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Center for Domestic and International Health Security

Non-Pharmaceutical Public Health Interventions for Pandemic Influenza

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Summary

- We evaluated choices among non-pharmaceutical interventions using an SEIR epidemiological model and an aggregate model of NPI effectiveness
- We sought to identify robust policy options given the wide range of uncertainty regarding disease characteristics and intervention effectiveness
- Preliminary conclusion: portfolio of low cost options competitive with or dominates costly and intrusive options used in isolation (i.e. school or work closure)

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Importance of Uncertainty Analysis

- **Significant uncertainty about many key factors:**
  - H5N1 reproductive rate (R_0)
  - Virulence (illness, death rate)
  - Effectiveness of NPIs in reducing transmission
  - Likelihood of optimal adherence to NPIs
  - Death rate

- **Policy choices optimal for one set of assumptions could be fragile if these assumptions fail**

- **There is a systematic tendency to underestimate uncertainty**

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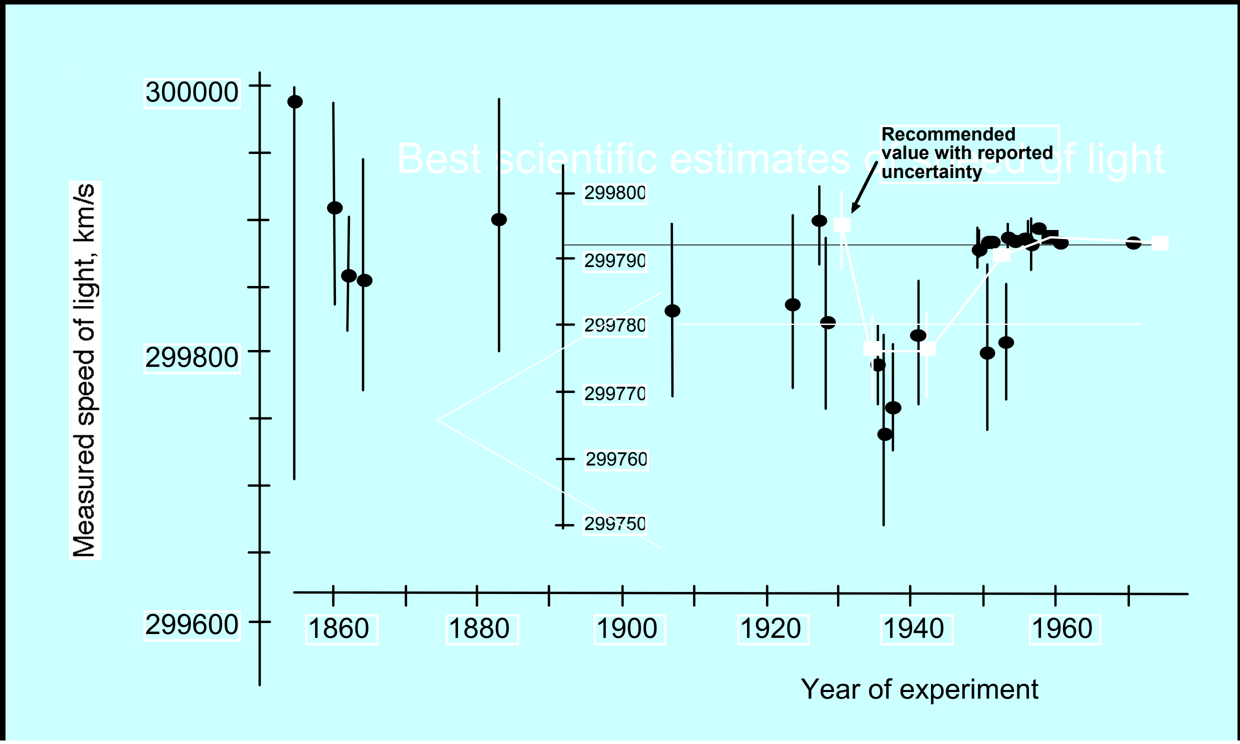
Uncertainties Are Frequently Underestimated

- Human probability judgments subject to systematic bias over confidence
- Even quantitative uncertainty calculations tend to be too small



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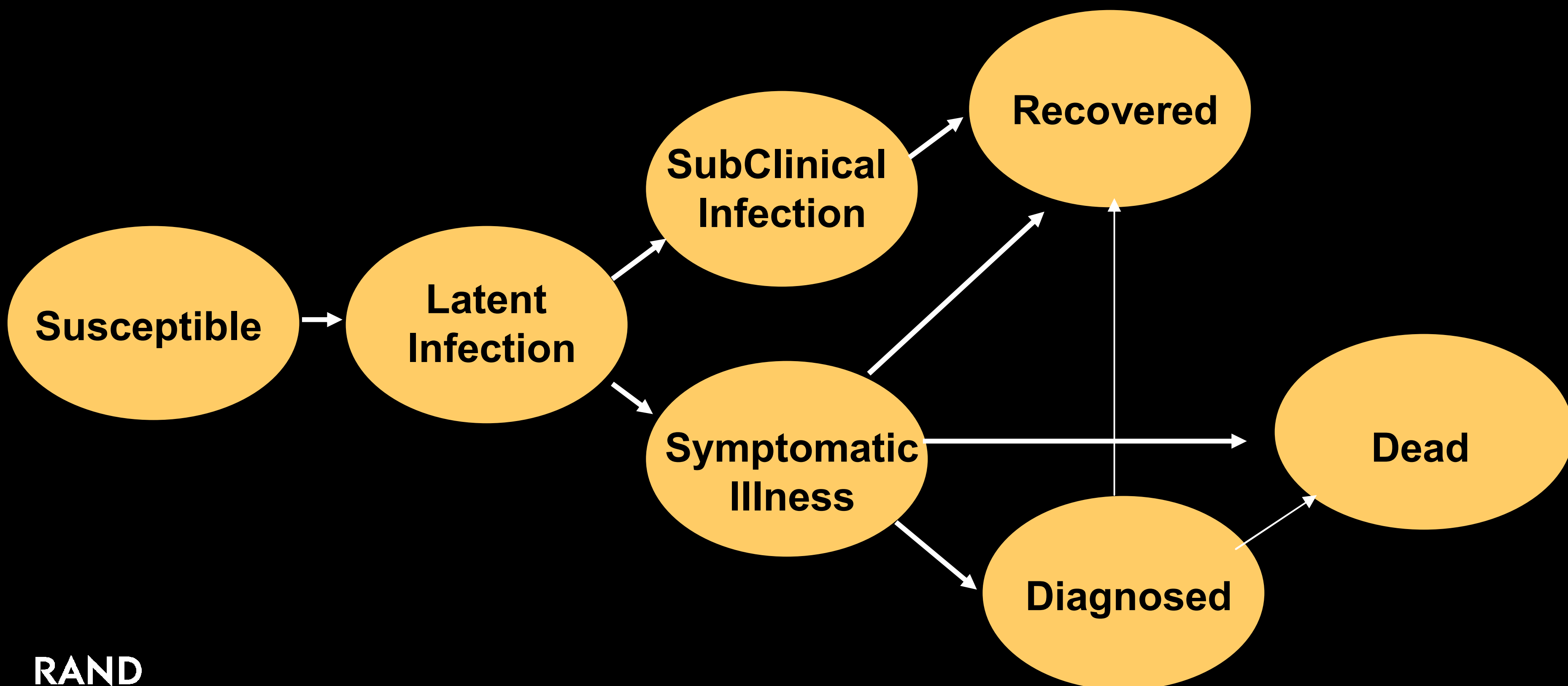
Robustness Analysis Helpful When Uncertainties Large and Poorly Characterized

Robust
-strong enough to withstand intellectual challenge.
-an ability to recover gracefully from the whole range of inputs and situations.

- **Account for fact that optimal policy may vary as assumptions vary**
- **Seeks policies that work "well enough" across the feasible range of assumptions**
- **Seek (and document) assumptions for which main conclusions will be false**

Compartmental Model Dynamically Tracks Trajectory of Epidemic

- **Uncertain assumptions regarding all rate parameters**
- **NPIs effect rates between specific pools**



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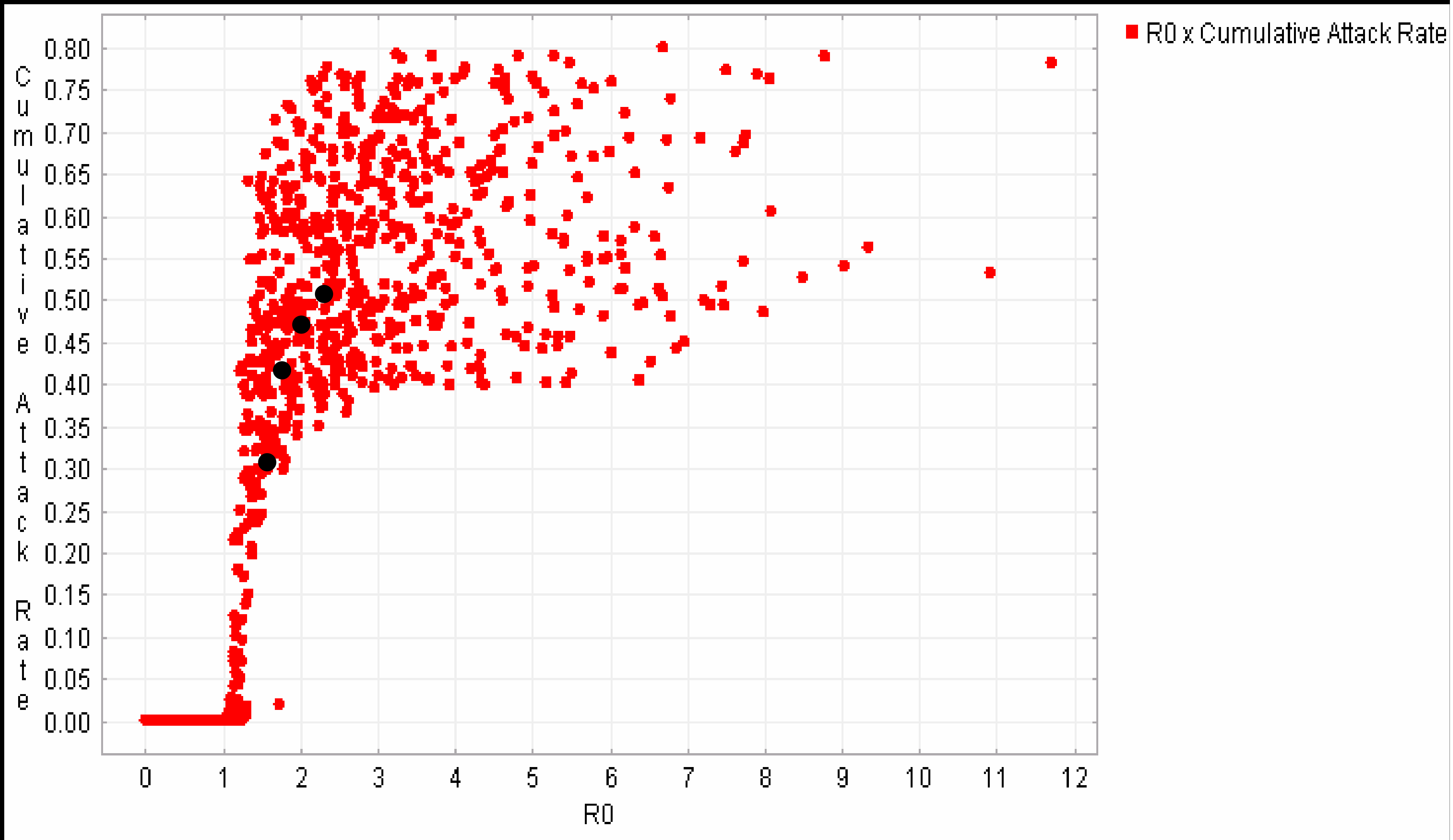
Comparison to Data from An Agent Based Model*



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* *Germann et. al.*, PNAS, 2006

We Modeled Individual NPIs

10. Hand Hygiene
11. Respiratory Etiquette
12. Surgical Masks*
13. Domestic Travel Restrictions
14. Cancel Community Events
15. School Closure
16. Workplace Closure
17. Voluntary Self Isolation
18. Voluntary Quarantine
19. Mandatory isolation
20. Limited Mandatory Quarantine
21. N95 Respirators*
22. Other PPE*
23. Surveillance
24. Contact Tracing
25. Rapid Dx
26. Social Support
27. No NPIs

* In ambulatory & hospital settings

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And Portfolios of Grouped NPIs...

1. All NPIs
2. "Expert Choice"
   - Hand Hygiene
   - Respiratory Etiquette
   - Surveillance
   - Rapid Dx
   - Social Support
   - Voluntary Self Isolation
   - Domestic Travel Restrictions
   - Surgical Masks*
   - N95 Respirators*
   - Other PPE*
3. Surveillance + Rapid Dx
4. Contact Tracing + Rapid Dx
5. Surveillance + Contact Tracing + Rapid Dx
6. Voluntary Self Isolation + Social Support
7. Voluntary Quarantine + Social Support
8. Mandatory Isolation + Social Support
9. Limited Mandatory Quarantine + Social Support

* In ambulatory care & hospital settings

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NPI Effect on Epidemiology Rates Estimated From Literature and Expert Elicitation

- Estimates for impact of each NPI on:
  - Time to detection of epidemic
  - Diagnosis Rate
  - Fraction of contacts known to PHS
  - Transmission from the diagnosed
  - Transmission from known contacts
  - Transmission rate among general population
  - Probability of correct application
- Large uncertainty bands assumed for all non-zero values

Combined SEIR and NPI Effectiveness Models Used to Compare Alternative Policies

Epidemiology model

Simulates epidemic spread over time

+

Policy model of NPI effectiveness

Construct portfolios of one or more NPIs

Outputs influence population-based model

X

Many model runs varying assumptions

For each, test all policies to assess the optimal choice

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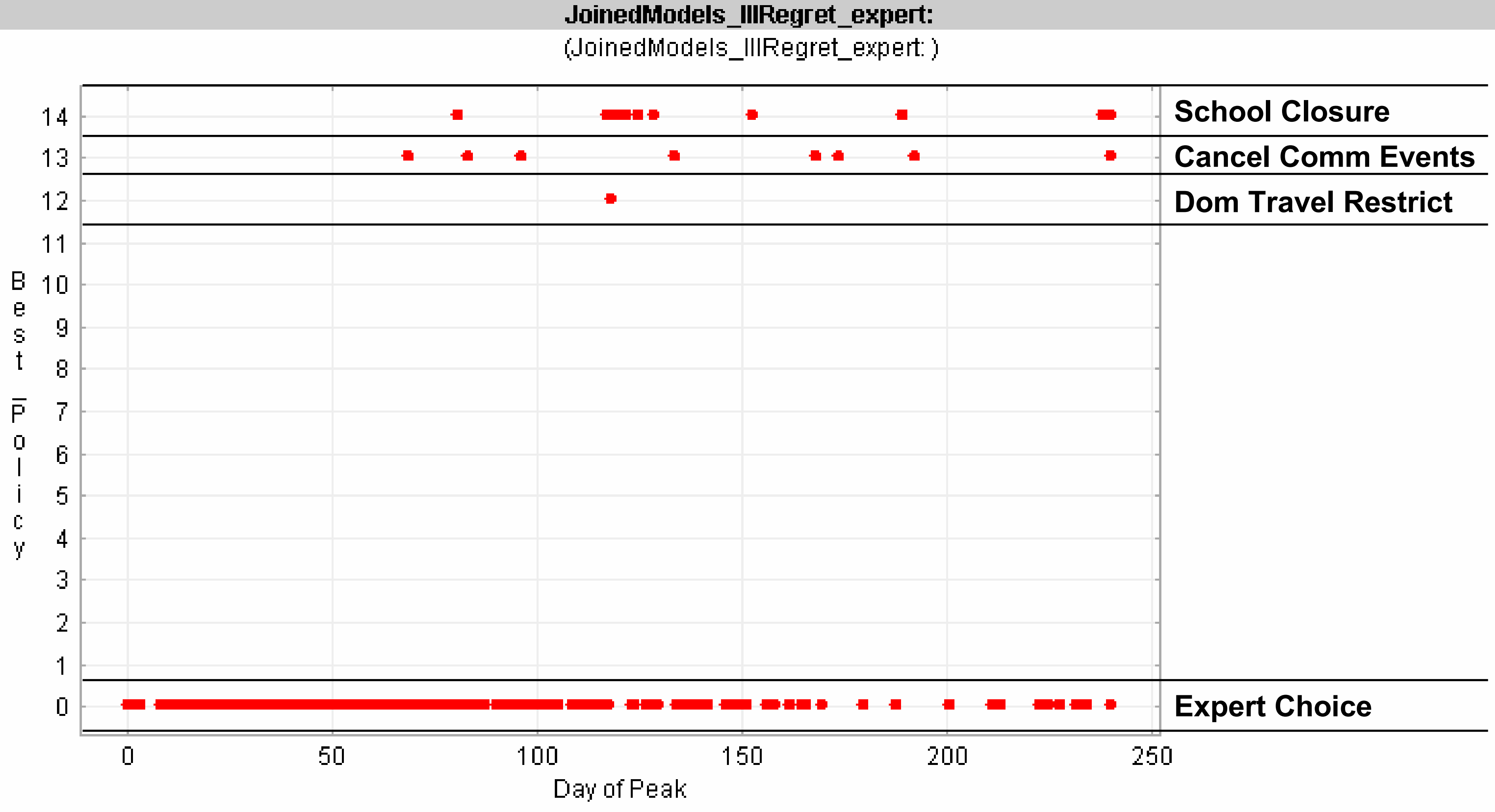
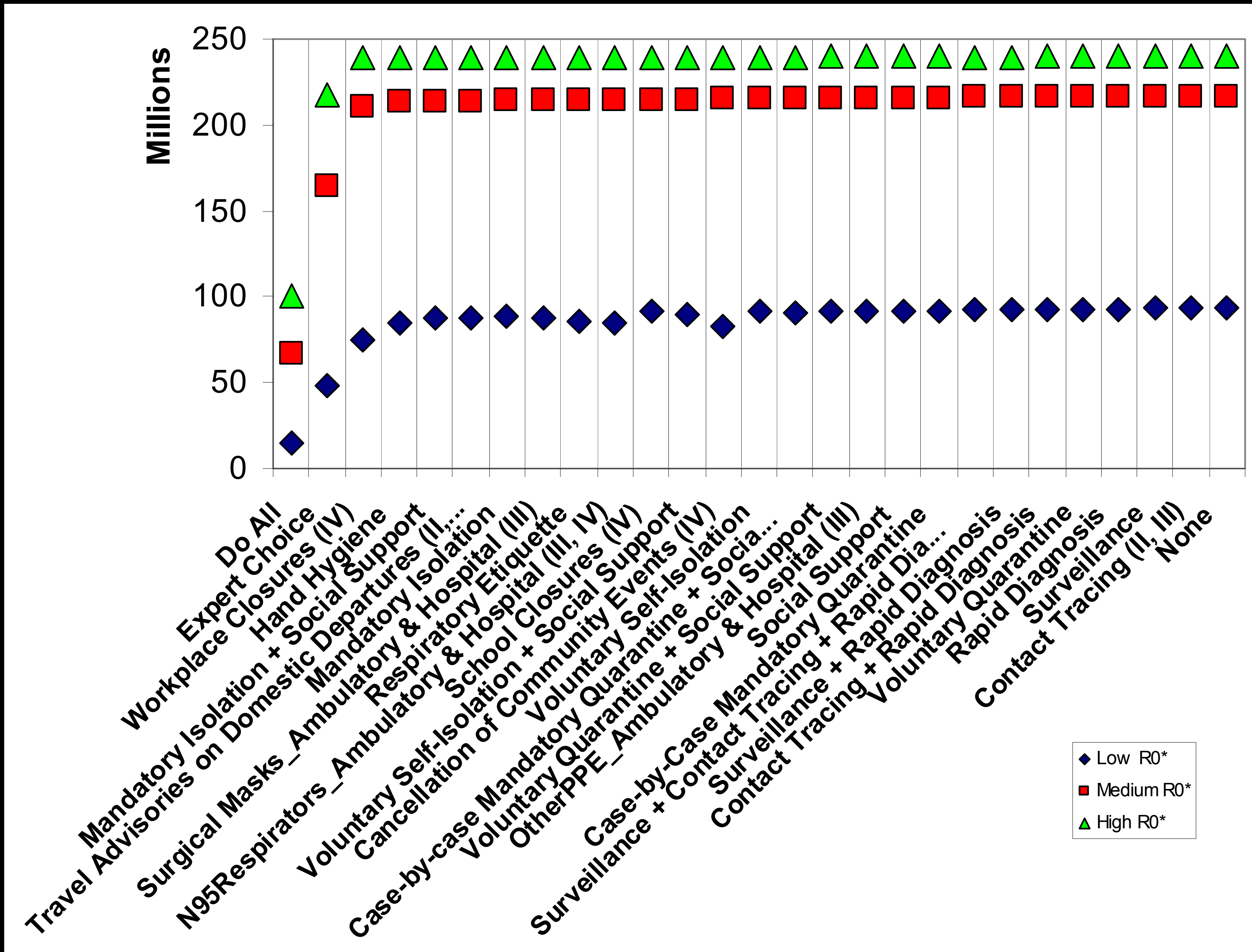
Findings are Robust Across Wide Range of Assumptions

- **Expert Choice wins in 974/1000 of model runs.**



Total Ill at Different R_o



Conclusions - Results

- A portfolio of low cost / recommended NPIs outperforms higher cost / not recommended interventions
- Choice of NPIs is most important for moderate R_o (1.6-2.4)
- Rankings not greatly different across R_o
- Robustness analysis can allow for strong conclusions in spite of allowing very large ranges of assumptions

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