London Business School

Wheeler Institute for Business and Development

A user guide to Covid-19

part ii – epidemiology for dummies

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Financial support from the European Research Council and the Wheeler Institute is gratefully acknowledged.

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Part ii- *epidemiology for dummies*

What we do

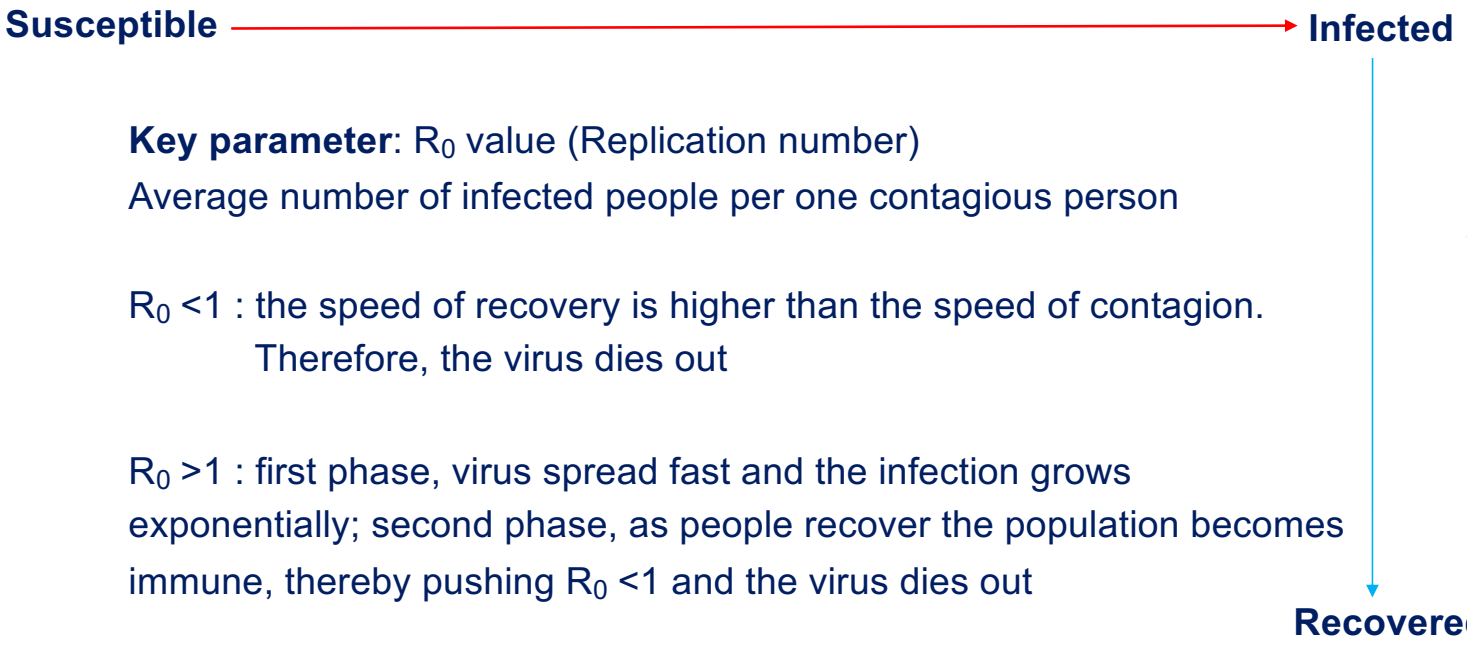
- Explain a “typical” epidemiological model of contagion (SIR Model)
- Present the Imperial College Covid-19 Response Team Report
- Highlight areas where more data and analyses are needed

What you learn

- Understanding better the trade-offs of existing health policies
- Form an opinion on the extent to which each policy reaches its intended goal
- Evaluate and improve existing policies

A typical epidemiology model

S(usceptible)**I**(nfected)**R**(ecovered)



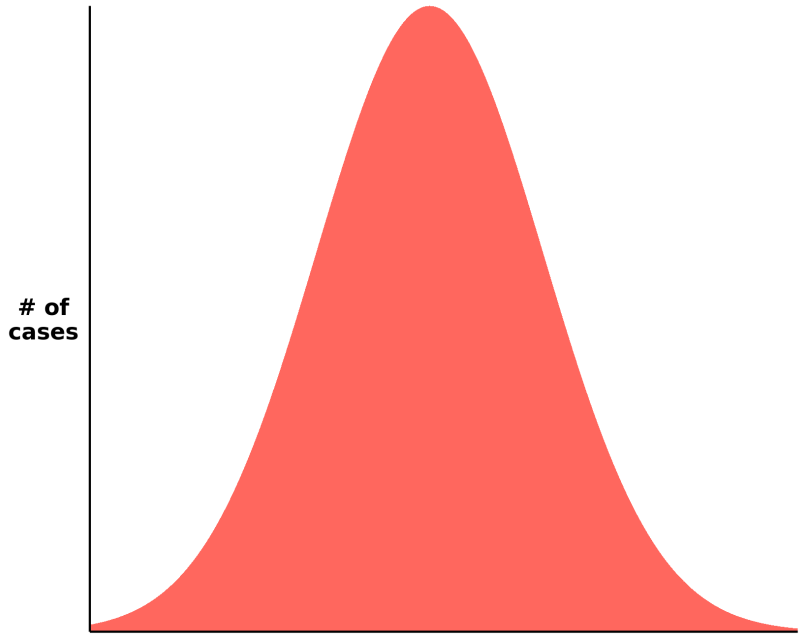
Key parameter: R_0 value (Replication number)
Average number of infected people per one contagious person

R_0 <1 : the speed of recovery is higher than the speed of contagion. Therefore, the virus dies out

R_0 >1 : first phase, virus spread fast and the infection grows exponentially; second phase, as people recover the population becomes immune, thereby pushing R_0 <1 and the virus dies out

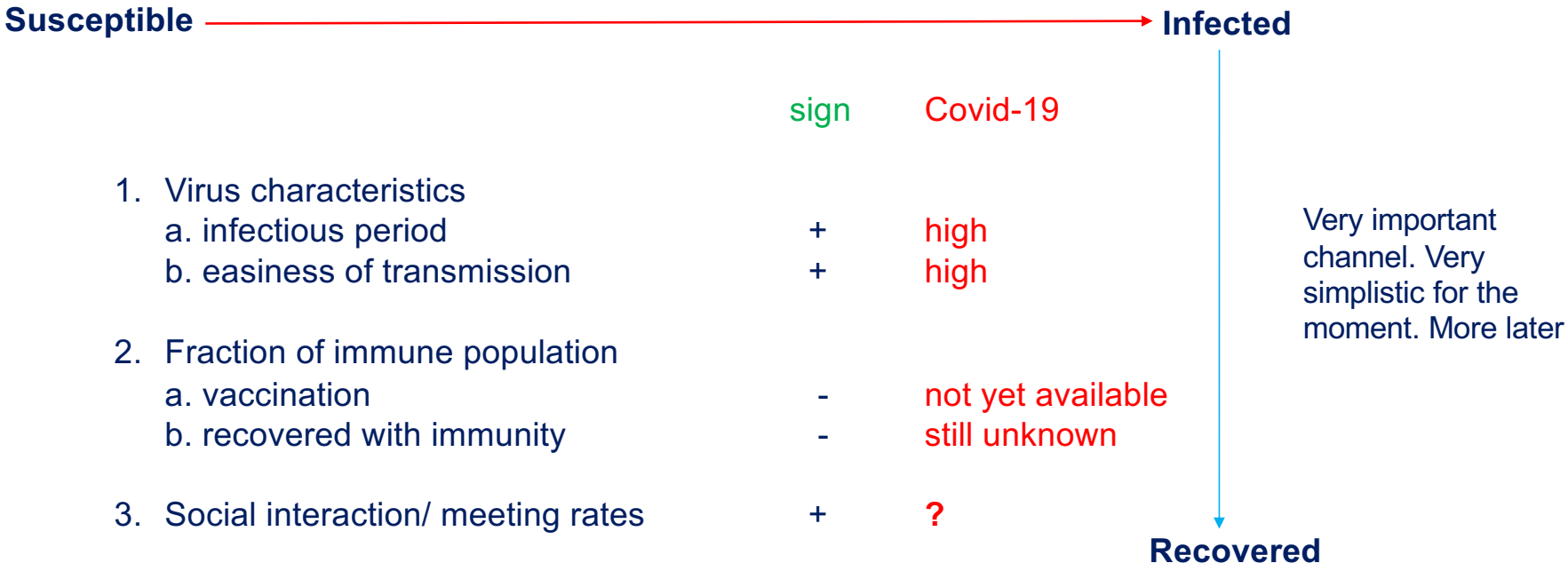
Very important channel. Very simplistic for the moment. More later

The theoretical contagion curve: R_0>1



Adapted from the CDC and The Economist
Visit flattenthecurve.com

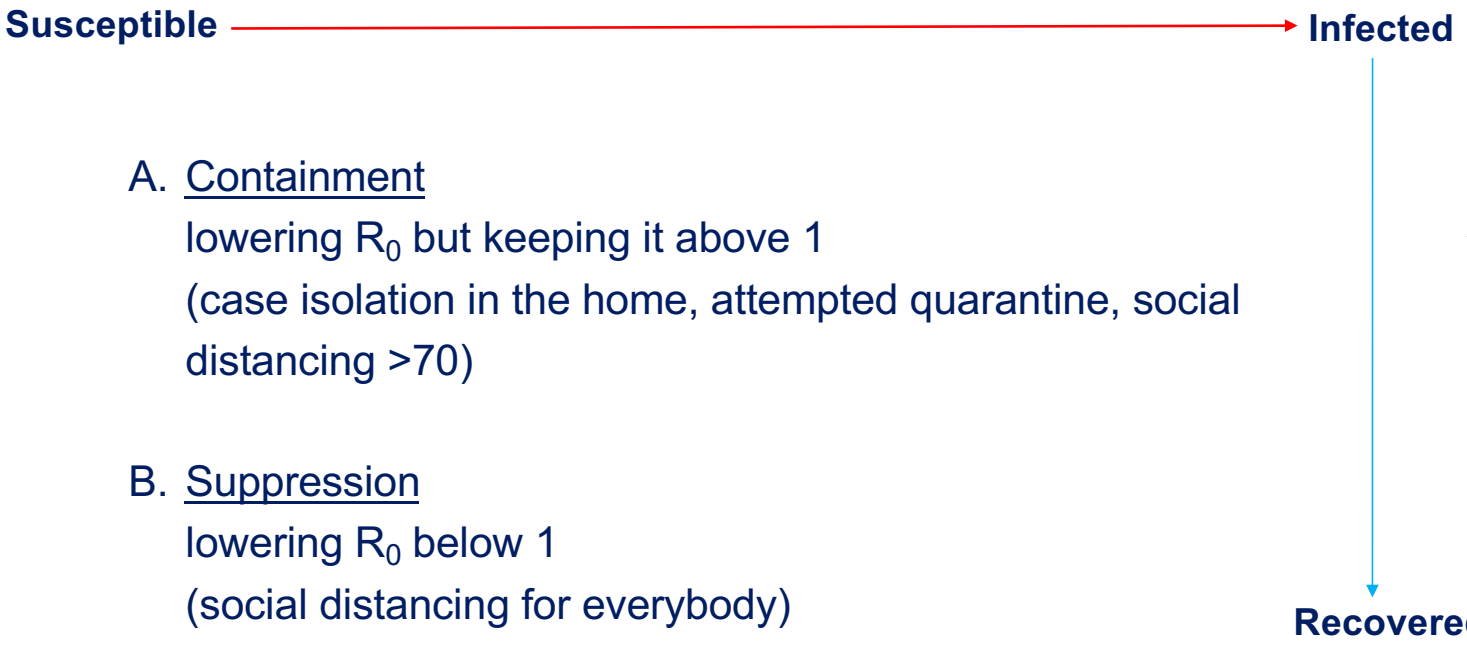
What are the determinants of R_0?



	sign	Covid-19
1. Virus characteristics		
a. infectious period	+	high
b. easiness of transmission	+	high
2. Fraction of immune population		
a. vaccination	-	not yet available
b. recovered with immunity	-	still unknown
3. Social interaction/ meeting rates	+	?

Very important channel. Very simplistic for the moment. More later

What policies can influence R_0?



A. Containment
lowering R_0 but keeping it above 1
(case isolation in the home, attempted quarantine, social distancing >70)

B. Suppression
lowering R_0 below 1
(social distancing for everybody)

Very important channel. Very simplistic for the moment. More later

Health care policies

Imperial College Covid-19 Response Team Report

Table 2: Summary of NPI interventions considered.

Label	Policy	Description
CI	Case isolation in the home	Symptomatic cases stay at home for 7 days, reducing non-household contacts by 75% for this period. Household contacts remain unchanged. Assume 70% of household comply with the policy.
HQ	Voluntary home quarantine	Following identification of a symptomatic case in the household, all household members remain at home for 14 days. Household contact rates double during this quarantine period, contacts in the community reduce by 75%. Assume 50% of household comply with the policy.
SDO	Social distancing of those over 70 years of age	Reduce contacts by 50% in workplaces, increase household contacts by 25% and reduce other contacts by 75%. Assume 75% compliance with policy.
SD	Social distancing of entire population	All households reduce contact outside household, school or workplace by 75%. School contact rates unchanged, workplace contact rates reduced by 25%. Household contact rates assumed to increase by 25%.
PC	Closure of schools and universities	Closure of all schools, 25% of universities remain open. Household contact rates for student families increase by 50% during closure. Contacts in the community increase by 25% during closure.

Source: Ferguson et al. (2020), Impact of non-pharmaceutical interventions (NPIs) to reduce COVID- 19 mortality and healthcare demand. Imperial College COVID-19 Response Team.

Policies to contain the virus

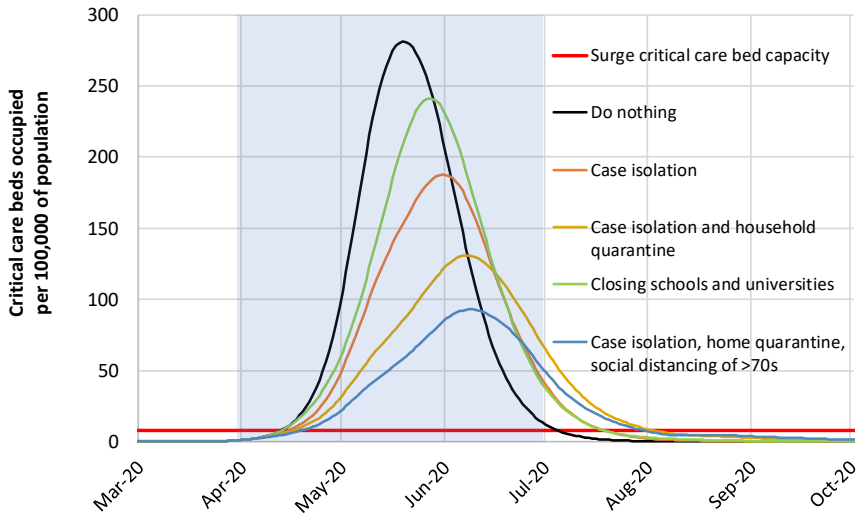


Figure 2: Mitigation strategy scenarios for GB showing critical care (ICU) bed requirements. The black line shows the unmitigated epidemic. The green line shows a mitigation strategy incorporating closure of schools and universities; orange line shows case isolation; yellow line shows case isolation and household quarantine; and the blue line shows case isolation, home quarantine and social distancing of those aged over 70. The blue shading shows the 3-month period in which these interventions are assumed to remain in place.

Policies to suppress the virus

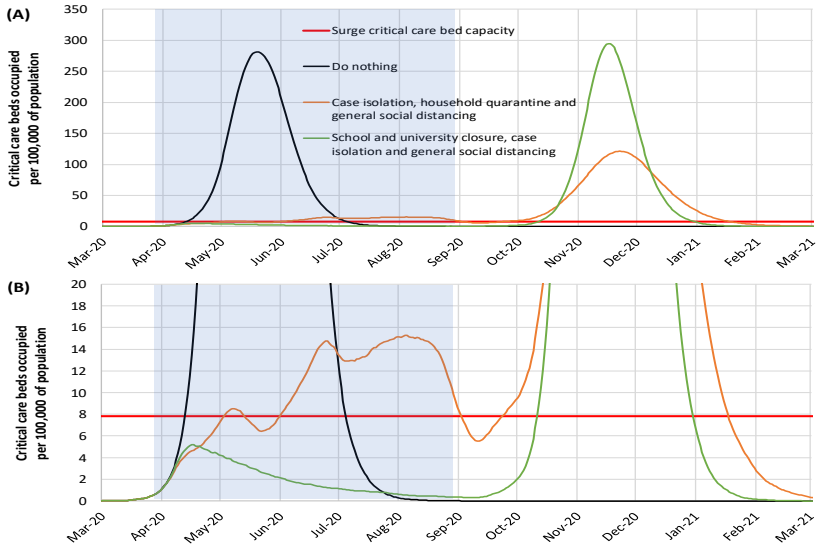


Figure 3: Suppression strategy scenarios for GB showing ICU bed requirements. The black line shows the unmitigated epidemic. Green shows a suppression strategy incorporating closure of schools and universities, case isolation and population-wide social distancing beginning in late March 2020. The orange line shows a containment strategy incorporating case isolation, household quarantine and population-wide social distancing. The red line is the estimated surge ICU bed capacity in GB. The blue shading shows the 5-month period in which these interventions are assumed to remain in place. (B) shows the same data as in panel (A) but zoomed in on the lower levels of the graph. An equivalent figure for the US is shown in the Appendix.

Source: Ferguson et al. (2020), Impact of non-pharmaceutical interventions (NPIs) to reduce COVID- 19 mortality and healthcare demand. Imperial College COVID-19 Response Team.

The key role of the asymptomatic

"We estimate 86% of all infections were undocumented prior to 23 January 2020 travel restrictions. Per person, the transmission rate of undocumented infections was 55% of documented infections, yet, due to their greater numbers, undocumented infections were the infection source for 79% of documented cases."

Source: Ruiyun Li et al. (2020), Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV2), Science, 16 March 2020, DOI: 10.1126/science.abb3221

A few consequences:

1. Good news: existing estimates of case-fatality rates and alike might be over-estimated
2. Good news: some immunity already in the system (consistent with the trend in China where the virus did not pick up after restrictions have been relaxed)
3. Bad news: it is likely that when interventions started in Europe and USA the virus was widely spread. The estimates from simulation on how measures of suppression will flatten the curve in the short run may be over-optimistic

Bottom line: we are designing policies based on highly incomplete evidence/information

A simple policy proposal

Random testing, statistical analysis and surveillance

1. Test a representative sample of the population (independently of symptoms), recording socio, economical, demographic and locational characteristics at the household level

2. Use standard statistical methods to infer the household characteristics most likely to predict whether someone is infected or not in the whole population

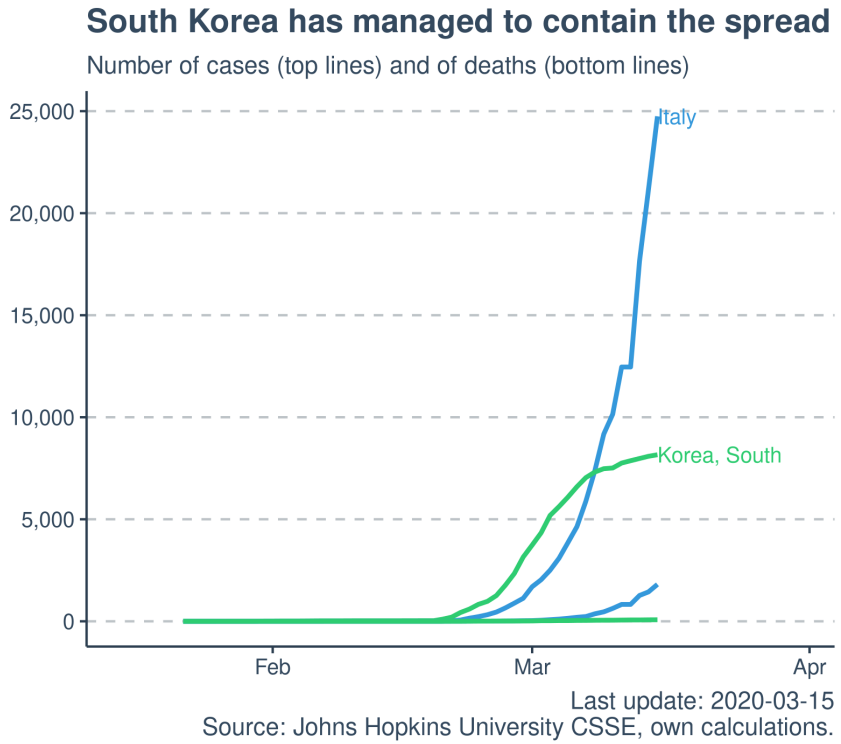
3. Develop surveillance strategies based on the information revealed in 2: nation-wide contact tracing, targeted social distancing

Collecting the right data and extensive statistical analysis can save MANY lives!!!

The early success stories in containment

- South Korea had a sharp increase in cases during February but has managed to slow the spread in March
- In addition the death rate as of March 15th has been particularly low: 0.9% (vs 7.2% in Italy)

- Additional measures in South Korea:
  - Rapid scaling of testing, (e.g., 5,500 test for every one million people; U.K.: 750 for every one million people)
  - Readily available tests (e.g., free with doctor prescription, available privately, but reimbursed by the government is positive)
  - Contact tracing, targeted testing and monitoring infected (e.g., government app to locate people)



Source: https://www.nytimes.com/2020/03/13/opinion/coronavirus-best-response.html

Summary

- Covid-19 health policies have all one objective: decreasing the replication number of Covid-19
- Given existing capacity of health care systems, suppression policies are the only one that can help us in the **short-run**
- **Please do follow government guidelines**
- Let's use the time bought by suppression policies effectively:
  - Test a representative sample of the population to gather reliable and unbiased information about the prevalence of Covid-19
  - Extensive statistical analysis within and across countries (that are in different phases)
  - Develop surveillance strategies based on this reliable information

Full set of slides available at https://sites.google.com/site/paolosurico/covid-19

Next video: A user guide to Covid-19. Part iii – economics for dummies