COVID-19 modelling & open outbreak science

Adam Kucharski
Associate Professor & Sir Henry Dale Fellow
Department of Infectious Disease Epidemiology

INI workshop
May 2020
Acknowledgements

CMMID COVID-19 working group (order generated randomly):


+ The many colleagues, collaborators & partners working on the response
Outline

1. Understanding the infection
2. Exploring control scenarios
3. Situational awareness
4. Open science in outbreaks
1. Understanding the infection

- Early dynamics of transmission/control in Wuhan
- Estimation of pre-symptomatic transmission
- Infection/case fatality risk estimation
- Age-dependency in symptoms/susceptibility
- Settings linked to transmission
- Length of hospital stay
1. Understanding the infection

Some considerations:

- Results often have limited shelf-life (e.g. estimated case fatality risk in absence of serology). Being roughly correct now more important than being precisely correct months later.

- Evidence synthesis: each dataset has caveats, so combine data with models to try and obtain more robust insights

- Design models with expectation that data will arrive (e.g. didn’t have subnational data early on, but knew it would come)
2. Exploring control scenarios

- Case isolation, contact tracing and quarantine
- Traveller screening and follow-up
- Large-scale social distancing strategies

Often focus on UK response (via SPI-M/SAGE) but also extend to other settings
2. Exploring control scenarios

Next steps:

• Evaluation of measures, e.g. Korea/Hong Kong: remote working, school closures, reclosures, testing, contact tracing. Which is most important?

• Exploration of combined approaches, e.g. how can physical distancing complement contact tracing?

• Potential for targeted measures? Increasing evidence R is overdispersed/setting specific. Possible to control without extensive distancing?
3. Situational awareness

- Estimation of infection curves, R and short-term forecasts
- Inferring undetected epidemics from severe outcomes
- Using cases & deaths to estimate proportion of symptomatic cases reported
- Understand changes in social behavior: contact surveys, Google/Facebook data

R estimation from epiforecasts.io

Real-time social mixing surveys:

cmmid.github.io/topics/covid19/
3. Situational awareness

Some applications:

• Estimates of dynamics can inform:
  – planning relaxation of measures
  – post-lockdown monitoring

• Estimates of true case numbers can inform:
  – testing/contact tracing requirements
  – planning surveillance/serosurveys
  – imported case risk

Using NHS calls (111/999) to estimate dynamics
4. Open science in outbreaks

Outbreak science needs to be:

- Fast
- Open
- Collaborative
- Peer-reviewed
Fast research

- Traditional journals too slow in fast-moving outbreak
- Noticed pre-print servers quickly overwhelmed, ~5-day processing time
- Set up dedicated online repository – went live on 28th Jan
- For papers, generally simultaneous upload + pre-print + journal submission
Open research

• Aim to make all code & data available alongside reports/papers
• Dashboards/apps can share early results while follow-up analysis happening

Inferring COVID-19 cases from deaths of confirmed cases

Authors: Thibaut Jombart, Sam Abbott, Amy Gimme, Kevin Zandvoot, Sam Clifford, Christopher Jarvis, Timothy Russell, Sebastian Funk, Henriq Gibbon, Rosalind Eggo, Adam Kucharski, CMMID COVID-19 Working Group*, John Edmunds

Disclaimer: This model is not peer-reviewed. The results generated here should not be interpreted to predict exact numbers of cases. Please read the study summary on the LSHTM CMMID website.

Data input
Dates of Death (format 'yyyy-mm-dd', e.g. 2020-02-18, separated by spaces or new lines. The data range must be 7 days or less):
2020-05-18 ...

Model input
Reproduction number (R):

Case Fatality Ratio (CFR), in %:

Duration of simulations (days after)

Simulation results: new cases per day

New daily cases

Percentage of cases reported

Also strongly encourage code adaptation/reuse (+ support where possible)
Collaborative research

• During outbreaks, lots of important work not always visible or publishable (e.g. data extraction/cleaning, literature reviews, code maintenance).

• Created ‘CMMID COVID-19 working group’ to ensure every resulting output credited this large team

• Major contributors to specific papers are named as authors, working group covers all other contributions

• Where possible for external dissemination/media: “if you’ve done the work, you present the work”
Peer-reviewed research

• Before any CMMID analysis goes online, undergoes ‘internal peer-review’ by working group. Also submit to traditional journals.

• Internal review: post Google doc on Slack with ~48-hour deadline for comments. Crowd sources feedback so no one person has large review burden.

• Work doesn’t go online until major comments/revisions are addressed.

cmmid.github.io/topics/covid19/
Summary

Outbreak modelling useful in many ways:
1. Understanding the infection
2. Exploring control scenarios
3. Situational awareness

Open science in outbreaks has made progress, but still long way to go...

Twitter: @cmmid_lshtm
Web: cmmid.github.io/topics/covid19/