Modeling for Disease Control Policy

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Simple Answers about Complex Systems

• Computer models can help inform policy decisions

• Models can sometimes find options and tradeoffs you would not have thought of otherwise

• Models allow you to try out many different policy options to find the best one

• What does “Best” mean when talking about disease control policy?
  – Fewer cases of diseases reported
  – Lower chance for epidemic outbreak
  – Reasonable cost
  – Realistic goals
Best policy: Performance and Reliability

- Many factors can affect whether a policy produces results according to plan
- Uncertainties about weather, availability of resources, novel pathogens, etc. can change the outcome of a policy from what was intended.
- So, besides good performance, we need policies which are reliable: perform well over a very large range of uncertainties.
- Models can help identify those policies which are good performing and reliable
  - Run computer model thousands of times with different settings
  - Identify those policy interventions which perform well and are not as sensitive to uncertainties
Example of Modeling for Robust Policy Design

- Animal disease model is not yet complete
- Look at results for a human disease: influenza
- Model of influenza spread through population of a town with a population of 10,000
- Find out which disease control interventions make the best policy
  - Anti-Viral Medication
  - Vaccination
  - Quarantine
  - Social distancing (Keeping infected people away from others)
    - Suspend schools
    - Cancel meetings
Effective, Robust Design of Community Mitigation for Pandemic Influenza: A Systematic Examination of Proposed US Guidance

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Abstract

Background: The US government proposes pandemic influenza mitigation guidance that includes isolation and medical treatment of ill persons, voluntary household member quarantine and animal culling, social distancing of individuals, school closures, evacuation of contacts at work, and prioritized vaccination. Is this the best strategy combination? Is choice of this strategy related to pandemic uncertainties? What are critical enabling factors for community resilience?

Methods and Findings: We systematically reviewed a broad range of pandemic scenarios and mitigation strategies using a simulated, agent-based model of a community of adults, multiply-ethnic and social contact network. We evaluated a range of strategies over a range of pandemic impacts, including the severity of infection, the size of affected population, the timing of activities, and the duration of pandemic. We found that the best strategy results in the highest number of people vaccinated and the least amount of economic loss. However, the same strategies may not be effective in all areas due to differences in population density, healthcare resources, and economic conditions.

Conclusion: While community mitigation strategies can be effective, the success of these strategies depends on their implementation. High community compliance and strong leadership are critical for effective mitigation.

Introduction

Background: Pandemic influenza poses significant societal and economic challenges. Community-level strategies are critical to minimize disease spread and reduce the burden on healthcare systems. However, the effectiveness of these strategies is dependent on a range of factors, including the severity of the pandemic, the population density, and the availability of healthcare resources.

Methodology: We used a simulation model to evaluate the effectiveness of different community mitigation strategies under varying pandemic conditions. The model incorporates factors such as population density, healthcare availability, and economic conditions to predict the effectiveness of different strategies.

Results: Our simulation results indicate that a combination of strategies, including isolation, household quarantine, and social distancing, is effective in minimizing disease spread. However, the effectiveness of these strategies varies depending on the severity of the pandemic and the availability of healthcare resources.

Conclusion: Community mitigation strategies are effective in minimizing disease spread and reducing the burden on healthcare systems. However, the success of these strategies depends on their implementation and the availability of healthcare resources. High community compliance and strong leadership are critical for effective mitigation.

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Scatter plot of pandemic study results shows numbers of people infected and variability in model runs.
Desirable Outcomes and Low Variability Characterize Robust Policies

• Each policy tried on 100 random social networks
• 2,780 cases expected with no treatment
• Closing schools is best single option
  – Mean = 137 cases
  – Moderate variation
• Social distancing is not as effective
  – Mean = 987 cases
  – Wide variation
• Both policies in conjunction create robust solution
  – Mean = 118 cases
  – Narrow variation
• Robust solution:
  – Good outcome
  – Most stable to uncertainty
Re-casting model results

A: No Intervention
B: Social Distancing
C: Closing Schools
D: Social Distancing AND Closing Schools
Tradeoffs: Effectiveness and Predictability
Applying to Animal Diseases

Model of animal movements and disease control actions

Try out policies before making a decision

Look at the range of possible outcomes

Help find those that perform well AND are reliable

Transmitting Information

Movement of Diseased Animals

Detecting Conditions

Implementing Controls

Deploying Information and Resources

Planning Responses
Thank You