BACKGROUND
The Ebola epidemic in West Africa has spurred an international response. The scope of this response has been strongly influenced by epidemiological models that predicted a devastating rise in cases without large-scale changes in behavior and intervention. One key change needed is a reduction in "unsafe" burial practices and the post-death transmission of EVD (Nielsen et al, MMWR 2015).

Post-death transmission raises a number of challenges for inference and control. Many different combinations of parameters in epidemiological models of EVD yield equivalent dynamics, particularly during early outbreak stages. Parameters may produce virtually identical early dynamics, but differ importantly in predictions about effectiveness of control interventions, or long-term attack rates. The core reason is due to the lack of identifiability of the time and route of transmission when inferred from epidemic case data.

Central Motivation of our Study:
We systematically investigate how "identifiability problems" arise and what robust inferences can nonetheless be made for EVD. The mechanism we focus on is the proportion of transmission originating from dead individuals.

Research Findings:

**Identifiability:** Models of EVD dynamics with different proportions of pre- and post-death transmission produce the same early dynamics.

**Under-estimation of R0:** Neglecting post-death transmission while fitting to epidemic growth rate tends to lead to underestimates of R0.

**Safe burials as a critical element of control:** ~50% of reduction to sub-critical dynamics can be achieved through control of post-death transmission. This result uses WHO estimates of post-death transmission fractions.

MODEL FITS TO EARLY-VEF CASE DATA

**Case Data**
We analyzed cumulative case count data from Guinea, Liberia and Sierra Leone, curated by Caitlin Rivers: [https://github.com/cmrivers/ebola](https://github.com/cmrivers/ebola).

Time periods focus on early dynamics, i.e., cumulative case count exceeded 50 with a final date at the end of August. Additional challenges for inference arise, in part, due to under-reporting, lapses between incidence and reporting events, and stochasticity (see poster presented by Bradford Taylor).

**Model Fits**
Model fits were trained on data through the end of August (open triangles in Figures at right, with predictions in closed triangles). As in the idealized case, many models fit the data equally well.

**KEY POINT:** Identifiability-induced uncertainty in R0 could be substantial. Points to structural uncertainties in current approaches.

SAFE BURIALS AND THE CONTROL OF EVD
We assessed the potential effect of safe burials on EVD dynamics by determining the "effective" reproductive number if safe burials became ubiquitous. To do so, we focused on a range of 10%-40% for the fraction of post-death transmission based on WHO survey results, of 701 individuals tracked with EVD.

• 67 individuals only had contact with individuals who died of EVD

• 148 individuals had contact with dead and living individuals with EVD

**KEY POINT:** Controlling post-death transmission of EVD can account for approximately 50% of the necessary reduction in transmission to bring R0 below 1.

CONCLUSIONS & RECOMMENDATIONS

• Improved estimation of the relative proportion of post-death transmission would help to decide how to allocate resources for complementary forms of control.

• It is essential to consider the logistics of deploying burial teams efficiently and safely while balancing public health benefits and community norms.

• Inclusion of identifiability problems into other models will help to improve estimates of uncertainty at early-stages.

REFERENCES


