

Modeling Disease Surveillance and Assessing its Effectiveness for Detection of Acute Respiratory Outbreaks in Resource-Limited Settings

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Objective

This modeling effort will provide guidance for policy and planning decisions in developing countries in the event of an acute respiratory illness (ARI) epidemic, particularly an outbreak with pandemic potential.

Background

A U.S. Department of Defense program is underway to assess health surveillance in resource-poor settings and to evaluate the Early Warning Outbreak Reporting System (EWORS). This program has included several information-gathering trips, including a trip to Lao PDR in September, 2006.

Methods

We are building a modified agent-based model to measure the spread of ARI in resource-poor countries. The initial implementation uses health and census data collected during the 2006 Lao visit and incorporates features of recently published agent-based modeling approaches. Modeled agents are restricted to infected individuals and contacts, not the entire population. Model runs are limited to outbreak stages before population behavior changes because of mass fear and emergency policy decisions. Modular software architecture was adopted for portability to similar settings. The surveillance model incorporates estimates of surveillance delays taken from real data. We model both standard and EWORS identification and reporting times as well as the effect of rapid test availability at individual hospitals. This application is eventually intended to be a stand-alone tool for examining the effectiveness of large-scale policy decisions such as travel restrictions or the installation of additional networked surveillance capability.

Results

Parameters for the distributions of demographic characteristics for the population model were inferred from Lao census data. The resulting stochastic simulated households are statistically similar to census and survey table figures [1]. Simulations are underway to measure variability of disease model and spread. Scenarios investigated were derived from the Lao site visit--the gain from adding EWORS capability in strategic location, and the benefit of

social distancing measures. Results will be compared using validation parameters such as effective reproductive number [2] and household attack rate [3], and the variability of these measures will be discussed.

Conclusions

This effort is designed to inform a cost-benefit analysis of various interventions on the early course of an ARI outbreak and surveillance, which has been lacking in similar models. One goal is for this model to be used to help identify additional locations for surveillance activities. Information gathered by the EWORS International Working Group strongly indicates that realistic modeling of surveillance capability is essential for informative simulation of large-scale outbreak progression and for assessing effectiveness of countermeasures.

References

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