THE EPIDEMIOLOGY ADVENTURE: BEING A DISEASE DETECTIVE
15.4.2020

Episode 5: Impact of measures to control COVID-19

COVID-19 Action Plan

In general, governments have been designing and implementing action plans related to COVID-19. The aim is to reduce the virus basic reproduction number (R_0 or the number of people, on average, to whom one infected person will pass the virus) as much as possible by using public health-mandated measures and by promoting change in individual and collective behaviors. A secondary aim is to minimize societal disruption and keep negative economic impact within manageable levels. This episode focuses on these measures and the way they are set and monitored.

Policy makers devise appropriate, proportionate and timely measures to control the spread of the virus. This is very challenging when considering the timing and intensity of transmission varies between countries, provinces and territories. For example, different measures need to be developed for populated areas and for remote or isolated communities, whilst also taking into consideration the possible lack of non-medical supplies, crowded or poor housing conditions, population response and behavior, etc. These differences in contexts will determine which measures are adopted and these are based on current available scientific evidence, experts' opinions and public health assumptions. The effectiveness of these measures is subject to change as new information on transmissibility and epidemiology becomes available. Hence, new information will ultimately affect plans already in place.

In general terms, policy makers outline three disease phases for COVID-19, running in time alongside with research and health communication plans (Fig. 1). For each phase different actions are considered.

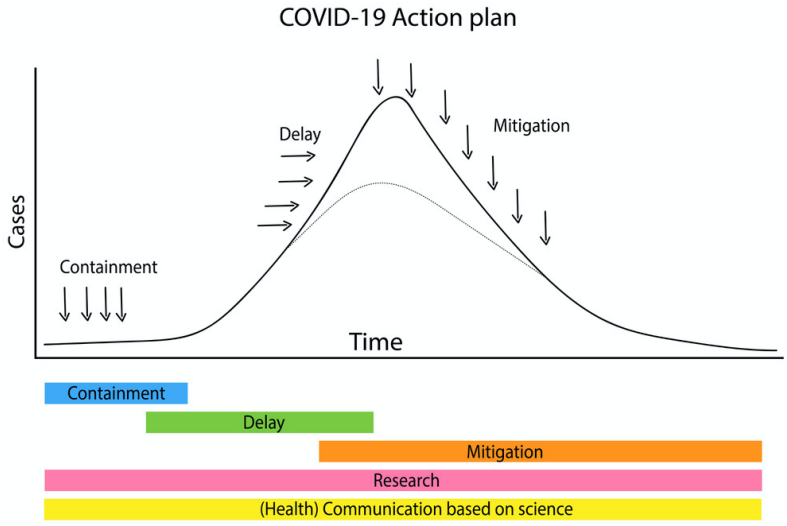

Figure 1. Covid-19 Action Plan

- **Containment: early detection** of imported or local cases take place together with follow up of close contacts.
- **Delay:** a phase to **slow the spread** and lower the peak impact.
- **Mitigation:** provide **essential services and protection of the most vulnerable**. This phase focuses also on the **reduction of excess mortality**.
- **Research:** essential as no effective vaccine or specific treatment is yet available. This needs a broad approach which includes a better understanding of the virus and the design of innovative responses.
- **Communication:** this is an important tool to create trust and public support. It has to be balanced, coherent and based on scientific facts.

Different countries in the world are at different stages, mostly moving from the delay to the mitigation phase.

Public health control measures to control Covid-19 impact

People are becoming familiar with the public health measures during the COVID-19 outbreak. Some measures are commonly also used for seasonal influenza and other outbreaks, while others are considered only for a severe pandemic. The World Health Organization (WHO, 2020), The European Centre for Disease Prevention and Control (ECDC, 2020) and national governments have published useful guidelines with mitigation measurements:

1. **Hand hygiene**: from laboratory to interventional studies, it has been demonstrated that this simple but very important containment measure is effective if it is done properly and regularly. The effectiveness depends on compliance and training (Saunders-Hastings et al. 2017).
2. **Cough etiquette**: The recommendation is mainly based on public health experience. There is less scientific evidence and if available, studies show that this measure helps but does not fully interrupt the chain of transmission (Zayas et al, 2013; Saunders-Hastings et al. 2017). As with hand washing, the effectiveness depends on compliance and training.
3. **Face masks** in community settings: there is a debate about this measure. There is consistency in the recommendation that symptomatic individuals and those in health-care settings should use face masks. However, discrepancies were observed in the general public and community settings in different countries.
   There are four reasons to discourage widespread use of face masks: (a) to preserve limited supplies for professional use in health-care settings; (b) the lack of evidence about the effectiveness against the coronavirus infection; (c) the risk of improper use of face masks, such as not changing disposable masks, which can even increase the risk of infection, and (d) the false sense of security that could make people forget about measures that are proven to be effective (washing hands, keeping surfaces clean and social distancing). Therefore, education is important if masks are used widely. Public Health experts find it reasonable – where available – that people in quarantine wear face masks if they need to leave their home in order to prevent potential asymptomatic or presymptomatic transmission in crowded areas. In addition, vulnerable populations, such as older adults and those with underlying medical conditions, could wear them (Feng et al. 2020).

4. **Environmental measures:** routine cleaning of surfaces, clothes and objects, minimizing sharing objects, and proper ventilation of closed spaces. These measures are proven to be effective during containment and mitigation phases in any infectious disease (WHO 2020).
5. **Early self-isolation and monitoring** during 14 days when transmission via contacts may have occurred is very effective in the delay phase. WHO (2020) guidelines classify contacts as 'close' or 'casual' with specific proposed actions for each group.
6. **Voluntary isolation** of people with symptoms not requiring hospitalization. This is one of the most important measures for reducing transmission during the mitigation phase. Although this measure is associated with complicated logistics, its combination with environmental measures have been proven to be very effective. It is important to facilitate medical advice remotely unless symptoms are severe (WHO 2020).
7. **Spatial or social distancing:** mathematical modelling of transmission under different scenarios has been the method to generate robust evidence about the effectiveness of this measure. Using this methodology, Koo et al. (2020) combined interventions with quarantine, school closure, and workplace distancing and found very significant reductions of infections. This measure has been applied worldwide for the outbreak (ECDC, 2020) in the delay and mitigation phases, preventing transmission from both symptomatic and non-symptomatic cases.
8. **School closure:** for this specific measure, data is scarce and results unclear (Lewnard and Lo, 2020). However, the approach from several countries is expected to provide data on its effectiveness. As this measure is associated with significant costs to society and the economy, the decision should be considered carefully in terms of timing and duration. For this reason, it is not considered in the containment phase. Mathematical models confirm its effectiveness during peak rates (Ferguson et al., 2006).
9. **Measures at the workplace** include using flexible shifts, teleworking, etc. The ECDC report (2020) from last March considers that these can be effective and should be used during the mitigation phase. There is still insufficient data to assess the effect of these measures and scientists tend to consider that they have a modest impact compared to their high cost.
10. **Avoid large gatherings of people:** reduce the number of super-spreading events and this has been justified during the containment phase. Due to the significant secondary effects of cancelling gatherings, this decision should be made based on a risk assessment plan (WHO, 2020).
11. **Travel-related measures:** these relate to advice regarding international and domestic flights but also includes screening at entry points. Legal and economic implications are significant and there is still a lack of evidence on its effectiveness. However, close contact with people travelling from areas where transmission is ongoing increases the risk of importation. Regarding the screening at entry points, the low sensitivity of the systems used to identify mildly symptomatic infections makes it difficult to detect cases during incubation (ECDC 2020).

Health policy mandated-measures are challenging. Some measures are easy to communicate and implement while others have significant social and economic impact. At the same time, their effect is not immediate and consequences on effectiveness could change over time. Therefore, decisions are complicated. They can be made proactively or reactively and during difference phases. Once in place, the major challenge is their duration in relation to the

availability of a vaccine. A possible **transmission rebound** could happen when interventions are relaxed.

How to set and monitor the effect of control measures

Quantifying the impact of the measures and behavior allows policy makers to design, adjust and monitor the action plan while preparing the exit plan.

Predictive models for decision-making:

Infectious disease modelling is a tool that has been developed for years to face the complexity of disease dynamics. It has a superior ability to predict outcomes compared to human judgement. With computational tools, information is synthesized to understand patterns. For COVID-19, scientists have been working hard in the last few months in integrating molecular epidemiology with social data, meaning that information about the virus and social networking of the population are engaged together in a mathematical model (the so-called 'socio-molecular' approach). Multidisciplinary teams are needed for this task, including microbiologists and other experts in the relevant areas. Where available, local information is used as social networking varies among countries. If not, similar population cohorts are used.

Figure 2 shows one example of a predictive model developed by the Imperial College Covid-19 Response Team (Ferguson et al. 2020). Different scenarios are considered in relation to intensive care bed requirements in the UK, each of which includes one or more (accumulative) measures. Model assumptions were considered based on China's outbreak information (incubation period of 5.1 days, R0=2.4, 50% of symptomatic individuals, etc.). The model helps to decide the measures that should be taken in order to reduce the amount of IC beds per 100'000 inhabitants. Multiple assumptions and scenarios can be tested in order to provide useful information and general conclusions can be obtained.

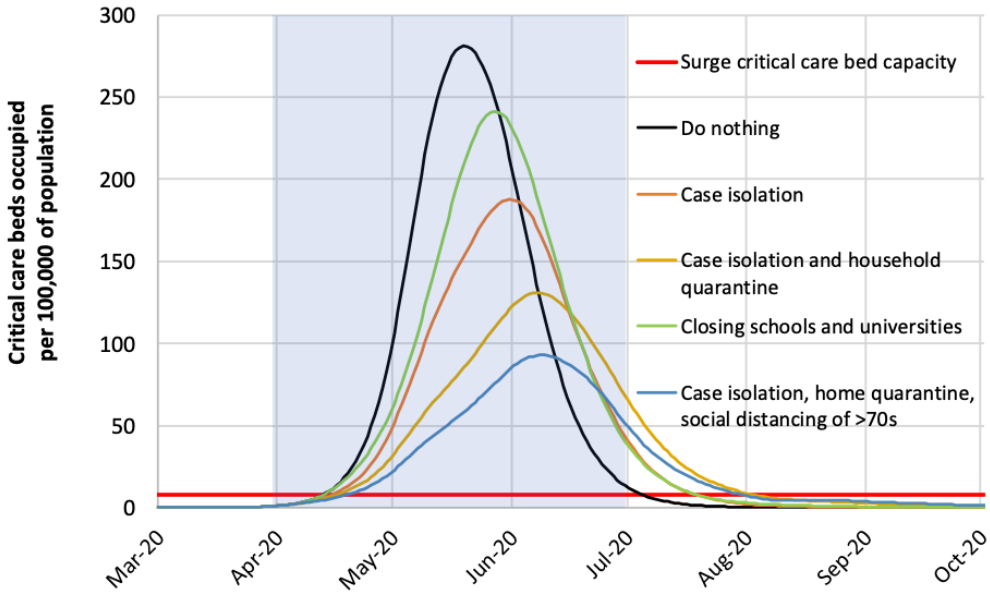

Figure 2. Mitigation strategy scenarios for Great Britain showing critical care (ICU) bed requirements. Source: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College London (16-03-2020), doi: https://doi.org/10.25561/77482.

Monitoring and evaluating for effectiveness:

This consists of collecting data at multiple time points throughout health interventions to prove the effectiveness of the measures and decisions. Figure 3 shows an example of real data monitoring. The graph presents the cumulative effect of mitigation measures in the Netherlands until March 20th. It was presented to inform the COVID-19 commission in the country's parliament. In this case, results are reported considering the reproductive factor (R_0). Results show that R_0 reaches values <1 after March 16th, and gives information about the impact of advice and mandatory measures. Deeper analysis with different factors or subgroups (type of measure, region, weekend effect, seasonal effect, etc.) gives useful information to guide future decisions while other studies are run in parallel (feasibility of measurements, economic and social impact).

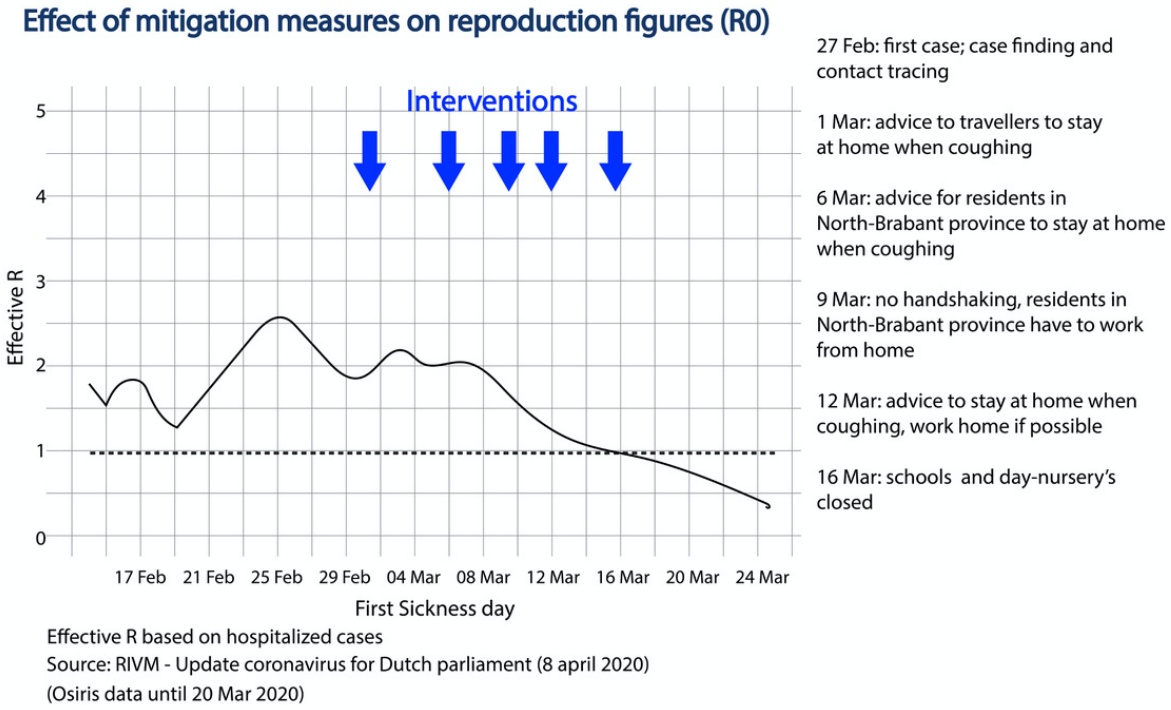

Figure 3. Major intervention measures in The Netherlands implemented at the national level

Figure 4 shows a similar example from China at a national level. At first sight, we could attribute the reduction of cases to the impact of each previous measure or number of cumulative measures. However, due to the complexity of the dynamics of infectious diseases, more statistical analysis is needed to clarify and provide valuable future knowledge.

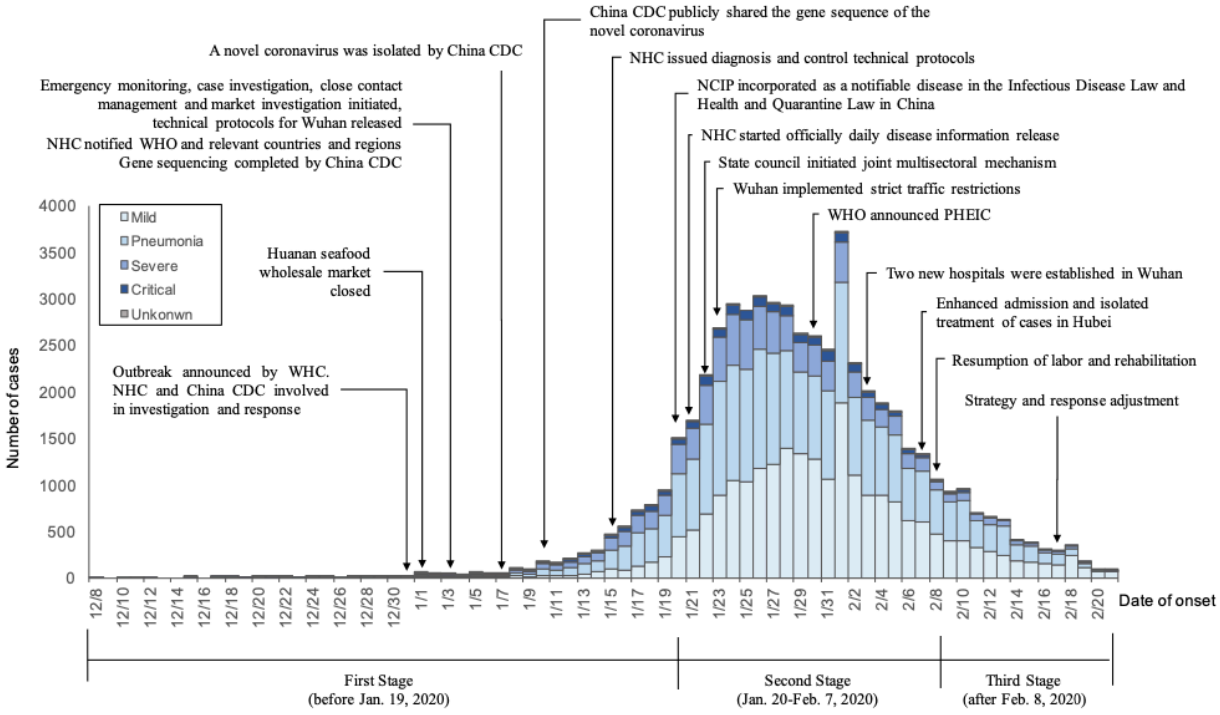

Figure 4. COVID-19 epidemic curves and major intervention measures in China as implemented at the national level
Source: WHO. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). 16-24 February

However, there are some general conclusions coming from health policy experience in China, previous epidemics and epidemiological research (WHO-China Joint Mission 2020; Ferguson et al., 2020):

- There are still gaps of knowledge in the effectiveness of the public health control measures and their socio-economic impact (social distancing, school and workplace closures, wearing mask in general public, mandatory quarantine, voluntary quarantine with active surveillance).
- Interventions' effectiveness differs among social contexts.
- Local policies for a smaller amount of time could be more effective than national policies.
- Layering of multiple interventions is needed.
- The choice of interventions depends on their feasibility.
- Social distancing rapidly reduced virus transmission and would need to be in force longer than other measures.

Cristina Alvarez, MVD, MSc, PhD

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