For my daughters: July 9, 2020

The Coronavirus Pandemic

Common Misunderstandings

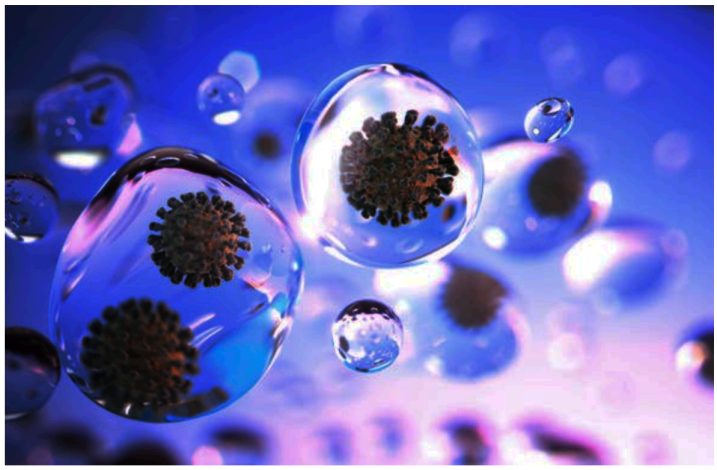
The pandemic continues to accelerate. From the initial report of an American infected with COVID-19, it took 99 days for 1 million Americans to contract the virus. 43 days later the United States hit 2 million cases. Last week, 28 days later, we hit 3 million. At today's rate we can expect to hit 4 million in 24 more days, on August 1. Lacking widespread federal surveillance testing and contact tracing, coupled with today's strong urging by the White House to open the nation's schools in September, it is difficult for me to imagine things getting better anytime soon -- and with flu season and the possibility of a second wave of coronavirus infection both looming in the fall, we are running out of time to sort this out.

Living under this darkening cloud, I think it important that you three stay well informed about the best ways to stay safe. So please forgive your father for again donning my professor cloak to dispel some common misconceptions you may see in the media.

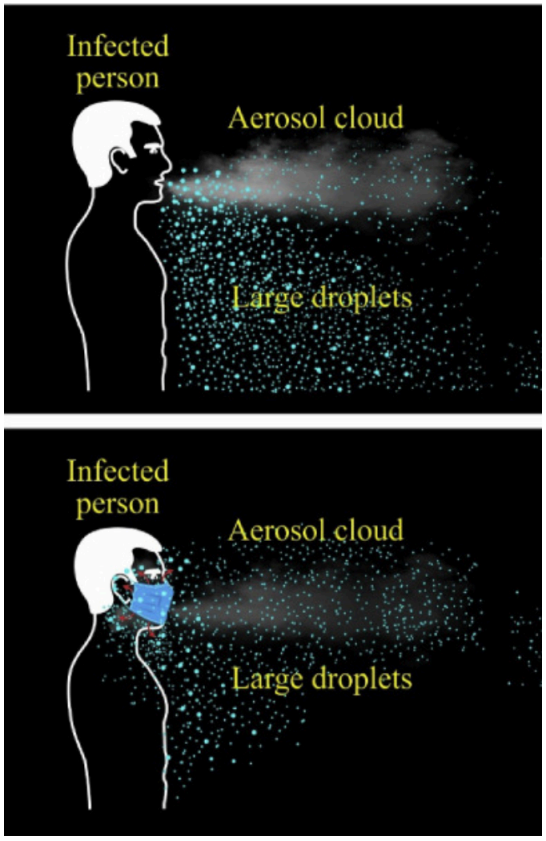
Air Droplets vs. Aerosols

As I explained to you girls preciously, COVID-19 is a respiratory virus that passes from individual to individual within tiny water droplets that spray out as we breath. Seems like a simple enough idea, but this mode of airborne transmission has led to considerable confusion. The problem is the word "droplet." Guidelines formulated by the WHO and CDC have focused on the droplets that we all spray on one another as we talk, laugh or sing, each heavy enough to fall to the floor within a few feet. That has led to social distancing guidelines encouraging six feet of separation between individuals, and handwashing to avoid contact with droplets that have fallen onto a surface.

As scientists have studied in more depth how the COVID-19 virus is transmitted, many have concluded that this view is too simplistic. We humans breath out water droplets of all sizes, some large and quickly falling, others smaller that fall less quickly, and some so small that they do not fall at all. Called aerosols, these super-tiny droplets are smaller than 5 microns. A micron is equal to one millionth of a meter, so these droplets are small indeed. A human hair is 50 microns thick. The human eye cannot see anything smaller than 40 microns in size.



The point is, aerosol droplets don't quickly settle to the ground. They float in the air. Respiratory scientists suggest we think of them like cigarette smoke. The cloud disperses outward from the person smoking, drifting throughout the room. Like cigarette smoke, aerosol droplets can stay in the air for a considerable time, and can be inhaled more deeply into the lungs. Wearing a mask is important because it blocks much of the aerosol at the source, where it can still be easily filtered out. Studies by scientists have confirmed that COVID-19 viruses are indeed released during exhalation in aerosol droplets small enough to remain aloft, and that these micro-droplets pose a risk of exposure at distances well beyond six feet. A 5 nanometer droplet will travel tens of meters in typical indoor air, much greater than the size of a typical room.



So avoid closed indoor settings. A lot of loud people crowded together in a poorly-ventilated room is an optimal virus-spreading situation. Stay away from bars, restaurants, theaters and churches – any place where people are confined close together. That includes dinner at a friend's house. Ok to have a drink outside, or on the porch keeping a 6 foot social distance – the circulation of outside air will carry away any aerosol, and the social distance will be enough to guard against droplet transmission. Inside, the opening of doors and windows can dramatically increase air flow rates.

None of you have school-age children, but there is much public discussion these days about the wisdom to sending kids back to school in the fall. As you can see from what I have just said, a key will be to ensure adequate ventilation of the air the kids are breathing. Indeed, the CDC's recommendations for school openings (today rejected by the White House) stress improved ventilation. How can a parent assess if their child's schoolroom ventilation is adequate?

A simple approach would be to insist that every schoolroom be equipped with an inexpensive carbon dioxide monitor. The ones pictured here each cost less than $200. Outdoors in a city environment CO_2 levels are about 350 parts per million in the air. Exhaled breath contains some 38,000 parts per million of CO_2. If the air in a schoolroom has 1,000 parts per million CO_2 content or less, the air in the room is being ventilated enough to be quite safe for the children. If there is more than that amount of CO_2 in the schoolroom air, open the windows! If the school will not install CO_2 monitors in its schoolrooms, I would advise parents to keep their children home.

Herd Immunity

As of today 1,400,000 Americans have recovered from COVID-19 infection. As their bodies now contain antibodies directed against the virus, they are for now immune to infection by it for now. Why not let the COVID-19 pandemic rage on, many are now saying. Let nature take its course, and soon so many will be immune that r_0 will fall below 1.0 and the disease will disappear. Called "herd immunity," the idea is that the probability that an infected person will infect another person is reduced if some of the folks around the infected person cannot be infected because they possess antibodies making them immune. The more immune folk in the herd of individuals, the less the probability of passing along the virus. When the proportion of the herd carrying antibodies exceeds a certain threshold, r_0 falls below 1.0, the spread of COVID-19 declines and the whole herd is protected.

All of our hopes for a coronavirus-free future depend on herd immunity. We are each of us potential victims of the COVID-19 virus until r_0 falls below 1.0 and the virus disappears from human populations. The only way this happens is if our "herd," the U.S. population, comes to contain a threshold number of immune individuals. What is this threshold number of immune individuals? For COVID-19, which has a base r_0 value of from 2 to 6, the herd immunity threshold is something like 50-80%, depending on the locality. Most scientists who study this sort of thing estimate the American threshold for COVID-19 as 70%. Take home lesson: our family is not going to be safe until 70% of the population is immune to the virus.

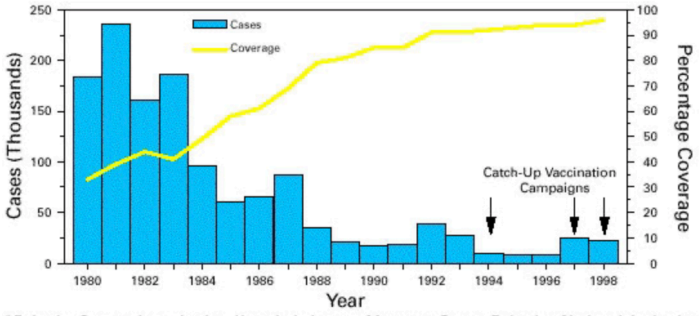
There are only one way for a person to achieve immunity to COVID-19 infection, and that is to acquire antibodies to the virus. These antibodies will activate your immune system to fight and defeat the virus when it enters your body. There is no other path to safety. You need to acquire COVID-19—specific antibodies. Period.

There are three ways you can do this:

1. You can catch the disease and survive it. The antibodies your body manufactures directed against the virus will protect you from future infection as long as you have them. It's not clear how long an infected individual's body will continue to make this antibody protein. In China some recovered COVID-19 patients have subsequently become ill with the virus again. We simply don't have the data to know, and can only hope antibodies directed against this virus are like most others, lasting several years.
2. You can be given plasma (blood with the cells removed) from a person containing antibodies directed against COVID-19. This is a highly effective therapy when available, but protection only lasts as long as the antibody proteins do in your bloodstream, weeks not months.
3. You can be given a vaccine that induces your body to manufacture its own antibodies against COVID-19. No such vaccines are yet available, but many are in various stages of development. With luck, large amounts of an effective vaccine will become available within a year.

So where does that leave us? Look at the three possibilities in reverse order:

Item 3 is practical and doable. It just takes time. People will die as we await an effective vaccine, many thousands of people. But we will achieve herd immunity when 70% of Americans have been vaccinated. Measles was eradicated in this way in the 1980s. As vaccination (the yellow line) went up, caseload (the blue bars) went down:



Item 2 is simply not doable. You simply cannot protect 70% of all Americans this way – there just isn't enough plasma available from COVID-19 recovered patients to treat any but the most seriously ill.

Item 1 is widely impractical, as it requires that 70% of the population be infected to achieve herd immunity. Just do the math: 320 million Americans X 70% = 224 million infected Americans. The death rate for COVID-19 infection is something like 5%, so the cost in lives of this approach would be over 11 million Americans dead of COVID-19! So far, some 135,000 Americans have died of COVID-19. Happily allowing 11 million more dead? No way.

In countries naive enough to attempt to let nature take its course, like Sweden, the approach has been a disaster. Sweden's death rate is ten times neighbor Norway's. In Spain, which had an intense outbreak and many deaths (they succeeded in defeating the virus by severe economic and social shutdown), a large-scale study revealed that just 5% of its population had become immune to infection. A long way from 70%. Many, many deaths away.

Herd immunity via community infection is a pipedream.

Other Misconceptions

A variety of other ideas are floating around that far off the mark. Here I am going to build you a list of the most egregious, with a brief comment about each:

1. **My genes will protect me.** Not so. Many scientists have looked for genes that influence COVID-19 infection. Only one has been found, a cluster of six genes on chromosome 3 that make you more susceptible to COVID-19 infection! People who carry two copies of the variant are three times more likely to suffer from serious COVID-19 infection. This stretch of DNA has been with humans a long time, passed down from Neanderthals 60,000 years ago. One third of people in South Asia have it today, and fully 63% of people in Bangladesh; only 8% of Europeans have it, and it is absent in Africa.
2. **Young people like me are safe.** Nope. While the median age group for those infected back in March was in their 60s, that number has plummeted in the last few weeks to young adults in their early 30s. While it is true that millennial and Gen Z age groups 18-35 years old die less often, it is also clear that they often get quite sick, stay sick for many months, and often may suffer serious long-term complications.
3. **I don't have a temperature.** Not good enough. While often done prior to admission to hospitals and other facilities, screening for elevated temperature only reveals those with active COVID-19 symptoms. Many infected individuals, however, have no symptoms. Estimates vary, but it looks like from 30% to 50% of all COVID-19 infections are asymptomatic.
4. **My state doesn't require face masks.** It should. There is no question that face masks block a significant portion of the droplets and aerosols that you eject outward as you breath and talk. The mask protects others from you – and protects you from them!
5. **COVID-19 isn't deadly anymore.** Sure it is. The falling nationwide death rates simply reflect a greater proportion of younger adults being infected as social distancing is relaxed – only 3% of those younger than 40 die of COVID-19. But if you are young, infected, and healthy, you can and will infect others, who in turn will infect still others, and many of these individuals -- infected because of you -- may be old or suffer from underlying conditions like diabetes that make them more likely to die. You will be the agent of their death.
6. **My neighborhood is safe.** Says who? If 30% - 50% of COVID-19 carriers are asymptomatic, who is to say that a person you meet there is safe to contact? Would you kiss and shake hands with a stranger in your "safe" neighborhood? I hope not.
7. **I've had it, so I'm safe.** Not clear. The antibodies protecting a recovered person from a virus are only produced by that person's body for a while – typically a few months to a years (although some virus infections give permanent immunity, these are rare). The jury isn't in on COVID-19 yet. In China, some of those infected last December are now being re-infected, so recovery is no guarantee.

Enough. Briefly said, don't believe everything you hear. Regard everyone outside your immediate living group as a potential CIVID-19 danger to you, always wear a face mask when around others, pay attention to ventilation, and avoid crowds. This time next year, with a little luck, we'll be together.

Dad