Modeling the COVID-19 Pandemic in Colorado

Jonathan Samet
Dean and Professor
Colorado School of Public Health

Presentation to the University of Colorado Regents

April 16, 2020
The Role of Models

• Infectious disease models long used to project the course of epidemics and to plan how to end them.

• Mathematical representations of how infections spread within populations.

• Many approaches to modeling and many different modelers.

• But, a fundamental tool for planning strategies for the COVID-19 epidemic.
Responding to the COVID-19 pandemic

• When will infections peak?
• How soon will we reach ICU bed capacity?
• How many non-ICU and ICU beds will we need at the peak?
• What will the impact of social distancing be? What has been the effect to date?

Need for rapid response in a highly fluid situation
Disease emerged ~4 months ago – scientific evidence is evolving rapidly and certainly incomplete
**R₀ basic reproductive number:** \( R₀ \) is the number of secondary infections produced by an infected individual in a population where everyone is susceptible and in the absence of controls.

The reproductive number depends on:

- **Contact rate:** the rate at which susceptible individuals contact infected individuals.
- **Transmission probability:** the probability that, given a contact between an infective source and a susceptible host, the susceptible host will become infected.
- **Duration of infectiousness**

![Graph showing the dynamics of susceptible, infected, and recovered individuals over time.](image)
Key assumptions

- Once a person is infected, their probability of developing symptoms and the severity of symptoms is age-dependent.
- An individual acquires at least short-term immunity following infection.
- The reported cases in Colorado do not represent all COVID-19 cases in Colorado.
- Individuals needing ICU care in excess of capacity die.
- No further transmission occurs once a patient enters a hospital.
Modeling the Epidemic: The Team and a Team Meeting

Colorado School of Public Health: Andrea Buchwald, Elizabeth Carlton, Debashis Ghosh, Richard Lindrooth, Jonathan Samet; Tatiane Santos; University of Colorado School of Medicine: Kathryn Colborn; University of Colorado-Boulder: David Bortz; Jimi Adams, University of Colorado Denver
When will we see the impact of social distancing?

The expected dates when the first impacts of different social distancing measures will be observed in reported COVID-19 cases and deaths.

Phase 1 social distancing begins (3/17)

Expected start of impact of phase 1 on reported cases (3/30 – 4/3)

Expected start of impact of phase 1 on deaths (4/3 – 4/5)

Phase 2 social distancing begins (3/26)

Expected start of impact of phase 2 on reported cases (4/8 – 4/12)

Expected start of impact of phase 2 on deaths (4/12 – 4/14)

Figure 4
Observed Cases with Fitted Curve

- Detected cases
- 70% SD
- 75% SD
- 80% SD

Count

Date

02/05 02/21 03/05 03/17 04/01
ICU Need

Count
0 5,000 10,000 15,000 20,000

Date
03/21 05/21 07/21 09/20 11/20

Bending the curve

Flattening the curve

40% SD
50% SD
60% SD
70% SD
80% SD
Moving Forward; Priority questions for COVID-19 in Colorado and beyond

• How long will people comply with social distancing orders? Will compliance wane after a “peak”?  
• Who are the most vulnerable populations and what is driving that vulnerability?  
• What will happen when social distancing is relaxed and what is the best way to do this?  
• How many people have been infected and are now immune?  
• What is the role of children in the transmission of COVID-19?  
• Will we see a decline in infections as the weather warms (a recent National Academy report suggests no)
“All models are wrong, but some are useful”
George Box