How to Stop a Pandemic: Lessons from Viralandia

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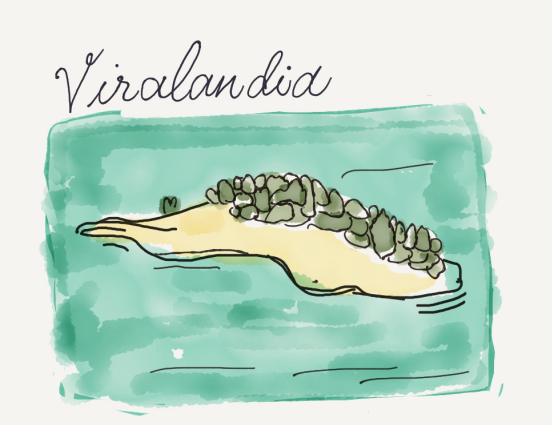
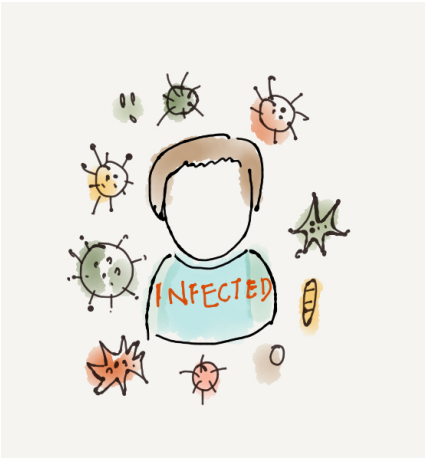


Lessons from Viralandia
A completely isolated community is protected from viral infection.

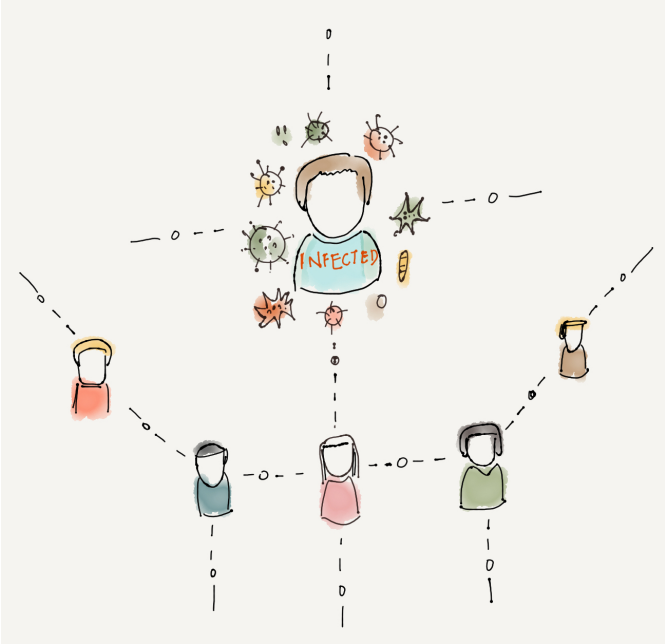
It is important to examine the steps needed to contain and control a potential pandemic, the complications that can cause containment measures to fail, and the methods needed to ensure the success of containment.

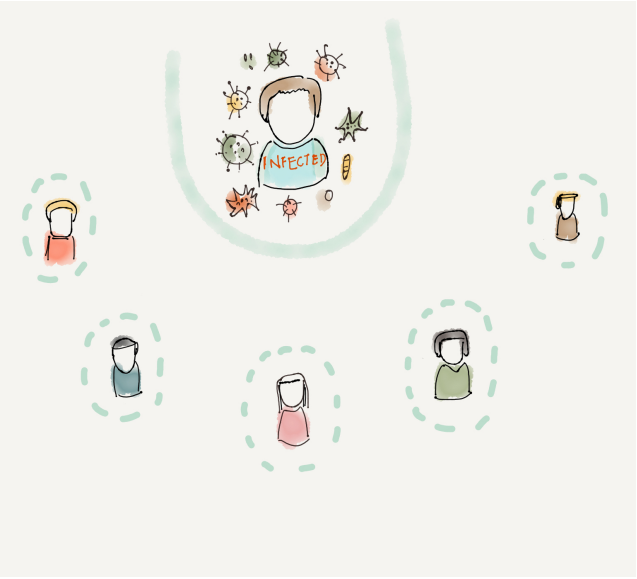
The baseline: a healthy but insulated community
Imagine the small island of Viralandia, where people go about their business interacting normally, but no one ever comes to or leaves the island. They would never get pandemic coronavirus, because the virus is not present.

How infection begins
Now imagine that an infected person arrives on the island.



At first, only the people who interact with the visitor might become infected. Subsequently, others might get infected from interacting with the people infected in the first round of infection.





Benefits of social distancing

On the other hand, if every interaction on Viralandia took place from a distance, then the inhabitants would still be protected — even upon the arrival of an infected individual. This is the benefit of "social distancing."

How long would people have to maintain social distancing?

They would have to wait until the infection in the infected visitor had run its course **and** the visitor was no longer contagious. This duration of time is the **contagion period,** and for coronavirus, one **contagion cycle** could last for several weeks.

What else could be done to prevent the spread of the virus?

One way to shorten the duration of public health emergency measures such as social distancing would be to isolate the infected individual. Then the period of time needed for such measures would be shortened to the **incubation period** for the virus —the time between exposure and the development of symptoms.

So it would be really important to know how long it would take to complete one **incubation cycle**. Below, we will get to the actual data, but the short answer is: around a week.

This example shows that social distancing with isolation of infected individuals would succeed in stopping the virus very quickly. In this simplified model, we do not need to worry about flattening the curve, because the virus would be gone in one incubation cycle.

It is important to note that the duration of one **incubation cycle** is different from the duration of one **contagion cycle**. In the case of pandemic coronavirus, the contagion cycle is likely to be much longer than the incubation cycle. (This is not the case for all viruses.) For pandemic coronavirus, the period of time during which someone sheds the virus is likely to be longer than the period of time it takes to develop symptoms once infected.

Five ways these protective measures might fail
Now it is important to see what might cause the public health intervention steps on Viralandia to break down. A number of complications might contribute to this.

1) Asymptomatic individuals. Asymptomatic individuals are infected but they do not know it because they are not sick. They may remain contagious and shed the virus for as long as a sick person, or longer. We now know that the majority of real-life infected individuals fall into this group.

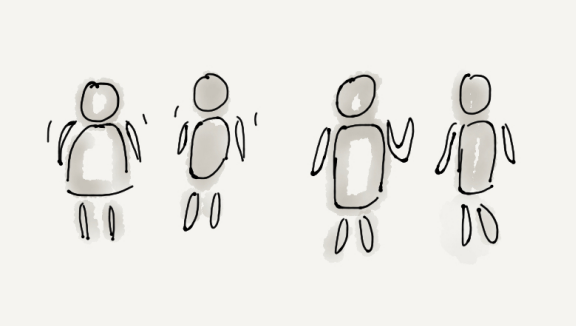
The presence of asymptomatic shedders increases the period of time affected communities need to maintain vigilant social distancing. In terms of isolation, asymptomatic shedders should be treated the same as infected individuals.

It is particularly important to separate contagious individuals from their families and the people they live with. For one thing, this helps to prevent the possibility of successive rounds of asymptomatic shedding in children or others, which would amplify the risk to everyone. Family and household members can develop more severe infections due to high levels of exposure. This phenomenon has occurred with other respiratory viruses.

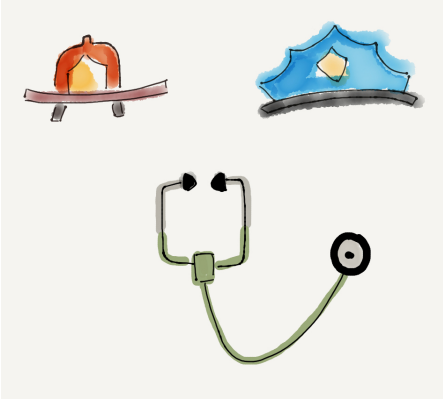
Inadequate testing. One huge benefit of testing *everyone* would be the detection of asymptomatic shedders. If testing were universal and perfect, we could dramatically decrease the period of time to stop the virus.

It is likely that the cost of pervasive testing would be more than offset by significantly decreasing the time it will take to restart the economy.

2) "Holes in the wall" caused by breaks in social distancing. When individuals do not maintain their distance, the virus can continue to spread. These cases can be viewed as holes in the wall.



Such breaks in the system can be due to denialism. One only needs to look at the daily photos of the President to see that he is consistently too close to the other people in the photos. Nor are any of these individuals wearing masks.



Another group of people who cannot maintain social distancing are first responders, including those who are taking care of infected individuals —symptomatic or asymptomatic.

People who are engaged in activities that have been deemed essential for allowing society to continue to function (such as those who work in pharmacies and supermarkets) may also be in close proximity and may potentially spread the infection.

Preventing transmission by first responders and those involved in vital activities is critical. To this end, it is imperative to have an abundant supply of personal protective equipment (PPE) and sanitizer. PPE and related measures allow these individuals to decrease their interpersonal distance while still avoiding exposure. Keeping these essential individuals safe helps incentivize them to engage in these important activities, and it protects the rest of us as well by breaking the chain of infection and ensuring that first responders will be available when needed.

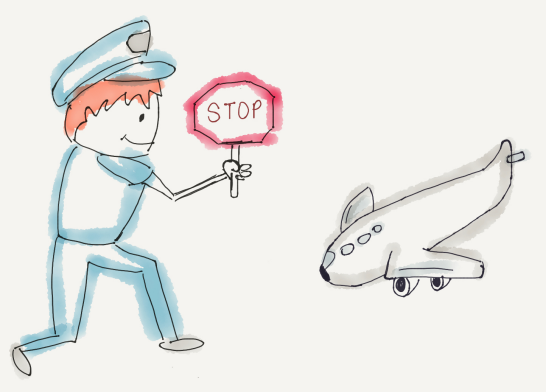
3) Inaccurate assumptions about the incubation period. The system can break down if we are wrong about the incubation period. Actually, the incubation period is a range of

times with a long tail. Testing will allow us to detect the virus before the development of clinical symptoms —with obvious benefit for everyone.

A recent study by Lauer and coworkers in the *Annals of Internal Medicine* indicated that the median incubation period for pandemic coronavirus is 5.1 days after exposure. This is consistent with other studies on this and other coronaviruses. The majority of patients develop symptoms by 11.5 days after exposure. Therefore, a cutoff of 14 days without symptoms is reasonable if we are forced to make that decision in the absence of testing data.

4) Inaccurate assumptions about the contagion period. The contagion period is also a range. For some diseases, the existence of chronic carriers may greatly extend the contagion period. Adequate testing would allow us to isolate these individuals. It would also mean we would not need to extend the period of social isolation for everyone else.

Data from the original SARS outbreak in China in 2002 (Liu and coworkers, *Emerging Infectious Disease*, 2004) indicated that infected individuals continued to shed the virus for three to four weeks, and in rare cases for much longer. This provides a rationale for sequential testing of infected individuals.



5) New virus carriers arriving in areas striving to maintain infection control. If more infected individuals from other places come to Viralandia, they could reinitiate the spread of the virus. In this case, the period of social distancing measures and isolation would have to start all over. This example illustrates why it is important to close borders.

This contingency also explains why every country must be proactive and vigilant about stopping the pandemic *everywhere*. China seems to have contained their outbreak, but that does not ensure the virus will not be reintroduced.

How do the lessons learned from Viralandia scale up to a region or a country?
The analysis discussed above applies if a country behaves like an island in terms of isolating itself. However, larger areas and countries have a much greater likelihood that the system will break down in any of the ways described above.

Offsetting the risk of containment failure
Regions or countries may partially offset the increased risk of containment failure by:

- Extending the period of public health emergency measures — to “play it safe”

- Ensuring an abundance of testing for diagnosis, screening, and research — there should be no need to make decisions about testing based on limitations in the supply of test kits or people and facilities to run the tests
- Ensuring a more-than-adequate supply of PPE to ensure the safety of front-line workers
- Incentivizing compliance and disincentivizing violation
- Providing enough high-quality facilities for isolation, quarantine, and treatment
- Detecting and immediately isolating all contagious individuals
- Isolating contagious individuals from their families
- Obtaining better data on the incubation period, the contagion period, the existence of chronic carriers, and the mechanisms of spread
- Providing high-quality, accurate educational materials to inform the public on the importance of public health interventions
- Funding research on drugs and vaccines to slow and prevent the spread of infection
- Helping to contain the pandemic globally, not just regionally

Flattening the curve

The notion of flattening the curve suggests that if we fail, it is better to fail with a slower time course than with an explosive outbreak. There are many reasons why this is true. These include:

- Decreasing the demand at any one time for hospital beds and other limited resources
- Increasing the number of immune individuals in the community to create a virtual barrier to additional infections, a phenomenon known as **herd immunity**
- Buying time for the development of new medical interventions and health infrastructure upgrades

We all live on Viralandia.

Prudent public health measures and collective action can clearly make a difference in controlling the pandemic threat that confronts us.