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Research Questions

What range of models and nonmodeling approaches can be used to answer policy questions related to disease prevention, detection, and response?

Which approaches are best suited for which situations and questions?

How can these tools be best used by modelers and policymakers in practice?

This report describes decision-support tools, including models and nonmodeling approaches, that are relevant to infectious disease prevention, detection, and response and aligns these tools with real-world policy questions that the tools can help address. The intended audience includes technical experts — for example, modelers and subject-matter experts — and the policymakers that those experts can support. On one hand, this overview should help modelers and other technical experts understand the questions that policymakers will raise and the decisions they must make. On the other hand, many policymakers can benefit from a basic understanding of the capabilities and limitations of the different tools that may inform their decisions. This report describes the characteristics, requirements, uses, applicability, and limitations of three classes of theory-based models (population, microsimulation, agent-based simulation) and two classes of statistical models (regression-based and machine-learning), as well as several complementary nonmodeling decision-support approaches. The report then aligns all of these tools and approaches with a set of real-world policy questions. Finally, based on a review of published literature, an assessment of the different models and nonmodeling approaches, and recent experiences (such as the 2009 influenza pandemic), the authors recommend nine best practices for using modeling and decision-support tools to inform policymaking.

Key Findings

Several Modeling and Nonmodeling Decision-Support Tools Are Available to Inform Infectious Disease Prevention and Control; Policymakers and Modelers Should Understand the Capabilities and Limitations of Each and Select the Best Approach(es) Based on the Circumstances and the Questions to Be Addressed

- Theory-based models work well when there is sufficient understanding and information on the disease dynamics and when the models are sufficiently validated in the context considered.
- Theory-based models are best suited to address questions about the magnitude of the threat and where interventions are possible, as well as to compare potential interventions; they are less useful than statistical models for forecasting disease incidence.

- Statistical models can make useful inferences and predictions without requiring a full understanding of all underlying causal mechanisms. But their use comes at a price: higher sensitivity to violations of the invariance assumption and difficulty using them to make decisions informed by causal relationships.
- Statistical models are best suited for mechanistic quantitative predictions concerning the phenomenon of interest (e.g., How fast will it spread? When will it peak?).
- Nonmodeling approaches are typically more valuable for real-time decisions. They can be informed by modeling, which is best undertaken before real-time decisions are needed. Examples include expert elicitation, policy analysis frameworks, preparedness exercises, and intra-action reports.
- A variety of techniques can assist in communication and planning for appropriate use of models and nonmodeling approaches. This starts with better mutual understanding between modelers and policymakers of both the tools available and the questions that policymakers face.

Recommendations

- Establish partnerships and communications between modelers and policymakers before an emergency arises.
- Coordinate at multiple levels, including with program managers responsible for implementing actions and interventions.
- Ensure the timely availability of data needed for modeling.
- Clarify priority policy questions and ensure that modelers understand them.
- Use relevant nonmodeling approaches to provide decision support.
- Use the most-appropriate models and other approaches to meet specific real-world needs.
- Set appropriate expectations for the use of models.
- Improve models and modeling approaches.
- Improve the modeling ecosystem.

Keywords: model, ecosystem, differential equations, disease, infectious disease, epidemic, model policy