Open Letter 2 on COVID-19: Aggressive Social Distancing is Everyone's Responsibility.

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Goal.

This letter aims at convincing the public that it is the duty and responsibility for every one of us to conduct the most aggressive social distancing measures we can afford.

COVID-19 Must and Will Be Eradicated Like SARS of 2003

You may want to read my Open Letter 1 first if you have not done so yet. In summary, COVID-19 is extremely dangerous. If unchecked, the number of infected cases doubles every 3 days. It is about 20 times as deadly as flu, has a high hospitalization rate, and patients require long hospital stay to recover. Letting COVID-19 spread will overwhelm the healthcare system and lead to devastation humanity cannot afford. **COVID-19 must be eliminated.** In my opinion, this deadly combination of extreme contagiousness and heavy burden on the medical system also means that **COVID-19 will be eliminated,** for the reason that humanity simply cannot let COVID-19 continue to exist.

Every society where COVID-19 spreads will eventually start adopting painful and costly Aggressive Social Distancing (ASD) measures to curtail its spread. When these measures start, their effect will not kick in immediately. Rapid exponential growth will continue, forcing the society to take increasingly desperate and drastic measures. Measures that may appear unthinkable now can appear inevitable 2 weeks later. Societies have no choice but to throw everything they have at containing COVID-19 until it takes effect. The cost of these measures, while extremely high, is still much less

than the cost resulting from the alternative of letting COVID-19 spread. When this happens, COVID-19 will be contained, as it has been in China and S. Korea.

Once COVID-19 is contained, it can be eradicated with a (relatively speaking) small additional cost. In the future, after the world has fully mobilized and won 90% of the war on COVID-19 by containing it, should the world continue the war to eradicate it, or to give COVID-19 another chance to come back so that we can enjoy the experiences of fighting it again?

The plan to gain herd immunity against COVID-19 is, in my opinion, either sheer madness or utter incompetence, even if one ignores the fact that it lets 2% or more (the fatality rate of COVID-19) of the population die when the cost of containing it is much less. Herd immunity requires 60% or more of the population to be infected. Italy's hospital system is thoroughly overwhelmed (see, e.g., NYT, Boston Globle) when 0.02% of the population are found to be infected. In a little more than one month, China mobilized 42,600 healthcare workers from across the country to Hubei to help treat the 67,790 confirmed COVID-19 patients in the Hubei province. To gain herd immunity without the healthcare system collapsing requires dramatically slowing down the spread of COVID-19, which can be achieved only by drastic and painful ASD measures. By the point that the COVID-19 case number stabilizes at a level the healthcare system can handle, keep enforcing these measures will lead to eradication of COVID-19, before herd immunity can be reached. The plan for herd immunity means that a society will be forced to act when it is almost too late, resulting in huge and avoidable losses of human life and economic disaster.

A CDC personnel, in private response to my first open letter shared through an intermediary, challenged my call for the government to action by pointing out that due to Bill of Rights amendments in the Constitution, US cannot take some of the measures China took. To this, I offer the following responses. First, US does not have to take

every measure China took for aggressive social distancing. S. Korea is a democracy and has effectively contained COVID-19. If S. Korea can do it, why can't the US? Second, desperate times call for desperate measures. Make no mistake about it: This will be a desperate time if we don't act. I read history in my spare time and have seen US presidents of the past take drastic actions that can be viewed as violations of the Constitution, and later vindicated by history. On April 27, 1861, Lincoln suspended the writ of habeas corpus between Washington, D.C., and Philadelphia to give military authorities the necessary power to silence dissenters and rebels. This was later challenged by the then Chief Justice on May 27, 1863. For another history lesson, the Constitution in 1862 specifically protected slavery and Lincoln had sworn an oath to preserve, protect and defend the Constitution. Yet, Lincoln issued the Emancipation Proclamation, because he believed that it was a military necessity and used his power as Commander in Chief to do so. When it is necessary to protect the lives of a large portion of its citizens, it is in the power of the government and in fact the duty of the government to take necessary measures.

A Simplified Model for Spreading of COVID-19

Here I describe a simplified generational model to analyze the spreading of COVID-19. A more realistic model that considers the dynamics of daily patient population is much more complex and difficult to explain. The message is the same whichever model we use. Even though I like math, I prefer to avoid complex math when simple math suffices. Let us assume that patients come in generations. There are two key parameters.

1. **Generation duration**, the number of days from when a patient is infected to the time when one is no longer a patient
2. **B,** the number of new cases, on average, an infected person will cause during their generation duration. The parameter B is closely related to the reproduction number R0 commonly used when studying infectious diseases. However, since my model is much simplified, it is not the same thing.

For our discussion, we assume that the generation duration of COVID-19 is 14 days. The exact number does not affect the message of the analysis. For simplicity, we consider patients in generations. In this simplified model, starting with X patients in Generation 0, then we have X*B number of patients 14 days later (Generation 1), and X*B*B patients 28 days later. Clearly, if B>1, we have an exponential growth, and if B<1, we have exponential decay. COVID-19 must have a high B value that causes the number of detected cases doubling every 3 days. The goal of aggressive social distancing is to reduce B. Below, we use the **Daily Transmission Rate (DTR)**, which is B/14 for COVID-19. (We assume, for simplicity, that a patient is contagious during the 14 days generation duration.) Roughly, the DTR is **the average number of new patients infected by one existing patient per day**.

Questions/Answers Using the Generational Model.

Question. What is the endgame? If 1% of the population are infected, why would aggressive social distancing work? Wouldn't COVID-19 be with us forever, like flu does?

Answer. Suppose that ASD measures can reduce DTR to 0.02. After one cycle of 14 days, the patient population size is 0.02*14=0.28 that of the original. This is when exponential decay becomes our brightest hope just as exponential growth is our worst fear. Starting from an infected population of 3.3 million, see the following table:

Time	Day 0	Day 14	Day 28	Day 42	Day 56	Day 70	Day 84	Day 96
Infected popul. size	3,300,000	924,000	259,000	72,000	20,000	5769	1590	445

Somewhere around Day 60, when there are less than 20000 patients, if people at risk are thoroughly tested so that the public can clearly identify almost all patients, then only the patients need to be isolated, the rest of the public can go back to normal life. After Day 96, it would take 3 more cycles for the number of patients to be in single digits. But

very few people's life needs to be affected in that phase. If we start now, assuming that the true number of virus carriers is 72,000, it would take 2 to 3 cycles, e.g., 4 to 6 weeks for the spreading in the US to be contained. If we wait, the period of containment will be longer.

One important caveat is that the above analysis considers only the patient population in the US. Since the US cannot totally isolate itself, patients in other countries will affect what happens in the US. Only coordinated efforts by the whole humanity can defeat COVID-19. Note that seasonal flu can be eliminated in the same fashion, but the fatality rate and hospitalization rate for flu are too low to compensate for the huge cost of the required ASD efforts. And depending on how prevalent flu viruses are with animals, flu can easily come back to humans. The last time something like this hit humanity was SARS in 2003; SARS was more deadly, but less contagious, and was eradicated. Countries and regions that were more exposed to SARS generally took more decisive actions due to memory of it. If something like COVID-19 hits again in the next few decades, hopefully the memory of COVID-19 will prompt people everywhere to be more vigilant and eradicate it before it spreads.

Question. US has lower population density than the other countries hardest hit by COVID-19, and relies less than mass transportation. Many organizations are already practicing social distancing. Wouldn't that be enough?

Answer. It is a very interesting question. I do not know the answer, and I don't think anyone does. However, we do not need to and cannot afford to wait to find out the answer. Due to the rapid exponential growth, our only choice is to apply all feasible ASD measures at once. **No matter how much ASD effort we have already taken, any additional measure that has reasonable cost will pay for itself, because it will greatly shorten the time it takes to contain and eradicate COVID-19**. Here is why. If the measures already taken are unable to reduce the DTR to less than 0.075, we will still see exponential growth, just at a slower rate. Below that, reducing DTR further will

greatly shorten the time it takes The following table shows the effect of different DTR in the generational model.

DTR	0.07	0.06	0.05	0.04	0.03	0.02	0.01
#cycles to half population size	34	4	2	1.2	0.8	0.54	0.35

Reducing DTR from 0.06 to 0.05 shortens the time it takes to contain COVID-19 by half. Reducing DTR to 0.04, further shortens it by 40%. I am quite sure that as of right now, we are far from reaching that low of DTR, and more actions are needed.

What should We do?

It is critical to reduce Daily Transmission Rate (DTR), and this is something every one of us can contribute to. By reducing DTR, we help the society to contain and eradicate COVID-19 faster, reducing the total cost caused by ASD measures. Any action that risks transmission of COVID-19 adds cost to the society, because it extends the time it takes to contain the virus.

The behavior of continuing non-essential social contact even if one knows that one has the virus is akin to reckless driving, and in fact much worse. Because such actions harm not just the persons of immediate contact, but also adds costs to the whole society. If such contact leads to death, this behavior seems to fit the definition of **involuntary manslaughter**, i.e., the killing of a human being without intent of doing so, either expressed or implied. For analogy, knowingly spreading AIDS is a criminal act.

Personally, I have started practicing something that may be called social disengagement (or perhaps miniscule social engagement). I have identified a small group of people that I will maintain close face-to-face contact. I have asked that everyone within the group try to avoid close contact with anyone outside the group if at all possible. (I do not count passing people in the store and on the road without talking or touching as close contact.) When having to have close contact with anyone outside the group, assess the risk (if possible, ask what measures the other person is practicing

and history of potential contact) and use precautions recommended by CDC, e.g, washing hands thoroughly afterwards, etc. With many cases in the US not yet identified, doing so is not just for protecting oneself, it is helping the whole society.

If you want to help fight COVID-19, practice Aggressive Social Distancing, and convince more people to do the same.

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