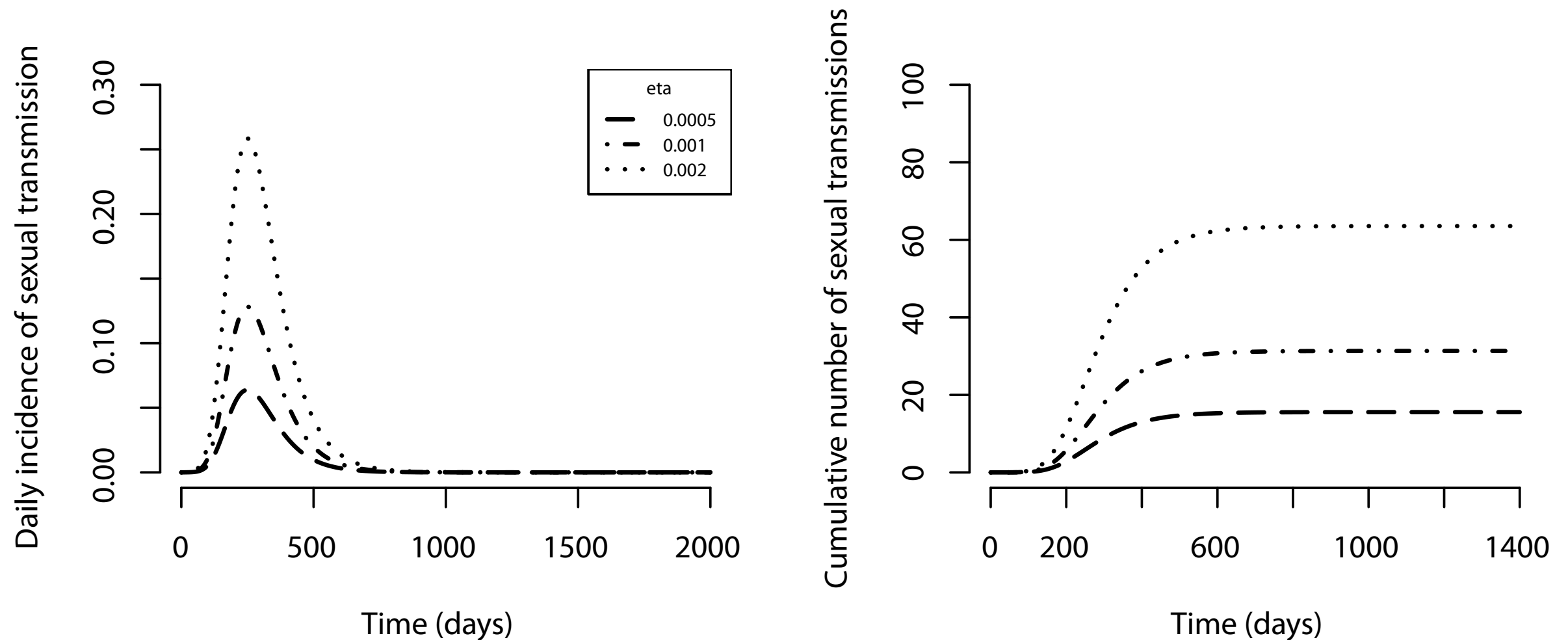
---



Model allows to **quantify the number of convalescent survivors** at any point in time.

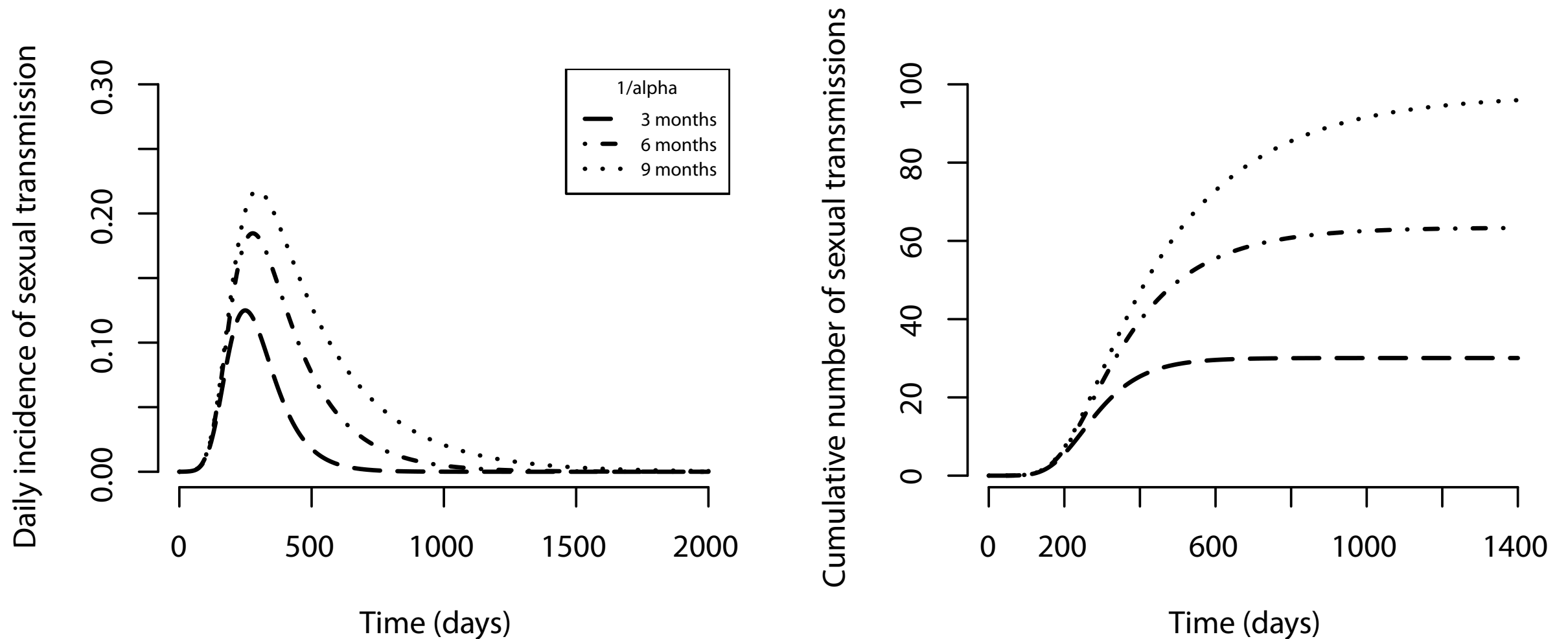
*Figure: Abbate et al (2016, PLOS Negl Trop Dis)*

# Expected number of sexual transmission events in Sierra Leone: sensitivity analysis



**Per sex act transmission probability** primarily affects excess number of Ebola cases.

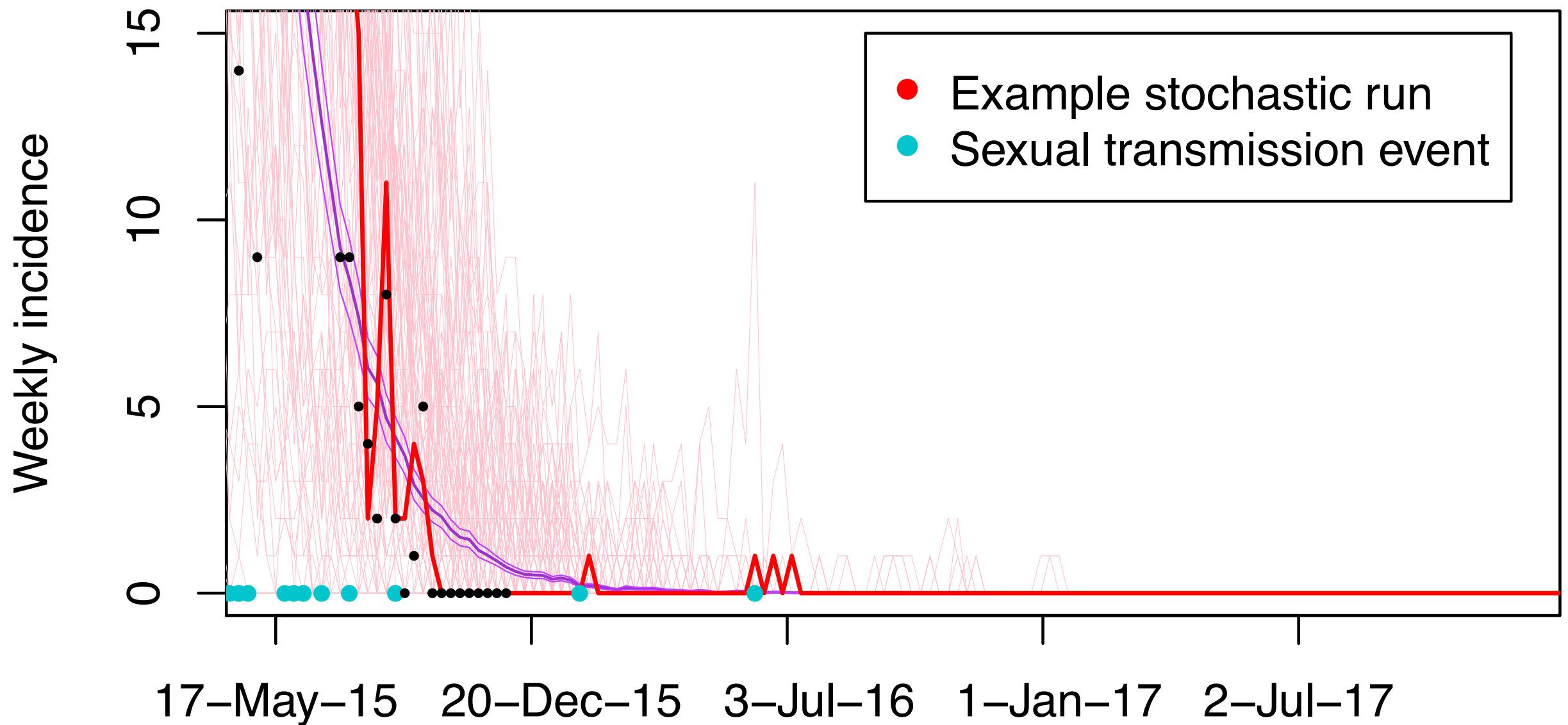
# Expected number of sexual transmission events in Sierra Leone: sensitivity analysis



**Duration of convalescence period** (persistence of infectious Ebola virus RNA) affects excess number of Ebola cases and the duration of the epidemic.

*Figure: Abbate et al (2016, PLOS Negl Trop Dis)*

# Impact of sexual transmission on epidemic tail in Sierra Leone



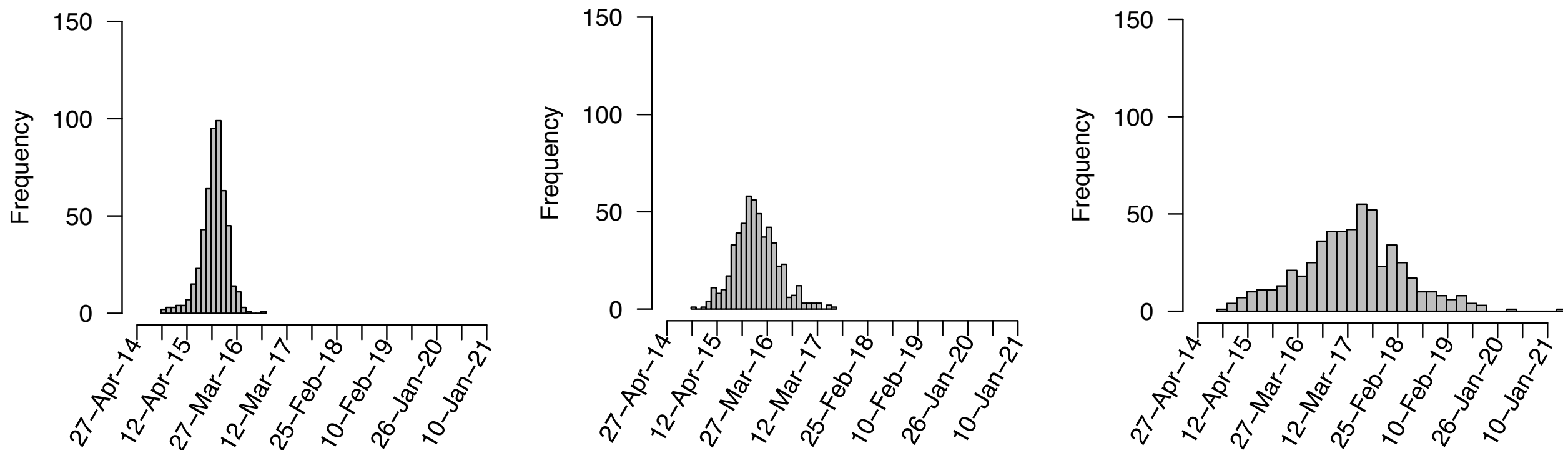
**Sexual transmission** (3 months convalescence, 0.1% per sex act transmission probability) **could extend the epidemic in Sierra Leone by several months.**



# Projected day of last Ebola case in Sierra Leone

Last reported case in week 3 (18-24 January) 2016.

**No sexual transmission    3 months convalescence    6 months convalescence**



**Variance** in simulated tail of the epidemic **grows** with duration of convalescence.

# How relevant is sexual transmission of Zika virus?

---

- United States: 23 out of 2,382 (**1%**) reported cases resulted **from sexual contact with a traveller to an affected area** (*Walker et al, 2016, MMWR Morb Mortal Wkly Rep*)
- Longest duration of Zika virus RNA detection in semen is **188 days** after the onset of symptoms (*Nicastri et al, 2016, Euro Surveill*)
- Mathematical modeling study suggest contribution to  $R_0$  is ~ **3%** (*Gao et al, 2016, Sci Rep*)
- No self-sustained epidemic, but **small transmission clusters** possible in sexual high risk groups
- Zika virus is **sexually transmissible**, but **not a sexually transmitted infection** (*Althaus & Low, 2016, PLOS Med*).

# References

---

1. Abbate JL, Murall CL, Richner H, Althaus CL. (2016) **Potential impact of sexual transmission on Ebola virus epidemiology: Sierra Leone as a case study.** PLOS Negl Trop Dis. 2016;10(5):e0004676.
2. Mate SE, et al. (2015) **Molecular evidence of sexual transmission of Ebola virus.** N Engl J Med, 373(25):2448-54.
3. Deen GF, et al. (2015) **Ebola RNA persistence in semen of Ebola virus disease survivors - Preliminary report.** N Engl J Med.
4. Eggo RM, Watson CH, Camacho A, Kucharski AJ, Funk S, Edmunds WJ. **Duration of Ebola virus RNA persistence in semen of survivors: population-level estimates and projections.** Euro Surveill. 2015;20(48):30083.
5. Althaus CL, Low N. **How relevant is sexual transmission of Zika virus?** PLOS Med. 2016;13(10):e1002157.