

A simple model to understand indoor infection risk

Imagine you have to spend some time indoors with a smoker, and your objective is to ensure that your spouse doesn't notice the smell of cigarettes when you get back home.

If the room is poorly ventilated and you spend enough time inside it, your clothes will smell like cigarettes no matter how far from the smoker you sit. Social distancing is useless.

However, if the room is well-ventilated, and you sit far enough from the smoker, you might get away with your clothes not smelling like cigarettes much. This is truer the less time you spend in the room.

In fact, the three variables (ventilation, social distance, and shortening exposure time) work together. If their product is high enough, your clothes will not get significantly smelly.

If you think of it in binary terms, all of this seems useless. No matter how good the ventilation and how far from the smoker you sit, some smoke particles will reach you.

But you don't need to be free from all particles to win. You just need to avoid getting so many smoke particles that your spouse notices the smell.



The same applies to virus risk. The objective is not to inhale zero virus particles, but to avoid inhaling so many virus particles that they can overwhelm your immune system.

And if the product of ventilation, social distancing, and reducing exposure time is high enough, you will keep the number of inhaled virus particles low enough that your immune system can fight it.

What about outdoors infection risk?

In general, outdoors infection risk is much lower than indoors one, though it might still be non-negligible. Standing very close to someone very infectious might still be risky.

Again, think of it like smoking. While your clothes will be significantly less smelly if you stand next to a smoker outdoors rather than indoors, they might still get some smell, depending on how close you stay and for how long, how heavy the smoker is, and how poor the wind is.

7 facts about masks

1. Masks **partially** reduce the risk of infection;

N99/FFP3 more than N95/FFP2, N95/FFP2 more than surgical, surgical more than cloth, and cloth more than none. Wear better masks when visiting riskier environments. Use N95s to visit crowded, poorly ventilated indoor locations such as subway stations. Consider wearing N99/FFP3 masks when visiting a hospital or in the presence of an infected person. Cloth masks work poorly and should be avoided if possible, but even a cloth mask is better than no mask.

2. Masks work even though their **holes** are larger than the virus

because they trap it using electrostatic charge, and because by slowing the flow of air when sneezing or coughing, they restrict the distance the virus travels, giving more time for aeration to disperse it.

3. Masks should be **comfortable**.

Just like shoes, you might need to try a few models before finding one that's comfortable for you. Adjust the elastic straps so that they still press the mask against your face but without causing pain to your ears, and Bend the metal wire on top of your mask so that it fits the shape of your nose.

4. Most people can fit their masks **even without professional training**.

While professionals exposed to high-risk situations should receive training on how to fit-test their masks, It just requires a bit of care. Bend the metal band so that it fits your nose, and check that you don't leave any gaps between your skin and the mask's borders.



5. Most people can **reuse** their masks

within reason. For example, buying five masks a month and rotating between them daily is a reasonable trade-off (keep them dry, though) for most people, though professionals exposed to high-risk situations should replace their masks daily. While changing masks daily is obviously better than reusing them, a reused mask is better than no mask.

6. Covid is an **airborne** virus,

which means that the risk of touching your mask and then touching your nose or mouth is unlikely to cause you to get infected, and anyway, the risk of that happening is lower than the risk of not using a mask and inhaling the virus unfiltered.

7. Wear a good mask before **entering poorly ventilated rooms even if no one is currently there**,

if they might have been recently occupied by an infected person (e.g., elevators). That's because Covid is airborne, meaning it lingers in the air for a few hours.

If masks work, why did infections continue?



People who wear a good mask while taking the bus are protected during their journey. However, if they later visit a crowded pub, they might contract the virus there. If they get sick this way, they get the impression their mask didn't work, but it very much did: as long as it was worn, it kept them protected.

People who do not intend to wear the mask consistently might think masking is useless. But masking being useless for them doesn't mean it's useless for others. For example, for an elder who must take the bus but doesn't plan to visit the pub afterward, wearing a mask makes the difference between her getting infected and her staying healthy.

Even for those planning to visit the pub later, wearing the mask isn't useless either. It reduces their chances of infection. For example, if they had a, say, 10% chance of getting infected during the bus ride and 30% chance during the pub, wearing a mask on the bus reduces their chances of infection by roughly a quarter. This matters even if "they are going to catch COVID anyway" because every time one catches COVID, it's like rolling the dice, risking severe consequences. Even if that risk is small, roll the dice enough times, and it might materialize.

But even assuming that one doesn't care about his or her health but only about being able to go to the pub, wearing a mask on the bus helps reduce spread, which reduces the chances that our governments enact policies that close the pubs.

If masks work, why did countries with strict mask policies have similar results to countries with lax mask policies?

How consistently people mask is a function of perceived risk: the more a virus spreads in a country, the more likely its population is to mask, with the result being similar to those of a country with lower virus spread and lower mask usage. It's just like people in winter are more likely to use heating than in spring, but their houses aren't any warmer than when heating is off – yet, that doesn't mean heating doesn't work. It does!

Another reason countries with different masking policies had similar results is that even when masks are mandated, not everyone wears them, and even when they are not mandated, many people wear them anyway. Therefore, two countries with different mask policies might actually have more similar behaviors than one might expect.

Why is good ventilation so important?

Ventilation is useful because it reduces the quantity of virus particles in the air, and therefore the chances one might get infected and, if infection does happen, a higher risk of severe outcomes.

Think about it as if your body were a country invaded by enemy soldiers (the virus). How many soldiers invade surely influences the chance of success of the invasion and how much devastation it causes.

Ventilation also has a critical role in improving the effectiveness of other precautions. For example, social distancing is rather useless if you sit in a poorly-ventilated restaurant room a few meters away from someone infected. This is because, earlier or later, the virus exhaled by the infected person will fill the room. However, if the room is well-ventilated, social distancing might be effective, as most of the virus might exit through the windows instead of traveling to your nose.

Think about it like smoking. If you sit at a poorly-ventilated restaurant and there's a smoker sitting a few meters away from you, your clothes might smell of cigarettes – but less than the clothes of the person sitting next to the smoker. However, if the restaurant is well-ventilated, your clothes might not smell like cigarettes at all, whereas the clothes of the person next to the smoker will still smell like smoke, though less than in the scenario with no ventilation.

Similarly, **masks work better in well-ventilated rooms.** Immune systems work better in well-ventilated rooms. Not in the sense that the mask or immune system act differently – simply, they will have fewer virus particles to “fight.” Therefore, the chances that a significant number of them slip through our defenses will be lower.



How to know if a room is well-ventilated enough?

The most accurate method is to use a CO2 meter: the lower the reading, the better ventilated the room.

That said, a good-enough alternative is to ask yourself if your clothes would smell if everyone inside the room smoked a cigarette. If the answer is yes, then the room is not ventilated enough.

This is a great way of thinking about it because the number of people inside the room, the ventilation, and how long people are expected to spend inside the room are all relevant variables both to the chances of your clothes smelling like smoke and you getting infected.

How to improve air quality?

- Ventilate by opening windows.
- Use air purifiers (they start below \$100).
- If you use mechanical ventilation, ensure that the air flowing inside the room is clean, as opposed to it coming unfiltered from another room containing infected people).

How to safely keep schools open during a pandemic?



To keep schools open during a pandemic, we must create the conditions for them to stay open. First of all, we must ensure teachers and students don't get sick so that attendance doesn't drop even if the schools are technically open.

More importantly, we must acknowledge that, like it or not, the main reason governments closed in-person schools has nothing to do with the students and everything to do with protecting the economy and the vulnerable. Countries that find themselves with viral spread so high that it impairs their economy and healthcare capacity have very strong incentives to close schools – and if they do not, they find themselves with an even worse economy and healthcare capacity.

Hence, we cannot just “wish that schools stay open.” **Keeping them open means keeping the viral spread within the general population low and/or taking precautions within the schools so that keeping them open doesn't contribute to viral spread.**

What about masking students?

It is possible to keep schools open and safe without requiring students to wear masks in the classroom, but that requires doing as much as possible other than that to keep the spread low: first of all, improving classroom air quality and using strict precautions in common areas such as hallways, but also keeping viral spread low within the general population.

Concrete strategies to keep schools open

One possible strategy is to reduce the viral spread within the general population. The lower the spread within the general population, the more schools stay safe even if no precaution is adopted within them (because the chance that someone within a classroom is sick and might infect others is lower).

Another possible strategy is to reduce the spread within the school. It is critical to achieve this as much as possible in ways that do not interfere with classroom life. Good options include improving ventilation, using air purifiers (a class of 20 students could buy one at a cost of less than \$5 each), and testing students to prevent the contagious ones from infecting others (*a reminder that asymptomatic people can still be infectious*).

Moreover, stronger precautions should be taken in common areas. For example, students might remain mask-free in their classroom but might be required to wear them in the hallways. This would prevent an eventual outbreak within a class from spreading to other classes.

How to organize a safe family dinner during a pandemic?



Imagine it's November. Thanksgiving is in two weeks, and you're planning to spend it with your family, which includes some vulnerable elders. A recent wave of viral infections makes you worry that you might infect your grandma, but you do not want to give up the opportunity for some quality family time.

When having an unmasked indoor gathering, the top priority should be to reduce the chances that any participant carries the virus inside the room.

A first step is to have all participants take a COVID test the morning of the gathering and to ask anyone positive to not attend the gathering this year (a reminder that someone might not be showing any symptoms and still be infectious). While useful, testing is by no means sufficient (it might result in false negatives or might miss viruses other than COVID) and, to be frank, it's annoying as hell – can you imagine preparing and traveling for a family gathering that you discover at the last minute you cannot attend?

The second step is to minimize the chances that any participant is sick on the day of the gathering. Have participants take basic precautions the week before the gathering, such as:

- wearing good masks while in crowded indoors,
- prefer outdoor meetings to indoor ones, and avoid the latter the week before Thanksgiving

The third step is to make the Thanksgiving gathering as safe as possible. Being this an important social gathering, masks are probably not an option; hence, the focus should be on improving air quality as much as possible – opening windows and/or using good air purifiers.

Acceptable risk

Obviously, none of the precautions just described can nullify the risk of infection.

If zero were the only acceptable risk level, then the gathering should not take place. And if near zero were the only acceptable risk level, in addition to the recommendations above, the vulnerable should use the highest-grade masks.

But if a family decides that preserving a family tradition such as Thanksgiving is worth some level of risk, it is still possible to bring that risk to a very low level without sacrificing the quality of the gathering – by taking precautions not during the gathering but over the preceding days.

A general principle

There are categories of preventive actions when it comes to indoor activities: those that occur before the gathering and those that occur during the gathering.

The activity's risk level is roughly the product of the two. Given a risk level deemed acceptable, the more one takes precautions before the gathering, the less precautions they should take during the gathering, and the other way around.

Why should we care about a virus with a 99.8% survival rate?



The first reason is that 0.2% might seem like a tiny percentage, but in absolute numbers, it amounts to a lot of deaths. If everyone on Earth gets infected, that would cause 0.2% times 8 billion people – that's 16 million deaths – almost three Holocausts! This alone would warrant taking the virus seriously. But that's not all.

Deaths are only the tip of the iceberg. For each person who dies of a virus, there are many who get hospitalized and many more who spend some terrible days in pain. Some might even develop chronic illnesses as a result of their infection.

This pain and suffering further add to the reasons to take a 99.8% survival rate virus seriously.

Moreover, **even if the virus had a 100% survival rate, it would still cause plenty of deaths.** That's because if enough of the infected require hospital treatment, high community spread might result in hospital overwhelm, which in turn results in healthcare capabilities to treat other illnesses.

So, for example, even if a virus doesn't kill anyone as long as serious cases get hospital treatment, we might still see a large increase in all-cause mortality during a pandemic due to, e.g., cancer patients receiving worse treatment and thus dying at a higher rate.

What about focused protection?

Can't we just protect the vulnerable and let the rest of the population act as if there was no pandemic?

Not really. One reason is the one highlighted in the previous paragraph – even if the most vulnerable were fully shielded from the virus, letting it run free in the general population would still cause hospital overwhelm and, therefore, still increase mortality amongst the vulnerable. Unless we extend the definition of vulnerable to something like 50% of the population – but in that case, it wouldn't be much different from a lockdown, and the isolation would potentially have to last much longer.

Ten small actions you can take to reduce viral spread without sacrificing your social life



1. Prefer local. Meeting your friends at the local coffee shop rather than at the Starbucks in the city center exposes you to fewer people and, therefore, reduces your chances of getting infected and infecting others. The more people we share a room with and the more networks they belong to, the more the virus circulates

2. Prefer off-wave. Meeting people when there are many cases is riskier than meeting them when there are fewer cases (e.g., COVID prevalence in the US was 60 times higher in January 2021 than it was in June 2020; hence, grabbing a coffee became 60 times riskier in January 2021 than it was in June 2020). Consider delaying social encounters until the current wave tapers off.

3. Prefer off-peak. Going to the restaurant or the gym when it's the least crowded exposes you to fewer people and exposes fewer people to you. *(Though, if you go after the peak, consider that some virus might still linger in the room, if poorly ventilated.)*

4. Prefer ventilated. Meet people outdoors. If it's not an option, choose somewhere well-ventilated and sit far from other tables. Wear masks before the food or drinks arrive and after having finished them. This reduces your risk and reduces the risk for others.

5. Protect your loved ones by being extra careful before meeting them. For example, the week before meeting Grandma, consider skipping social encounters. One way to protect others is to be extra careful while meeting them; another one is to be extra careful on the days leading to that meeting.

6. Minimize long-range travel. And if you do need to travel, make sure you don't contribute to spreading the virus far and wide by wearing high-grade masks and meeting fewer people over indoor meals in the days leading up to the trip.

7. Wear well-fit, high-grade, comfortable masks. Help others find high-grade masks that are comfortable. Teach others how and when to wear them properly. If masks are uncomfortable, you're doing it wrong.

8. Consider vaccinating. Vaccines reduce your chance of ending up at the hospital. Evaluate your personal risk of severe COVID outcomes by taking into consideration your age, your health, your exposure, and COVID prevalence in your region.

9. Every bit matters. Even if you do not bring your risk of contracting COVID down to zero, lowering it is still important. Not only does it reduce your chances of getting a severe illness, but it also reduces the chances of you infecting your loved ones.

10. Every bit compounds. If you take five small actions that each leads to just a 1% reduction in infection risk, you reduced that risk by roughly 5% total. That might seem small, but it compounds. If on week 1 there are only 95% of the infections that there would have been otherwise, on week 2 there will be 90% of the infections that there would have been otherwise (as there were fewer people around spreading the virus), on week 3 there will be ~85% of the infections, and so on.

14 dos and don'ts of institutional communication



Don't: appeal to the in-group

A lot of institutional communication during 2020 and 2021 used polarizing language that appealed to those who were already aligned with what was asked of the population and instead angered those it was supposed to convince.

This type of communication is useless at best and damaging at worst.

Do: appeal to the out-group

A better alternative is to speak to those who aren't aligned with the institution yet, addressing their concerns instead of ignoring them.

Don't: write for scientists

Some institutions use overly technical language or assume that the general population knows the reasoning behind the proposed policies. This severely limits the effectiveness of the message.

Do: write for common people

A better alternative is to write in the simplest language possible, explaining assumptions and reasonings – all the while without feeling patronizing.

Don't: use the words “trust us”

Only institutions with a long track record of trustworthiness can use the words “trust us” effectively. In all other cases, their use will backfire. Institutions that are at least partially distrusted should instead use other arguments to achieve buy-in.

Don't: dismiss difficult questions

For example, in early 2021, the public had questions about the safety of vaccines. Some governments didn't take those concerns seriously and either ignored them or used dismissive replies such as “They're safe, trust us.”

Not only does this behavior destroy trust. But the public has questions, and if institutions don't answer them, the public will believe whatever charlatan does.

Do: earn trust by answering difficult questions

Institutions can and should build trust by answering difficult questions. They can proactively ask the public what concerns they have, listen without interrupting, and then answer the concerns without dismissing them.

Don't: order (unless truly necessary)

People don't like being ordered to do things, especially if they're not explained first why, and especially if they don't trust the person ordering them.

Do: explain

Instead of ordering the population to do something, or at least before ordering them, explain what they should do and why it matters. If what you ask of them is hard, proactively address these difficulties without dismissing them, and offer solutions or explain why you believe that what you ask of them is worth doing despite the costs of doing so.

Don't: treat people like children

Treating people like children (e.g., patronizing them) yields child-like behavior.

Do: treat people like adults

Acknowledge that the people you address have complex, busy lives and real concerns. Do not expect 100% compliance on everything you ask of them. Respect them, prioritize your asks, and avoid unnecessary waste of their time and energy.

Don't: say things that might be incorrect

In March 2020, the WHO tweeted: “FACT: #COVID19 is NOT airborne.” Not only do we know now that the tweet was factually wrong (COVID is, in fact, airborne), but more importantly, we could have known even then that the tweet was wrong. That's because there was no certainty that COVID wasn't airborne.

Never say things that might be incorrect, and especially do not present them as FACTS. Because once people realize that an institution said something incorrect, their trust in it will vanish.

Don't: exaggerate

In 2021, US President Biden said, “If you're vaccinated, you won't get COVID-19.” This was an exaggeration. While COVID vaccines do help reduce the likelihood of severe outcomes from an infection, they certainly do not prevent infections fully. Exaggerating should always be avoided: it destroys public trust and gives easy openings to charlatans to peddle even worse claims.

Do: use nuance when necessary

Do masks work? While the answer “yes” is technically correct (in the sense that they do reduce the chance of infections,) such an answer is also prone to be misunderstood. For example, it might invite remarks such as “if masks work, why did I get infected even if I wore one?” or “if masks work, I will be safe with my cloth mask.” Instead, a better approach is to use nuance when required. For example, “masks reduce the risk of infections significantly but not fully; N99 masks more than N95 ones, N95 masks more than surgical ones, surgical masks more than cloth ones, and cloth masks have very little effect but still more than no mask.”

Keep things simple but without oversimplifying.

How can we prevent the next pandemic?

The 2020 pandemic brought plenty of suffering – both from COVID directly and from the measures implemented as a reaction to it. If we want to avoid similar suffering in the future, we must prevent the next pandemic, so that we won't find ourselves ever again with overwhelmed hospitals, rushed vaccines, and businesses closed.

It begins with making virus research safer

The most likely origin for a pandemic like the 2020 one was and still is a lab leak. The world is full of virus labs operating on dangerous viruses, and their track record is abysmal.

"Between 2015 and 2019, US labs reported more than 100 accidents a year while experimenting with some of the world's most dangerous pathogens. [...] More than 100 US labs with bioterror pathogens had faced federal sanctions for safety violations [...], and regulators allowed them to keep conducting experiments while failing inspections, sometimes for years," wrote USA Today in 2021.

Regardless of whether the 2020 pandemic did originate from a lab leak, lab leaks were and still are very likely. It is only a matter of time before another lab leak starts another pandemic.

Hence, we must make virus labs safer. They shouldn't be built within large metropolises like Wuhan. That makes containing leaks much harder and costlier.

Virus lab personnel must be required to follow quarantine protocols that are at least as strict as the quarantine protocols the general population had to follow in 2020.

The COVID pandemic showed how costly it might be to ignore virus lab safety. It's time to take action and change that.

It continues with reacting to outbreaks fast

On the 5th of January 2020, the WHO publicly alerted the world of the Wuhan outbreak. The US waited 18 more days to ban flights from Wuhan. That was too long. Blocking long-range travel is the most effective when done early.

Conversely, Taiwan began quarantining travelers from Wuhan as early as the 31st of December 2019 (!) and thus managed to have negative excess deaths in 2020 – despite its closeness to Wuhan. That's the power of reacting to outbreaks fast.

If we want to avoid the suffering that would come with a new pandemic, we must improve our governments' reaction times.

It further continues with training

Populations that were trained about how to react to pandemics – such as Singaporeans and the Taiwanese, who were scarred during the SARS epidemics of the early 2000s – were faster to react to the outbreaks. For instance, many Singaporean families already had masks in their homes and already knew how to wear them properly and why they work.

Such preparation helps react faster to outbreaks. It is very effective: both Singapore and Taiwan recorded near-zero excess deaths in 2020.

It is time to train our populations, explaining what to do and why in case of future pandemics.



It ends with remembering

Remember how, in early 2020, masks were scarce? You would be shocked to learn that France used to have a stockpile of 900 million N95 masks (13 per citizen) and 1 billion surgical ones. That was in 2009, after the SARS outbreaks. Then, people forgot about them, the stocks got used up or expired, and haven't been renewed. So, when COVID arrived, France was short on masks, too.

There are two lessons here. First, build equipment stocks. Second, do not forget about the reason you built them.

Currently, the memory of the 2020 pandemic is still fresh. Designing plans to prevent another pandemic and preparing for it is relatively easy. The hard part will be to keep rehearsing the plan and renewing the stocks even when they will start to seem a waste of time and money because too much time passed since the last time there was a need for them.

The solution is to set up systems to remember. Let's keep talking about the 2020 pandemic every year. Let's remember the mistakes. Let's proactively remember that we shouldn't forget.

Why were governments so slow in their reaction to Wuhan's outbreak?

Part of the reason is that most governments signed the International Health Regulations (IHR) of 2005, which contained a clause saying that unless the WHO recommends travel restrictions, other countries must refrain from imposing travel bans or trade restrictions on nations that are grappling with disease outbreaks.

These regulations weren't written to protect the health of the human population but to protect trade. The WHO's website says, "One of the objectives of the IHR (2005) is to minimize unnecessary restrictions to travel and trade. [...] The IHR] sets the parameters for notification to WHO of all events which may constitute a public health emergency of international concern based on the following criteria [including] the risk that restrictions to travel or trade may result because of the event."

Until the 2005 IH Regulations are in place, our countries are guaranteed to react too slowly to future outbreaks. We cannot allow this to happen.