Modelling COVID-19 transmission and control

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centre for mathematical modelling of infectious diseases

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



Datasets can have limitations, so can combine with models to extract more robust insights about underlying (and often unobserved) features of infection.



Pre-symptomatic transmission

Liu et al, Wellcome Open Research, 2020



Age patterns of COVID-19 severity

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Pre-symptomatic transmission

Liu et al, Wellcome Open Research, 2020



Age patterns of COVID-19 severity

Davies et al, Nature Med, 2020



Wang et al. *MedRxiv*, 2020 Kucharski et al. *Lancet Inf Dis*, 2020

Uncertainty in real-time case data...



Tsang et al. Lancet Public Health, 2020

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

- Case data in Wuhan
- Internationally exported cases from Wuhan
- Infections on evacuation flights

Imperial College COVID-19 Report 1 Kucharski et al. *Lancet Inf Dis,* 2020

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%)
	Wu et al. Nature Med, 2020	Verity et al. <i>Lancet Inf Dis,</i> 2020	Russell et al. Eurosurveillance, 2020

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



Abbott et al, Wellcome Open Research, 2020









Jarvis et al. *BMC Med*, 2020 cmmid.github.io

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

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3. Exploring control scenarios: COVID-19

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



Davies et al. Report from: cmmid.github.io

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

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