

COVID-19 modelling & open outbreak science

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centre for
mathematical
modelling of
infectious
diseases

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Acknowledgements

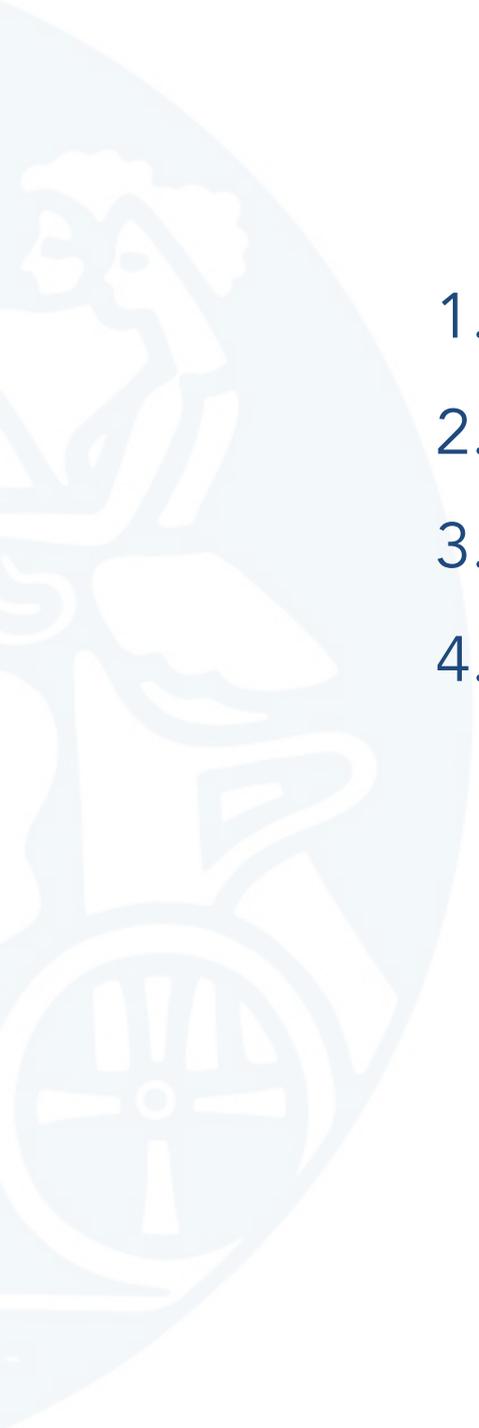
CMMID COVID-19 working group (order generated randomly):

Jon C Emery, Graham Medley, James D Munday, Timothy W Russell, Quentin J Leclerc, Charlie Diamond, Simon R Procter, Amy Gimma, Fiona Yueqian Sun, Hamish P Gibbs, Alicia Rosello, Kevin van Zandvoort, Stéphane Hué, Sophie R Meakin, Arminster K Deol, Gwen Knight, Thibaut Jombart, Anna M Foss, Nikos I Bosse, Petra Klepac, Katherine E. Atkins, Billy J Quilty, Rachel Lowe, Kiesha Prem, Stefan Flasche, Carl A B Pearson, Rein M G J Houben, Emily S Nightingale, Akira Endo, Damien C Tully, Yang Liu, Julian Villabona-Arenas, W John Edmunds, Kathleen O'Reilly, Sebastian Funk, Rosalind M Eggo, Mark Jit, Eleanor M Rees, Joel Hellewell, Samuel Clifford, Christopher I Jarvis, Sam Abbott, Megan Auzenberg, Nicholas G. Davies, David Simons

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

Outline

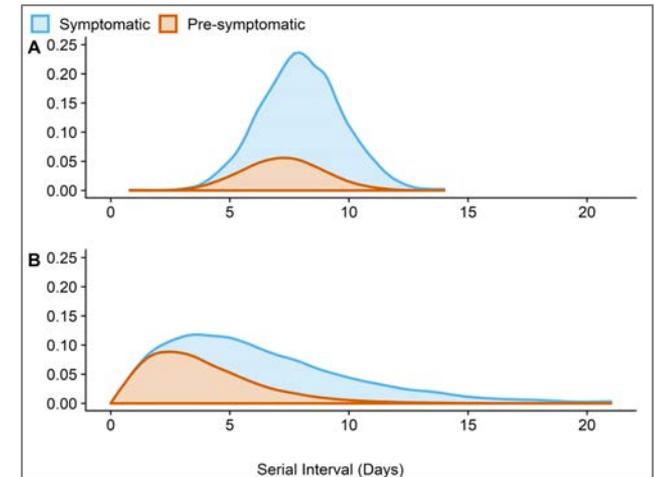
1. Understanding the infection
2. Exploring control scenarios
3. Situational awareness
4. Open science in outbreaks



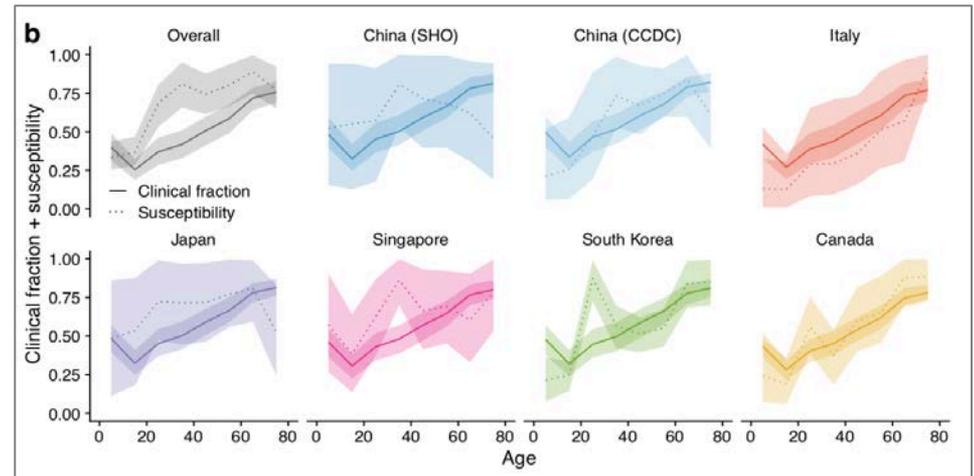
1. Understanding the infection

- 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

Pre-symptomatic transmission



Age patterns of severity

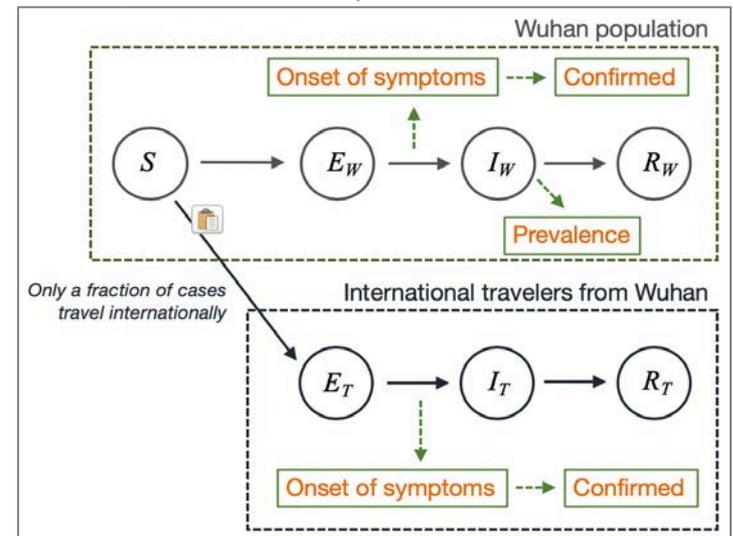


1. Understanding the infection

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)

Linking domestic/exported cases

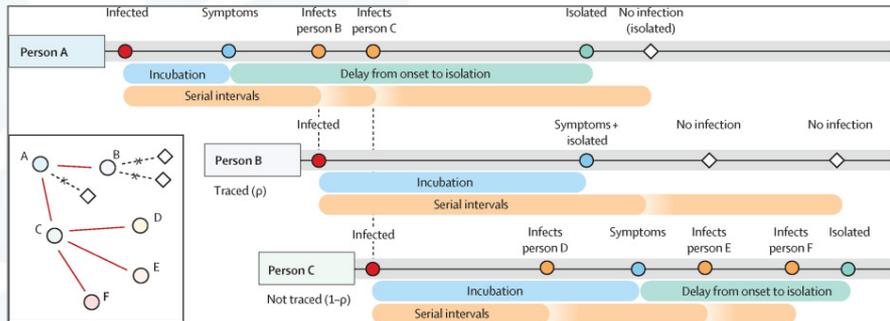


2. Exploring control scenarios

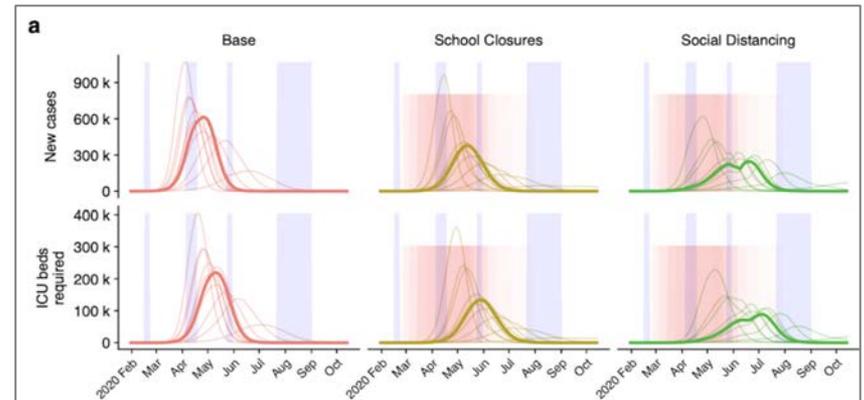
- Case isolation, contact tracing and quarantine
- Traveller screening and follow-up
- Large-scale social distancing strategies

Often focus on UK response (via SPI-M/SAGE) but also extend to other settings

Early isolation/contact tracing modelling



Early UK scenario modelling

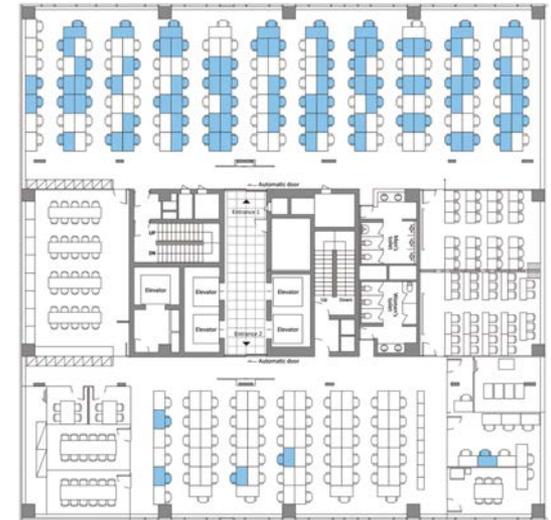


2. Exploring control scenarios

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?

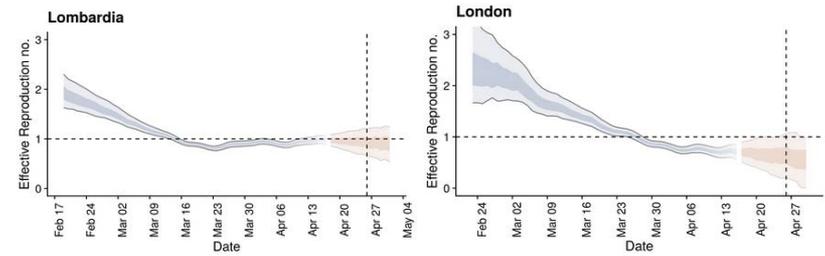
Call centre outbreak, Korea



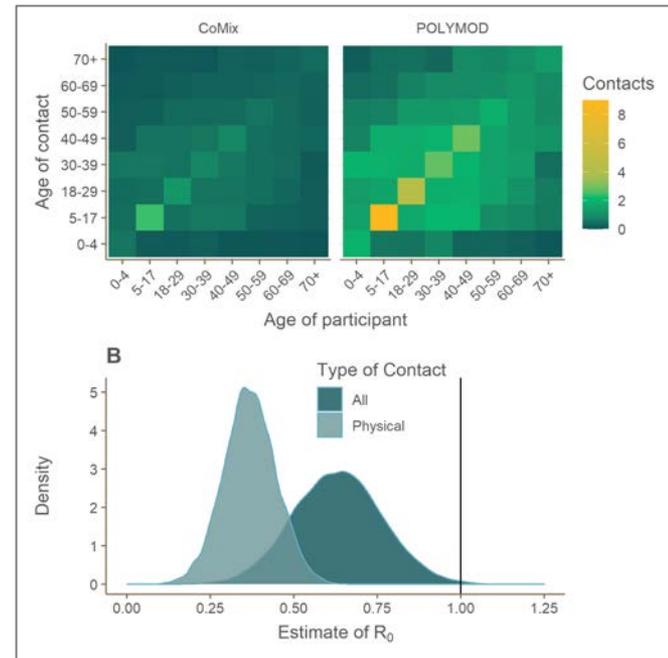
3. Situational awareness

- 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:

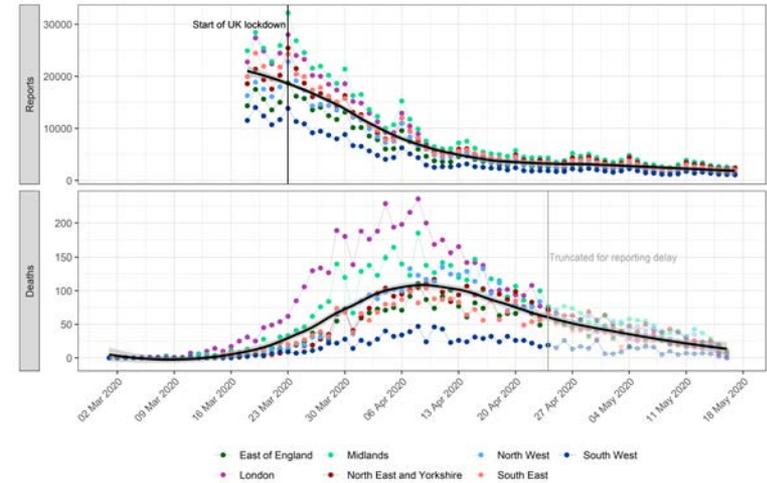


3. Situational awareness

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

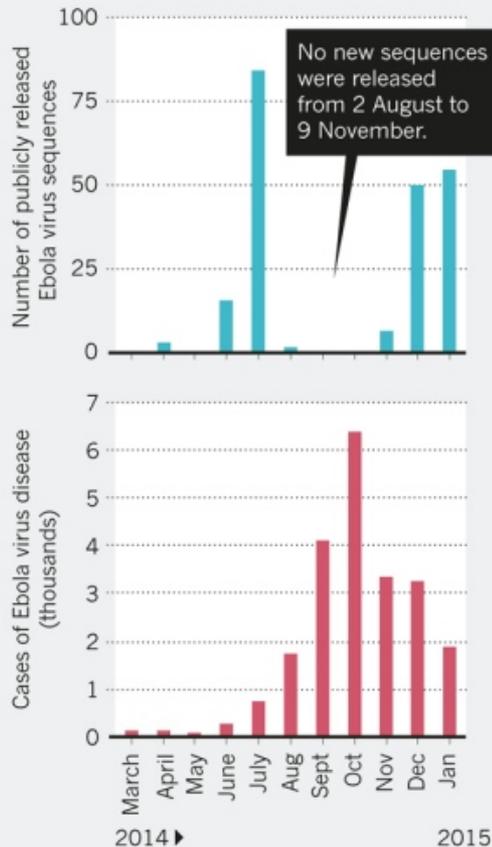
Using NHS calls (111/999) to estimate dynamics



4. Open science in outbreaks

GAPS IN THE DATA

Genome sequences from the West Africa outbreak of Ebola virus were first made publicly available in April 2014. Since 99 genomes were released in July, data sets have been shared sporadically, even though more are known to have been generated.



Outbreak science needs to be:

- Fast
- Open
- Collaborative
- Peer-reviewed

Fast research

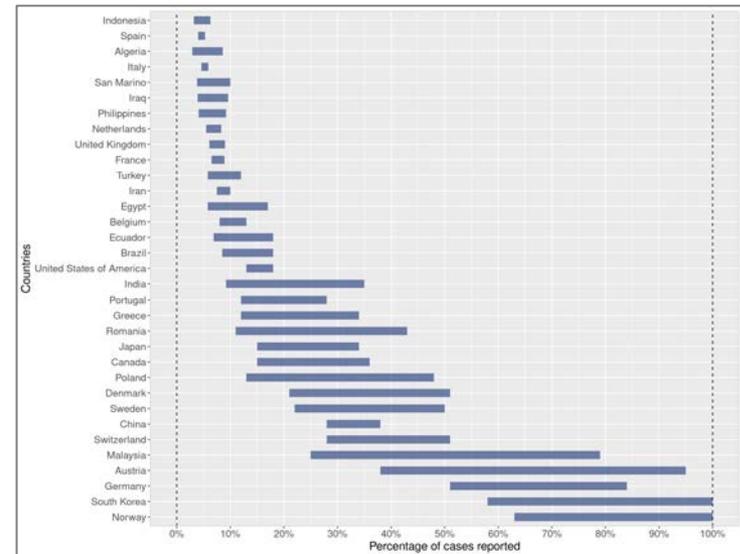
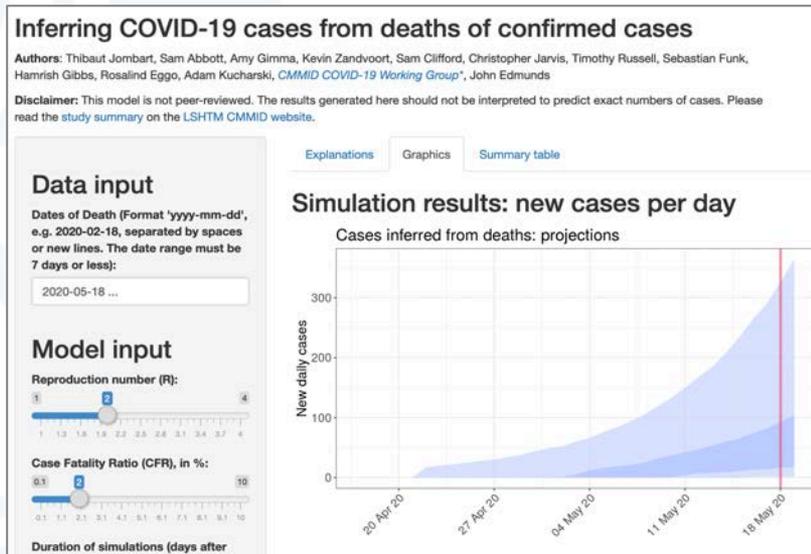
- Traditional journals too slow in fast-moving outbreak
- Noticed pre-print servers quickly overwhelmed, ~5-day processing time
- Set up dedicated online repository – went live on 28th Jan
- For papers, generally simultaneous upload + pre-print + journal submission

The screenshot shows the CMMID Repository website. The header includes the CMMID logo and navigation links: Home, Covid-19 (highlighted), Apps, and About. The main content area is titled "Covid-19" and contains an overview of the center's work on the ongoing outbreak. It lists several studies, including "Using a delay-adjusted case fatality ratio to estimate under-reporting" and "Age-dependent effects in the transmission and control of COVID-19 epidemics". A sidebar on the left provides navigation options such as "Transmission dynamics", "LMIC considerations", and "Control measures".

The screenshot shows the CMMID GitHub repository page. The header includes the CMMID logo and the center's name: "centre for the mathematical modelling of infectious diseases". It also lists the location (London) and website (http://cmmid.lshtm.ac.uk). The repository page displays a search bar, filters for "Type: All" and "Language: All", and a list of repositories. The first repository is "covidm_reports", described as "LMIC reports using the covidm model framework", with 1 repository, 4 stars, 1 issue, and 0 pull requests, updated 1 hour ago. The second repository is "covid19_automation", described as "Automated reports for COVID-19 outbreak", with 0 repositories, 2 stars, 17 issues (3 need help), and 2 pull requests, updated 21 hours ago.

Open research

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



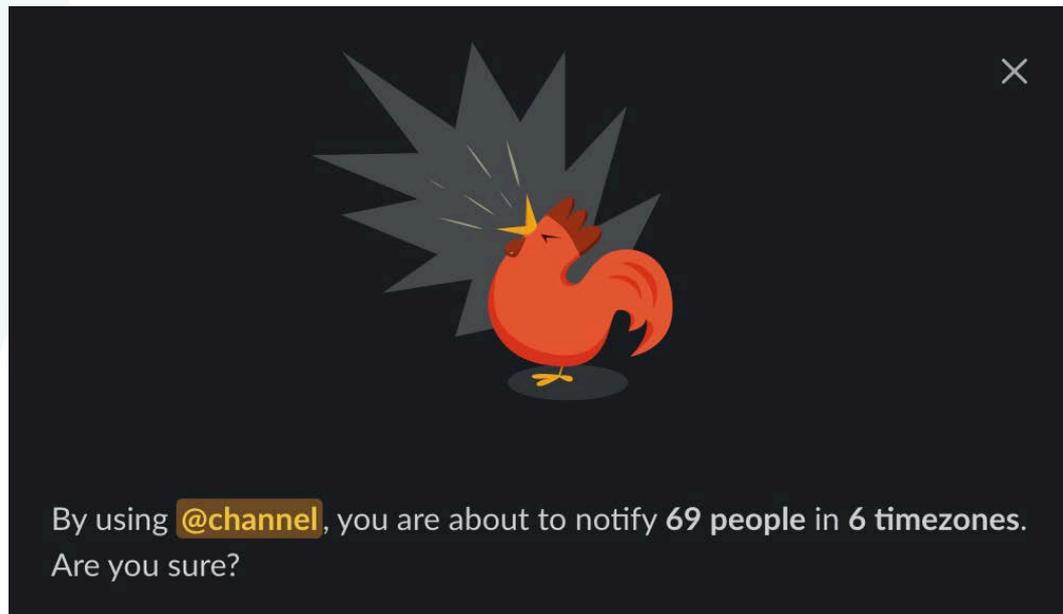
- Also strongly encourage code adaptation/reuse (+ support where possible)

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.



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_Ishtm

Web: cmmid.github.io/topics/covid19/