

**Sustained transmission of Ebola in new locations: more likely than previously
thought**

Robin N. Thompson^{1,2,3}, Katri Jalava⁴, Uri Obolski^{5,6}

¹Christ Church, University of Oxford, Oxford, UK

²Department of Zoology, University of Oxford, Oxford, UK

³Mathematical Institute, University of Oxford, Oxford, UK

⁴University of Helsinki, Helsinki, Finland

⁵School of Public Health, Tel Aviv University, Tel Aviv, Israel

⁶Porter School of the Environment and Earth Sciences, Tel Aviv University, Tel Aviv,
Israel

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Contact information

Corresponding author 1: robin.thompson@chch.ox.ac.uk; Tel. +44 1865 281 066

Corresponding author 2: uriobolski@gmail.com; Tel. +972 5263 095 08

A recent Editorial in *The Lancet* (July 20, 2019) called for the international community to unify to contain the ongoing Ebola virus disease (EVD) outbreak in DR Congo. This epidemic has caused 2713 confirmed/probable cases with 1823 deaths, including three cases in Goma and three cases in Uganda; the recent Newsdesk emphasised the high risk of spillover into neighbouring countries.¹

When EVD arrives in a new location, the standard estimate for the probability of a major outbreak starting from a single imported case is $1-1/R$, where R is the reproduction number at that time. R represents the transmission potential of the virus, accounting for any public health measures. This formula was used to assess the risk of sustained outbreaks in different countries during the 2014-16 West Africa epidemic,² and was considered in the context of vaccination.³ In that epidemic, R ranged from 1.51-2.53 in Guinea/Liberia/Sierra Leone, leading to major outbreak probabilities of 0.34-0.6 in those locations, with a higher value of $R=9.01$ estimated for Nigeria.²

However, implicit in these estimates of the risk of flare-ups is the common assumption that the infectious period follows an exponential distribution (Fig 1A, blue).⁴ It has been recognised for many pathogens that infectious periods are less dispersed than exponential distributions suggest, and that gamma distributions (Fig 1A, red dotted) characterise epidemiological periods more accurately.⁵ The standard estimate for the major outbreak probability must be altered to account for this difference (see Supplementary Material). With this amendment, the risk is larger than the formula $1-1/R$ suggests (Fig 1B). Consequently, in West Africa the major

outbreak probability in different countries should have been estimated as 0.52-0.83 rather than 0.34-0.6. Figure 1 shows this discrepancy between the standard and more realistic estimates, using parameters consistent with EVD transmission.² Our main qualitative result is robust to interventions used during EVD epidemics (including vaccination, which is playing an important role currently): for any $R > 1$, assuming an exponentially distributed infectious period leads to underestimation of risk.

Control of the ongoing epidemic is being hindered by factors including recurrent violent attacks on health workers and distrust of the government and outside organisations. Our result underlines the importance of public health measures, including surveillance and outbreak preparedness in regions without observed cases and fast responses whenever newly imported cases are found. These measures are vital for minimising the risk from imported EVD cases; this risk is higher than previously estimated.

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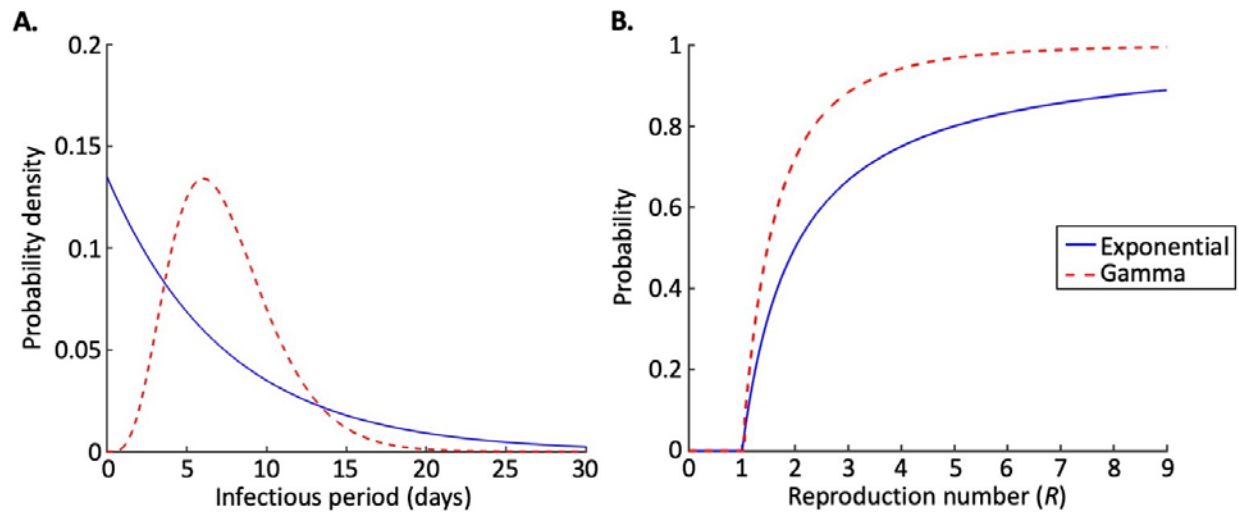


Figure 1. The risk of major outbreaks of EVD is higher than previously thought. A. Infectious period distributions according to exponential (blue) and gamma (red dotted) distributions, with parameters consistent with data from the 2014-16 EVD epidemic in West Africa.² B. The probability of a major outbreak starting from a single imported infectious host corresponding to the distributions in A. Model parameter values: $\mu = 0.135$ for the exponential distribution and $k = 5.29$, $\theta = 1.41$ for the gamma distribution² – see Supplementary Material for descriptions of the models and their parameters. In panel B, the x-axis range is set to 0-9 to reflect the wide variation in estimated values of reproduction numbers for EVD outbreaks in different settings.