Modelling COVID-19 transmission and control

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cmmid.github.io
Outline

1. Understanding disease dynamics
2. Situational awareness
3. Exploring control scenarios
A simple model: Use reproduction number, R, to project short-term growth

- Initial cases
- New cases
- Time
- R above 1
- R = 1
- R less than 1
Datasets can have limitations, so can combine with models to extract more robust insights about underlying (and often unobserved) features of infection.
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1. Understanding disease dynamics: COVID-19

Pre-symptomatic transmission


Age patterns of COVID-19 severity

1. Understanding disease dynamics: COVID-19

Reproduction number over time:

Wang et al. MedRxiv, 2020
Kucharski et al. Lancet Inf Dis, 2020
1. Understanding disease dynamics: COVID-19

Uncertainty in real-time case data...

...so useful to incorporate multiple data sources in early models:

- Case data in Wuhan
- Internationally exported cases from Wuhan
- Infections on evacuation flights
1. Understanding disease dynamics: COVID-19

Early estimates of severity in China:

Additional data:

Symptomatic case fatality risk: 1.4% (0.9–2.1%)  1.4% (1.2–1.5)  1.2% (0.3–2.7%)

Infection fatality risk: –  0.7% (0.4–1.3)  0.6% (0.2–1.3%)


Verity et al. *Lancet Inf Dis*, 2020

Russell et al. *Eurosurveillance*, 2020
2. Situational awareness: COVID-19

Models can help estimate and monitor key epidemiological values in real-time.

• Estimation of infection curves, reproduction number and short-term forecasts

• Evaluate effectiveness of interventions, e.g. association between R vs control measures

2. Situational awareness: COVID-19

Estimates from social mixing data

Estimates from REACT-1 community testing
2. Situational awareness: COVID-19

Estimates from social mixing data

Pre-COVID R

Post-lockdown R

Type of Contact
- All
- Physical

Density

Jarvis et al. BMC Med, 2020
cmmid.github.io
2. Situational awareness: COVID-19

R estimates can depend on data source:

Sherratt et al. MedRxiv, 2020
Gostic et al. MedRxiv, 2020
B.1.1.7 variant

Davies et al. CMMID Report, 2020
Volz et al, Imperial College Report 42, 2020
B.1.1.7 variant

Tom Wenseleers (@TWenseleers)
Data: COG-UK & Statens Serum Institut Report, 2021
3. Exploring control scenarios: COVID-19

Models can synthesize available evidence to help answer ‘what if?’ questions.

3. Exploring control scenarios: COVID-19

Models can synthesize available evidence to help answer ‘what if?’ questions.

Epi parameters  →  Transmission model  →  Burden model

Davies et al. Lancet Public Health, 2020
3. Exploring control scenarios: COVID-19

Models can synthesize available evidence to help answer ‘what if?’ questions.
Summary

1. Understanding the infection
2. Situational awareness
3. Exploring control scenarios

Key uses of models:
– Extract additional insights from available data
– Identify features of dynamics that may not be predictable otherwise
– Compare possible control scenarios