Why we should be able to stop the COVID-19 Pandemic without destroying our economy and way of life

An optimist's scenario from a risk management perspective

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The COVID-19 pandemic is stoppable and we should be able to stop it and save lives without destroying our economy or our way of life. Hygiene measures as part of our future social etiquette, a moderate reduction of everyday social interaction, some restructuring of schooling and day-care services and an abstinence from mass events and entertainment in public might be enough to stop the pandemic. We should be able to restore public and social life and business activities with moderate and sustainable cutbacks. A systematic risk management is required and research to weigh the effects and social and economic costs of mitigation measures.

The COVID-19 pandemic is unprecedented and has brought about restraints to our public life as well as our social and business interactions which would have been unthinkable yet a few weeks ago.

COVID-19 is not just another flu. It is extremely dangerous for our elderly population and most likely also has severe detrimental impact on the health of the younger generation. Lethality overall is estimated to be between 0.3%-1% (with a well-functioning health system that is not overburdened).[1] For above 60-year-olds lethality is estimated to be around 5%. But also infected people between 20 and 60 have a frighteningly high need for hospitalization of above 5%.[2] And a large share of hospitalized cases, also among the younger patients, might suffer from long-term aftereffects in terms of long-term damages to their respiratory system.

However: there is light at the end of the tunnel!

We can influence the factors which define the COVID-19 pandemic

The severity of a pandemic depends largely on 3 factors:

1. Severity of the disease (i.e. lethality or damage to our health)
2. Current number of infectious cases (i.e. today or at the start of mitigation measures)
3. Reproduction rate (i.e. how many other people are infected by one case)

(1) Severity of the disease: The medical world focuses with unparalleled intensity on measures to reduce severity of COVID-19. This includes ensuring that an increasing number of ICUs (Intensive Care Units) is available, sharing best practices on treatment of patients, finding drugs which limit the

[1] https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200219-sitrep-30-covid-19.pdf?sfvrsn=3346b04f_2 (accessed 30.04.2020)

[2] Calculations based on data presented in the Imperial College COVID-19 Response Team study from 16.03.2020: https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

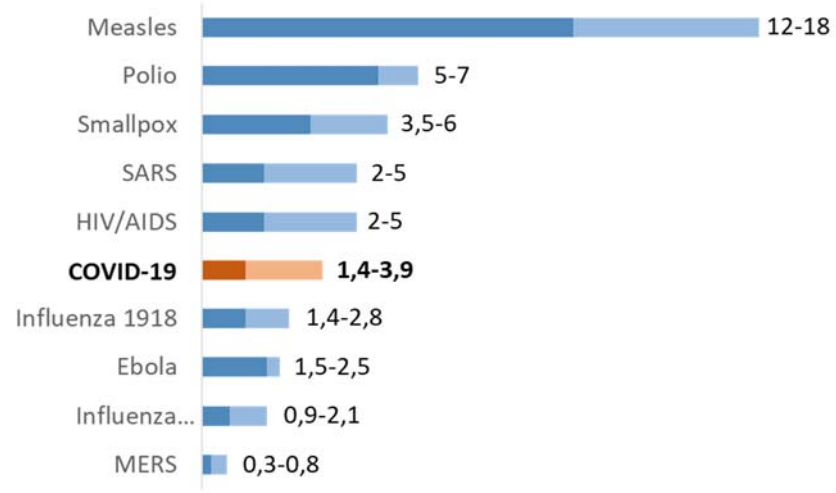
damage to the respiratory system or fight the virus directly, and developing tests to assess which patients need which treatment and when.

(2) Current number of infectious cases: The total number of cases impacts to what extent the medical system is overburdened – with catastrophic effects, if it is. Hence, there is a direct connection to (1). Furthermore, it also affects to what extent we can contain a pandemic. If there are few cases, one can isolate them and identify contacts which need to be quarantined. If large parts of the population are infected this is more difficult if not impossible. This is one of the reasons why acute measures are taken now, to hopefully reduce the number of active cases to a manageable level.

(3) Reproduction rate: The reproduction rate is important for the progress of a pandemic and whether a pathogen creates a pandemic or not. A metric which is used here is the Reproduction Number R. Simplified it can be interpreted as a measure for how many other people are directly infected by one infected person. If this number is above 1 we can see exponential growth of cases and a pandemic is possible. If the number is below 1, a pandemic cannot develop.

This paper focuses mainly on the reproduction rate. This is where the right risk management and mitigation approaches can have the highest impact. Here is where we need to assess the sustainability of "exit strategies" to the current lockdown of society and the success chances of a long-term strategy for dealing with COVID-19.

Epidemiologists define R_0 as the Basic Reproduction Number. This is the number which would describe the progress of the disease in unmitigated circumstances. Estimations for R_0 for a selection of diseases are presented in the graph below.



Source: Own graph based on data from Wikipedia
(https://en.wikipedia.org/wiki/Basic_reproduction_number, accessed 31.03.2020)

Figure 1: Estimations for Reproduction Number R_0 for select diseases

R_0 can also be used to calculate the percentage of people who need to be immune to the disease in order to stop an escalating number of infections. The so-called "herd immunity" should be reached, if the share of immunity in the population is at $1-1/R_0$. This number is around 90-95% for Measles and would be around 50-80% for COVID-19 given the range for R_0 above. Herd immunity can be reached either through previous infection or through vaccination. For COVID-19 we hope that we will reach it through vaccination since the alternative would mean millions of deaths worldwide. However, for this

we first need a vaccine. The WHO currently reports 2 candidate vaccines in clinical evaluation and 48 in pre-clinical stage.[3] But experts expect that vaccines at scale will likely not be available until mid-2021 or even 2022.[4]

However, the effective rate of reproduction of diseases can be reduced by other measures as well. For example, instead of an exponential increase, we have seen a steady decline of new HIV-infections globally since 2001.[5] Why is this the case when R_0 is far larger than 1 and we are far away from herd immunity? The reason lies in the mitigation measures implemented. For HIV/AIDS, one of the most effective measure to reduce infections and lower the reproduction number has been the use of condoms for safer sex. This, plus antiretroviral drugs, widely implemented testing for risk groups etc. has brought down the effective reproduction number for HIV/AIDS below 1.

Can we reduce the Reproduction Number of COVID-19 below 1 and stop the pandemic?

The answer is: probably yes! A few countries already show flattening curves for new COVID-19 infections. Most encouraging developments can be seen in South Korea where reduced and somehow stable number of new cases has been sustained for more than 3 weeks since 09.03.2020.[6]

The Imperial College COVID-19 Response Team published a paper on 30.03.2020 in which they modelled the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries.[7] They see large changes to the Reproduction Number R in response to combined interventions such as school closing, social distancing etc. On average and across countries they modelled a 64% reduction of reproduction value R_t compared to pre-intervention values. With today's data, however, they are not able to determine which interventions had the greatest effect nor whether current interventions are sufficient to drive R_t below 1.

Whether or not it is possible, depends largely on assumptions about R_0. Fauci et al. published in the New England Journal of Medicine on 26.03.2020 an estimation of R_0 at 2.2.[8] If this was true, measures which reduce the Reproduction Rate by 55% would stop the pandemic (as then is R<1).

Similar thoughts were presented in a paper published in The Lancet on 06.03.2020, while also highlighting the problems for defining concrete measures which would have the desired effect: "*it is easy to suggest a 60% reduction in transmission will do it or quarantining within 1 day from symptom onset will control transmission but it is unclear what communication strategies or social distancing actions individuals and governments must put in place to achieve these desired outcomes*".[9]

Let's look at what actions governments and societies can take in order to reduce the Reproduction Number. A very simplified structure of actions and impact on the Reproduction Number is depicted in the graph below.[10]

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[3] https://www.who.int/blueprint/priority-diseases/key-action/novel-coronavirus-landscape-ncov-21march2020.PDF?ua=1

[4] https://www.ecdc.europa.eu/en/novel-coronavirus-china/questions-answers

[5] https://ourworldindata.org/hiv-aids

[6] https://www.worldometers.info/coronavirus/ (accessed 01.04.2020)

[7] https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-Europe-estimates-and-NPI-impact-30-03-2020.pdf

[8] https://www.nejm.org/doi/full/10.1056/NEJMe2002387

[9] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30567-5/fulltext

[10] The author is aware that this is a very simplified – strictly speaking wrong – depiction of the reproduction mathematics. However, given low levels of overall infection in the population it should still be sufficient for illustrative purposes and to draw general conclusions on mitigation options and effects on a strategic level.

The reproduction depends on the infectious period, i.e. the time during which an infected person can infect other people, and on the number of infection producing contacts during this infectious period.

The number of infection producing contacts is impacted by the overall number of contacts one has, the level/kind of contacts and some factor for the general contagiousness of COVID-19.

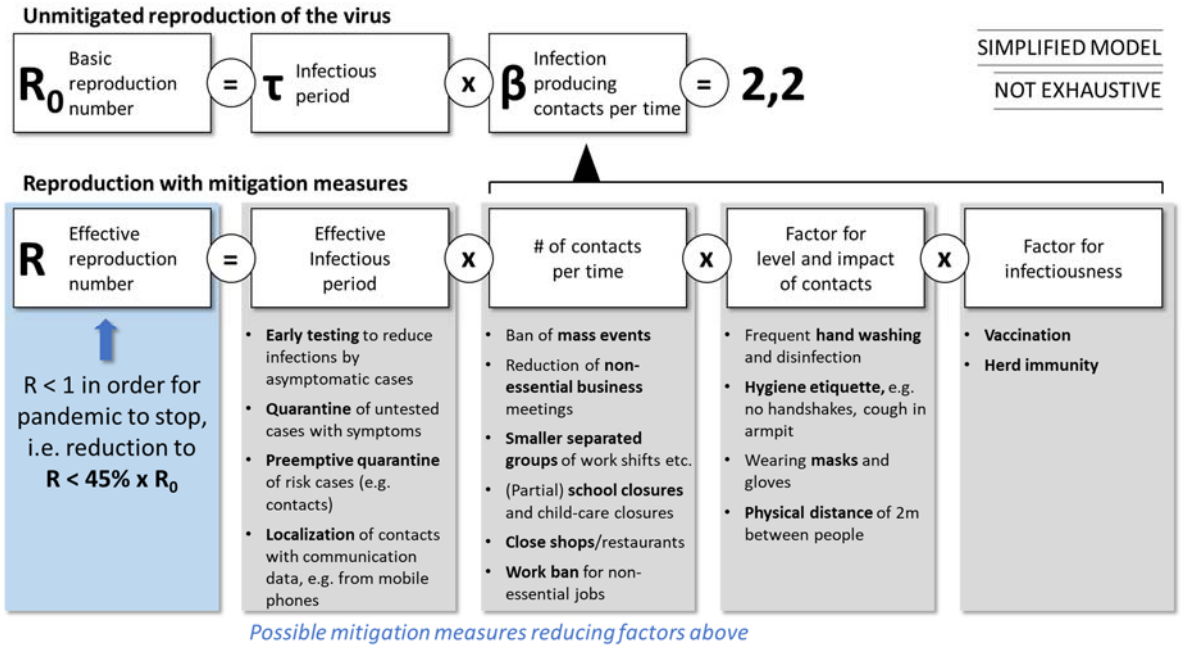

Figure 2: *Simplified model of factors influencing the Reproduction Number*
(Note: R_0=2,2 is an assumption based on current studies.[11] The real number can be different but is likely in the range of 2-4)

So there are mainly three areas in which mitigation activities can have an impact in order to reduce the effective Reproduction Number below the Basic Reproduction Number R_0.

- **Reducing the effective infectious period:** The smaller the time window, in which a contagious individual can spread the virus the better. Measures to reduce this time window are:
  - Increase frequent and early testing, to then isolate positive cases as early as possible
  - (Voluntary self-)quarantine of cases which have not been tested but show symptoms similar to COVID-19
  - Pre-emptive quarantine of contacts of positive COVID-19 cases or of people which travelled to high-risk regions
  - The last point can be further increased by using telecommunication data in order to identify possible contacts (e.g. with location data from mobile phone networks, Google or Apple)

- **Reducing number of contacts:** The fewer contacts one has, the less likely it is to infect others or to be infected. Measures to reduce this are:
  - Ban of mass events such as concerts, football games etc.
  - Reduce the number of business meetings (e.g. more video-conferencing and phone calls) as well as the size of business meetings (less people in one meeting)

[11] https://www.nejm.org/doi/full/10.1056/NEJMe2002387

- Reduce the number of variation of contacts, e.g. by organizing work shifts in a fashion that always the same group of people is in one shift and is separated from other shifts.
- Close schools and child-care services or reduce contacts in these institutions by installing smaller groups. If a kindergarten reduces the number of children from 20 per group to 10 per group (and manages to prevent contacts between groups) the likelihood of infections is roughly halved.
- Work ban for activities which are non-essential or less important to the overall economy and critical supply chains

- **Changing the level and impact of contacts:** The more distance we put between people and the less physical the contact, the lower the likelihood of an infection. Measures to reduce infection likelihood therefore are:
  - Frequent hand washing and disinfection and not touching one's face
  - Hygiene etiquette such as not shaking hands, no hugging or welcome kisses, coughing in armpit
  - Wearing masks and gloves in public and to work
  - Keeping a physical distance of 2m to other people

There are many other examples of measures in these three areas by which we can reduce the likelihood for infections. Each of these measures will have a different impact on infection likelihood and a different cost to or impact on our economy and society and way of life.

Frequent hand washing and hygiene etiquette are probably the measures which have the least detrimental impact on our society. Ban of mass events are probably less problematic for our economy and society than a larger of ban of work in industrial or service jobs. So we will need to find out which measures have the least impact on our way of life and our economy while providing the highest reduction of the Reproduction Number.

If we assume Basic Reproduction Number R_0 to be 2,2 (knowing that it might or might not be higher!), we need to reduce the Reproduction rate by 55% in order to stop the pandemic. This would not mean that we would stop the disease – but we would stop the exponential growth and the number of active cases would slowly decline over time. The graph below depicts an illustrative example of how a scenario could look like, in which we reach this goal.

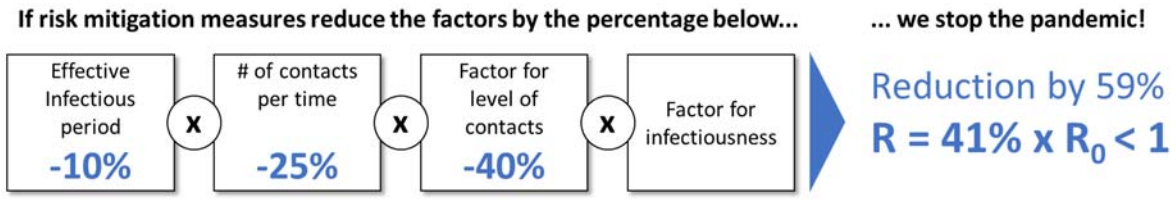

Figure 3: Hypothetical example of the impact of mitigation measures on R
(Note: This example uses the assumption that R_0=2,2 based on some studies. It also depicts a very simplified model.)

How we can reach a systematic risk management approach and a long-term strategy for COVID-19

First, we need to be very clear about our strategic objective: If our objective is to contain the virus, we would need to be near-perfect and contain all cases of COVID-19. However, my understanding is, that the current objective is to flatten the curve, in order to not overburden the medical system and to buy time for the development of drugs, and, in the long term, a vaccine.

The good news is: In this strategy, we do not need to be perfect. We just need to reduce the chances of the disease spreading. We do not have to prevent it completely. We need to lower the effective Reproduction Number R below 1. This can mean reducing R by only 55-60% (depending on what R_0 is). And we can use a mix of different measures to reach this effect in combination.

To my knowledge, scientific studies telling us exact quantitative effects of individual mitigation actions on COVID-19, do not yet exist. However, I do not see any reason why it should be impossible to combine a smartly selected portfolio of interventions which in sum provide a reduction of the Reproduction Number in the order of magnitude required to slow the pandemic without destroying our economy and our way of life.

Increased testing, higher awareness of COVID-19 symptoms and voluntary self-quarantine should have an impact on the effective infectious period. A reduction by 10% could for example be reached if infectious cases were contained on average roughly 1 day or so earlier than in an unmitigated scenario.

Significant reduction of the number of contacts can be reached without a complete lockdown to society: a continued ban of mass events, reduction of business meetings etc. should be possible if people understand the reason behind this.

Schools and child-care might need to be restructured, e.g. by starting them with two separate groups of half the size for half the time each. This single measure would cut infection likelihood in these institutions by 50%! And it would bring some relief to parents who have to take care of their children while being needed in important jobs for the economy. In addition, the regular in-person interaction would probably make the remaining online-learning in schools (which would still be required) more effective.

For universities it might be reasonable to continue the lock-down as e-learning is possible to a large extent at that educational level. On the other hand, exams should be possible in person at the end of term, as other examination modes have clear disadvantages. And the risk for infections could be held at bay in the controlled environment of an exam. It is all about weighing the costs of measures to the society and the benefits for the goal to reduce R. Differentiated approaches for different institutions will be required.

Biggest impact for the smallest cost to society could come from changing our level or impact of remaining contacts: Hand washing, hygiene etiquette and potentially wearing masks in public and at work should have a significant impact on infections. And these measures will not keep our society or economy from functioning well.

Whether the measures above reach the order of magnitude necessary to stop the pandemic, remains to be seen. However, I believe there are good reasons to be optimistic. In the best case, we need to lower the Reproduction Number perhaps by only 55% or 60% in order to reach a sustainable level for the COVID-19 pandemic. This seems to be a reasonable and manageable goal.

In order to develop a long-term strategy, we will need to identify the impact of measures on the Reproduction Number and the social and economical costs associated with them. For this, epidemiological studies should identify the impact of different measures on R. Then we need a broader

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assessment with economists, supply chain experts etc. in order to evaluate the social and economical cost. However, I do not believe that we will get exact answers from science on these questions soon (if at all) and we cannot afford to wait for them before starting to act. Instead, we will need to make estimates and judgement calls based on the risk-return assessments. And we will then need to closely monitor the effects over time and adjust measures as required.

In addition, we need psychologists, communication experts and legal experts to work on communication strategies and legal frameworks for these mitigation measures. Since, for them to work, people need to comply to them: If half or the population complies and the other half does not, we cannot stop the pandemic. Instead, the effect will be similar to taking no action at all. Measures need to be designed and communicated in a way that the vast majority of people complies to them.

Furthermore, we will most likely need to differentiate between countries and within countries between different categories of industries and jobs, and within the population between groups with different risks. In any case, a solution can only be found if epidemiologists, economists, experts for supply chains and communication experts work together to develop and risk-assess the different options and combine them in a long-term strategy for stopping the COVID-19 pandemic.

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