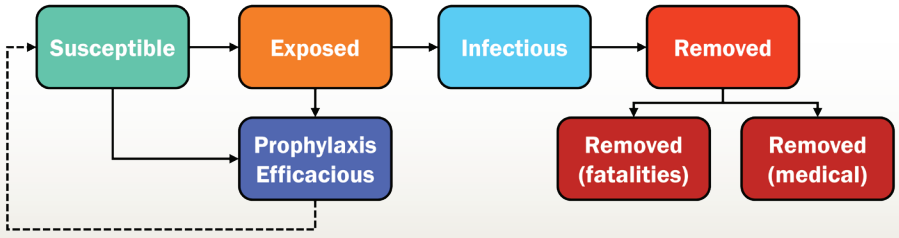
IDA | Research Summary

Ahead of the Curve: Rapid Contagious Disease Modeling

IDA researchers have developed contagious disease modeling capabilities that can be rapidly updated to support civilian and military national security decision makers as they plan, evaluate, and respond to emerging infectious disease outbreaks that have the potential for global spread.

Recent outbreaks of Ebola virus disease (EVD), Zika virus, and the 2019 novel coronavirus have generated enormous resource and response challenges for the global public health community. The unpredictability and transmission potential of such outbreaks necessitate analytic capabilities to support forecasting, course of action (COA) evaluation, planning, and other activities.

IDA's contagious disease models are derived from the susceptible, exposed, infectious, and removed (SEIR) construct in which members of a population at risk are categorized into cohorts based on their disease status. Built upon this foundational framework, IDA's modeling capabilities evaluate disease transmission and potential consequences, as illustrated below.



(continued)

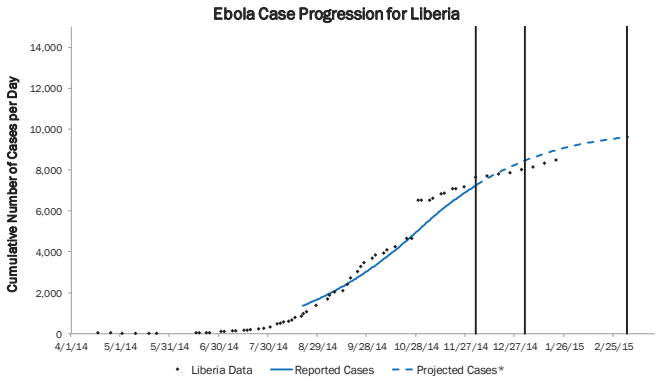
February 2020
NS D-12072

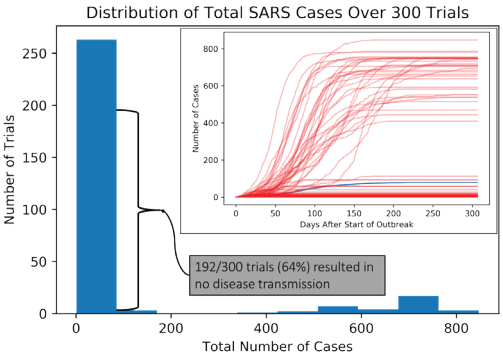
The resulting suite of capabilities includes models that can:

- Account for efficacy and duration, or course, of medical countermeasures, including vaccines and pre- and post-exposure prophylaxes;
- Incorporate the effects of social and behavioral interventions and response actions, including isolation, quarantine, restrictions of movement, and other forms of social distancing;
- Vary transmission rates over time or between individuals to account for super spreaders;
- Estimate multiple stages of illness and removal of individuals due to fatality, medical treatment, and convalescence separately to support planning and resourcing; and
- Propagate outbreaks through multiple geographically separated populations, including both domestic civilian populations and deployed military populations.

IDA uses two types of models that illustrate how outbreaks might unfold: (1) rapidly deployable deterministic models that track the outbreak at the population level and (2) sophisticated stochastic models that track the outbreak at the individual level.

IDA previously developed EVD modeling parameters that it used to support an assessment of an investigational new drug. When the 2014 EVD outbreak occurred in West Africa, IDA was ready with a unique modeling capability to support collaborative government modeling efforts, including predicting future disease spread in real time to inform resource requirement assessments (shown at right).





Simultaneously, IDA has expanded its stochastic model to assess the threat posed by emerging infectious diseases to military operations to inform future planning, including the spread of a disease outbreak across multiple units in a military theater. The example to the left illustrates the bifurcated estimates for Severe Acute Respiratory Syndrome (SARS) due to a high level of individual variation in SARS infectiousness (super spreaders), which yields unique public health and military health challenges.

Researchers **Robert L. Cubeta** (rcubeta@ida.org) and **Deena S. Disraelly** (ddisrael@ida.org) of the Strategy, Forces and Resources Division of IDA's Systems and Analyses Center (SAC) work to develop, execute, and update these models with other IDA researchers, including **Margaret Barber, Julia Burr, Luke LaViolet, Sean Oxford, Stuart Smith, Terri Walsh,** and **Robert Zirkle**.

Research sponsored by IDA's Independent Research Program. Development of the models described herein was supported by the Defense Threat Reduction Agency; the Office of the Surgeon General of the Army; the Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense; and the Department of Homeland Security.