EFFECTIVENESS OF LOW SENSITIVITY INTERVENTIONS IN WEST AFRICA EBOLA EPIDEMIC

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Introduction

This study investigates the effect of low sensitivity interventions on the containment of an emerging pathogen. The model consist of a network of populations coupled by small levels of migration and an “intervention sub-model” in which exiting or entering persons are screened and febrile (infectious stage) patients are isolated. The main question is how does the sensitivity and duration of the incubation period interact to undermine such interventions.

•S: Susceptibles
•E: Exposed/incubating/non-febrile
•I: Infectious
•R: Removed
•N: S+E+I+R

The transition rates follow the SEIR model
•S->E at rate $\beta SI/N$
•E->I at σE
•I->R at rate γI

In a time interval of one unit (one day), these rates give rise to the following probabilities:
•S->E with probability $1-exp(-\beta I/N)$
•E->I with probability $1-exp(-\sigma)$
•I->R with probability $1-exp(-\gamma)$

Objective

Modeling the effectiveness of interventions based on low sensitivity early detection methods.

Methods

1. Derive a discrete-time SEIR model for transmission at a given site and develop computer code to implement the associated simulation algorithm

2. Develop a wrapper code that allows you to couple multiple sites as updated in step (1) and includes variable pairwise movement probabilities and an intervention that targets movement (thermal scans) with tunable sensitivity and specificity; this code also tracks the number of uninfected persons incorrectly denied permission to travel

Results

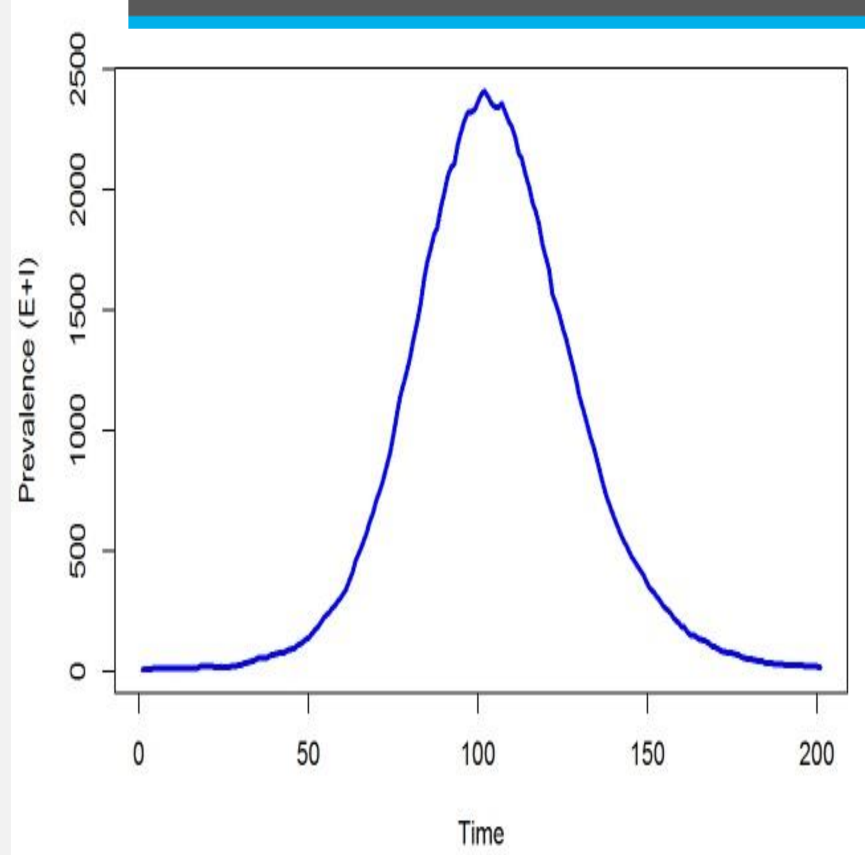

Figure1: This plot simulates the number of people harboring a disease in an outbreak at a single location.

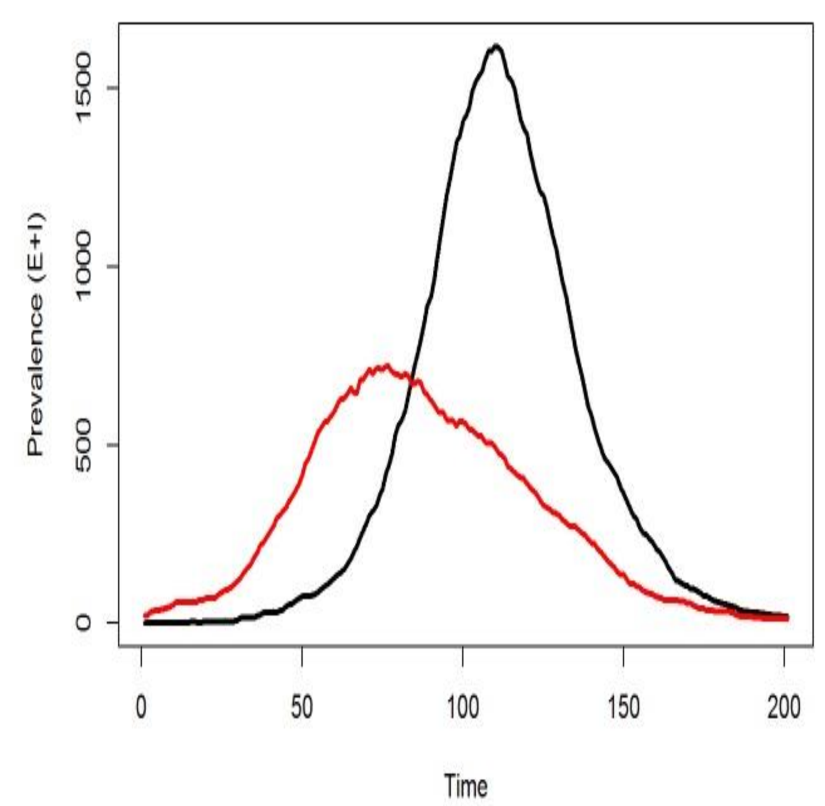

Figure2: This plot simulates a coupled epidemic.

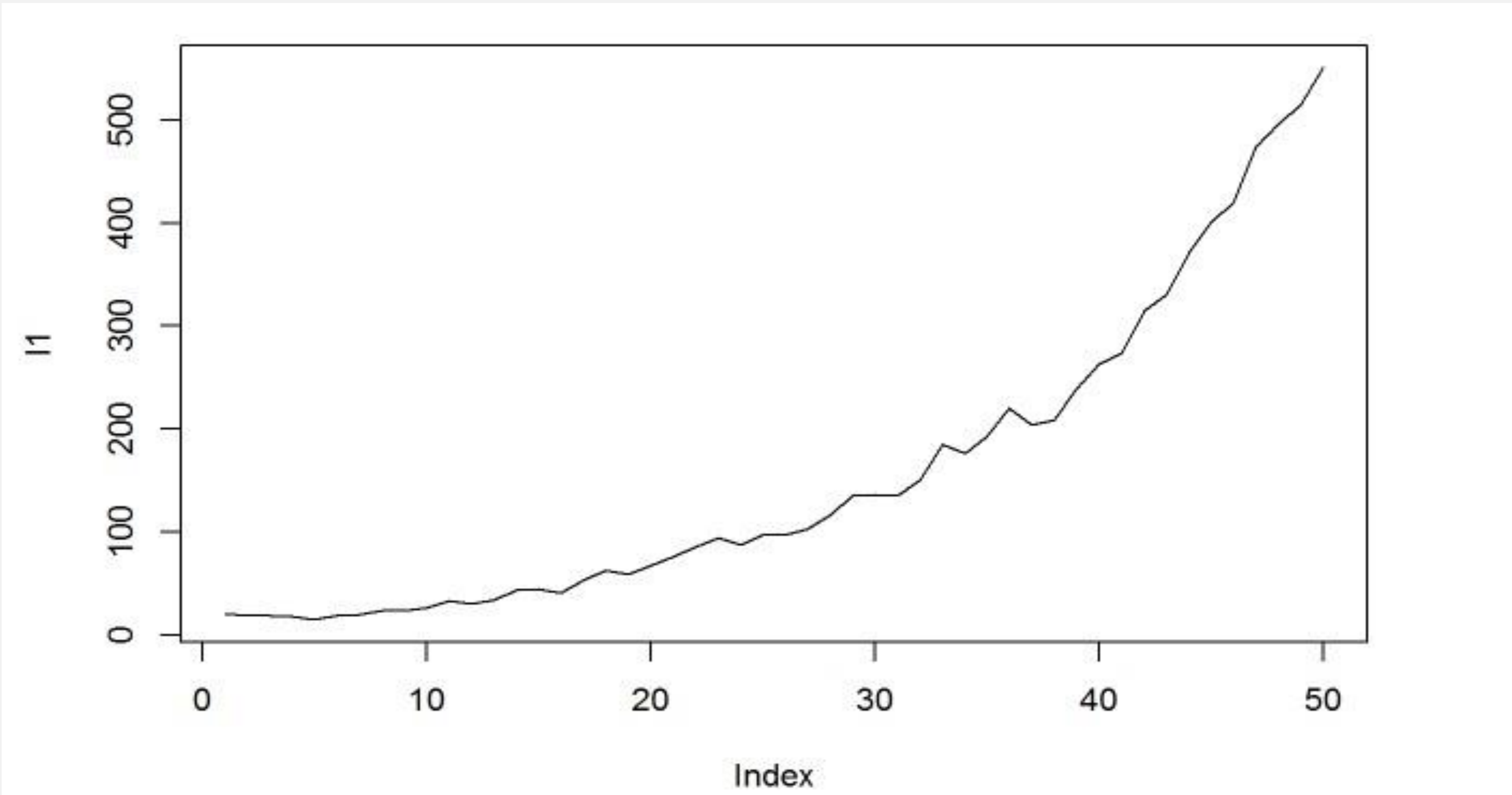

Figure 3: A widespread epidemic looking at the curve the infected class of travelers. Including the sensitivity and specificity on thermoscans using the variable Z.

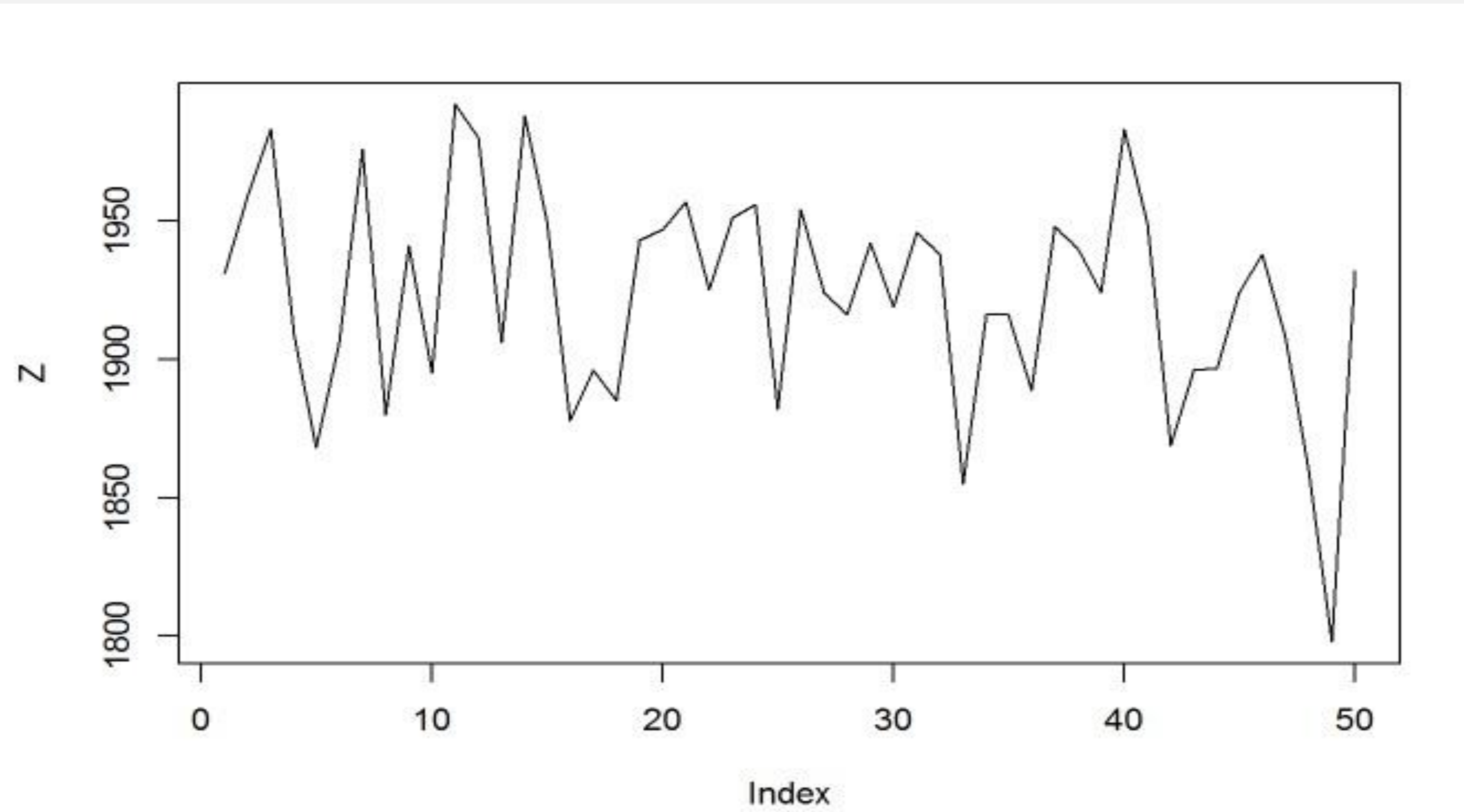

Figure 4: Sensitivity and specificity of thermoscans using the variable Z.

Conclusion

- Although thermal scans are inherently of low sensitivity due to the fact that infected patients may not be febrile, they are also one of the few population-level interventions available to reduce international spreading.
- The effectiveness of thermal scans to prevent international spreading of an Ebola-like disease is unknown.
- How does global epidemic size vary with intervention sensitivity?
- In future research we plan to do a global model with real air traffic data.

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