Erin Bromage ★ 3 days ago · 12 min read

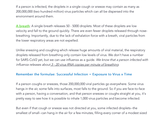
The Risks - Know Them - Avoid Them

Updated 10 hours ago

It seems many people are breaking some relief, and I'm not sure why. An epidemic curve has a relatively predictable upslope and then the peak is reached, the back slope can also be predicted. We have robust data from the outbreaks in China and Italy, that shows the epidemic curve, and we can see the impact of the lockdowns. Yesterday, in Italy, there were over 5,500 new cases and 1,000 deaths. It is possible that we saw another 10,000 people over the next 6 weeks as we come off that peak. That's what's going to happen with a lockdown.

As states reopen, and we give the virus more fuel, all bets are off. I understand the reasons for reopening the economy, but I've said before, if you don't solve the lockdowns, the economy won't recover.

There are very few states that have demonstrated a sustained decline in numbers of new cases, and even fewer that have demonstrated the capacity to test, trace, and isolate. Without this it's hard, when you take out the data from Texas and just look at the rest of the USA, daily case numbers are increasing. Bottom line: the only reason the total USA new case numbers are not higher right now is because the New York City epidemic was so large and it is being contained.



So throughout most of the country we are going to add fuel to the viral fire by reopening. I'm going to happen if the it not, so my goal here is to try to guide you away from situations of high risk.

Where are people getting sick?

We know most people get infected in their own home. A household member contacts the virus in the community and brings it into the house where sustained contact between household members leads to infection.

But where are people contracting the infection in the community? Hospitals have people who are sick with COVID-19 and they are isolated from others, so we can't use hospitals as a means - we have photos of some of them, but not really. Let me explain.

In order to get infected you need to get exposed to an infective dose of the virus, based on infective dose studies with SARS and MERS, it is estimated that as few as 300-1000 infectious particles are needed for an infection to take hold. Please note, this will vary by the individual and their immune status, but this is a good estimate for a healthy individual. Infectious particles are small droplets, PM2.5 or smaller particles, so droplets that can linger in the air for hours, or 100 nm and particles smaller than each droplet, over 10 microns or 10 and particles with 100 droplets. Each of these droplets can hold a lot of infectious

How much Virus is released into the environment?

A Bathroom Bathroom has a lot of high touch surfaces, door handles, faucets, and toilets, and we know that toilets can be a source of virus. In a study of a high rise apartment complex where infective material is found in the apartment complex, but no virus is found in toilet flushing does aerosolize many droplets. Treat public bathrooms with extra caution. Surface and air, until we know more about the virus, I'd avoid them.

A Crowd. A single cough releases about 3,000 droplets and droplets nucleate at 30 million per hour. Most droplets are large, and fall to the ground, but they do stay in the air, and travel across a room in a few seconds.

A Sneeze. A single sneeze releases about 30,000 droplets, with droplets traveling at up to 200 miles per hour. Most droplets are small and travel greater distances barely across a room.

If a person is infected, the droplets in a single cough or sneeze may contain as many as 200,000,000 (two hundred million) virus particles which can all be dispersed into the environment around them.

A Laughing. A single breath releases 50,000 droplets. Most of these droplets are too small to be seen, and they can remain in the air for hours. Laughing is a combination of deep breathing, importantly, due to the size of infective dose with a breath, and exposure from the lower respiratory areas are not respiratory

Infective aerosols are generally which release huge amounts of viral material, the respiratory droplets released from breathing only contain low levels of virus. We don't have a number for how many droplets are released from breathing, but we know that aerosols which inflame whereas about a 1,000 times more virus in breathing.

Remember the formulae: Successful Infection = Exposure to Virus x Time

If a person coughs or sneezes, their 200,000,000 viral particles go everywhere. Some virus lodges in the so some falls into surfaces, the virus begins to degrade. So if you are face to face with a person, being in a room with a person who has coughed or sneezed, you are at risk, but the virus has to be in a position to reach your lungs and be inhaled.

But even if that cough or sneeze was not directed at you, some infected droplets will remain in the air for hours, and if you walk into that room, you will breathe in some of the room with infectious viral particles. So if you have to go to a store that room will be a few minutes of the coughs/sneeze and take a few breaths and you have potentially received enough virus to establish an infection.

But with general breathing, 20 pages per minute into the environment, even if every virus particle in that breath survives, it would take about 10 days to produce 30 copies of the infectious virus.

Conclusion: increase the release of respiratory droplets about 10-fold. 1,000 copies of the virus per minute. Again, assuming every virus is viable, it would take 1-2 minutes of breathing face to face to receive the required dose.

The exposure to virus is more fortuitous is the basis of contact tracing. Anyone you spend greater than 10 minutes with in a face-to-face situation is potentially infected. Anyone who shares a space with you but is not difficult or extended period is potentially infected.

This is also why it is critical for people who are symptomatic to stay home. Your sneezes and your coughs expel far much more that you can infect a whole room of people.

What is the role of asymptomatic people in spreading the virus?

Symptomatic people are not the only ones who are sick. We know that at least 40% of infections and the majority of community-acquired transmissions, occur from people who are asymptomatic or presymptomatic at the time of infection. So, they are breathing into the environment for up to 2 days before symptoms begin.

Infective people come in all ages, and they all shed different amounts of virus. The figure below shows that no matter your age or sex, you can have a little bit of virus or a lot of virus (with 1x10).

The amount of virus released from an infected person changes over the course of infection and is also different from person to person. Data that I personally tackle up to the point of symptoms, but there is little data on how the virus changes after symptoms. Virus releasing the most virus into the environment. Interestingly, the data shows that 20% of infected people are responsible for 99% of viral load that could potentially be released into the environment.

So now let's get to the crux of it. Where are the personal dangers from reopening?

When you think of outdoor classes, and as we move into the time when we think that people would go to the cinema or bar, they would be wrong. Skip outdoors don't even land in the top 50 outbreaks to date.

Ignoring the terrible outbreaks in nursing homes, we find that the biggest outbreaks are in meat processing plants, and workplaces, such as meat packing facilities and call centers, the environment that is enclosed, with poor air circulation and high density of people, quite trouble.

Some of the biggest cases involving outbreaks:

- Meat packing: In meat processing plants, densely packed workers track contamination to one another under the deafening roar of processing machinery. Workers are in close proximity to one another. There are now outbreaks in 115 facilities across 23 states, with over 4,900 cases and 20 deaths. Ref.
- Weddings, funerals, birthdays: 100 or so people in a room. Ref.
- Business networking: Face-to-face business networking like the Bergen Conference in Boston in March.

As we move back to work, or go to a restaurant, let's look at what can happen in those environments.

Restaurants Some really great close-quarter epidemiology demonstrated clearly the effect of a single asymptomatic carrier in a restaurant setting. The infected person ate at a table and had dinner with 9 friends. Dinner took about 1 to 1 hours. The group ate, drank, and socialized, but the person never left their table, except for a bathroom breaking. Airflow from the restaurant's various after-serial was from right to left. Approximately 50% of the people at the infected person's table became sick over the next 2 days. The other 50% of people in the restaurant, sitting at other tables, did not get sick. Of 2 people at the upstream table, one became infected but happen to be vaccinated against flu. No one at tables 3-7 or therefore infected, they were out of the room airflow from the air conditioner on the right to the exhaust fan on the left of the room. Ref.

Workplaces Another great example is the call centers in a call center (see below). A single infected employee came to work on the 11th floor of a building. That floor had 216 employees. Over the period of a week, 94 of those people became infected (43.5% the total floor). The building had 7 floors and 1,000 people, and everyone else in the building, who did not work on the 11th floor, were not infected, so they saw the people infected on the other side. While exact number of people infected by respiratory droplets / respiratory exposure versus touching infected surfaces is difficult to tease out, the epidemiology is well unknown. It serves to highlight that being in an enclosed space, sharing the same air for a prolonged period increases your chances of exposure and infection. Another Example: on a cruise ship, 1 person infected with COVID-19 boarded a cruise ship, and 7 days later, infections by primary cases on the 13th floor. Interestingly, even though there were considerable interaction between aisles on different floors of the building in elevators and stairs, the infection was only found on the 13th floor. Ref. This highlights the importance of exposure and time in the spreading of SARS-CoV2.

Church The church cluster in Washington State. Even though people were aware of the virus, and masks were in attendance, a day-long conference brought together people from all over the state, with extensive hugging and socializing, and socially distanced behaviours. Of the 60 people who attended, 45 became infected, and 3 secondary transmissions occurred. The virus was 0.13 fatal, made an estimated death toll which was roughly the size of a volleyball court.

Singing is a great degree than talking, aerosolizes respiratory droplets extraordinarily well. Singing in a choir, singing facilitated those respiratory droplets getting deep into the lungs, and the virus was able to establish infection. Choir practice was a superspreader event. Choirs are a prolonged period of time in close proximity, and in a closed environment, with heavy breathing for an extended period. This tournament resulted in 24 of the 72 people becoming infected. Ref.

Birthday parties / Funerals Just to see how people infection chains can be, this is a real story from Chicago. The name is Nick. Nick was infected but didn't know. Nick shared a birthday party with 7 people, and 6 of those people became infected. Nick went to Chicago. The next day, Nick attended a funeral, and 3 people became infected. Nick's attendance to a memorial was contributed. Within 6 days, both family members who attended the wake were sick. A family member, who had gathered at the funeral became sick. But Nick was not sick. Nick was the only person who was not sick. Nick was the only person who had to leave his house to go to work. Season of contact tracing interviews. Dr. Clare the nurse that Nick became sick, he was hospitalized, ventilated, and died.

Nick's story highlights the fact that people who are infected at the birthday were in church, where they were, jammed in the lifting elevator. Members of the church became sick, it all, and they were responsible for infecting people between the ages of 3 and 90. Three of those 16 died.

The spread of the virus within the household and back out into the community through funerals, birthdays, and church gatherings is believed to be responsible for the broader transmission of COVID-19 in Chicago. Ref.

Sobering right?

Commonality of outbreaks

The reason to highlight these different outbreaks is to show you the commonality of outbreaks of COVID-19. All these infective events were indoors, with people closely spaced together, and in a closed space. The virus was able to spread, and in some of these situations, infected people in a prolonged period of time, and in a closed space, with poor air circulation. In contrast, outbreaks spread from shopping aisles to be responsible for a small percentage of known infections. Ref.

Importantly, of the countries performing contact tracing properly, only a single outbreak has been attributed to an outdoor environment (less than 1% of tracked infections). Ref.

Go back to the original thought of you, and

Indoor spaces, with limited air exchange or recycled air and lots of people, are concerning for transmission of COVID-19. Indoor spaces with poor air circulation and high density of people (short-ranged or inhalation infections, Same situation with the restaurant and call center. Social distancing guidelines don't hold in indoor spaces where you spend a lot of time, so people on the opposite side of the room can infect you.

The principle is not exposure over an extended period of time. In all these cases, people were exposed to the virus for a short period of time, and they became sick. The virus was able to stay there in an closed space, even a few steps of the virus in the air reaching them, over a sustained period, was enough to cause infection and in some cases, death.

Social distancing rules are really not going to work with virtual exposures in outdoor spaces. In these situations there is not enough time to achieve the infective viral load when you are passing by someone. Outdoor spaces are not the problem, and we need to be careful about what we do. The effects of sunlight heat, and humidity on viral survival, all serve to increase the risk to everyone when outside.

When assessing the risk of infection to yourself and the groups, time is vital, you need to consider the volume of the air space (very large), the number of people (restricted), how long people are spending in the area (another day), outdoors or not. Food, friends and family are important sharing the last family night at a restaurant, sharing with the restaurant staff, and the other people in the restaurant, is a risk that I personally don't want to take. But for the same reason, the outdoor dining is great in the stone possibility to open opportunity to receive the infectious dose and therefore the job becomes more risky.

Basically, as the virus is known and we learn it, workers are more comfortable in the workplace, people are more willing to go back to their environment and make judgments, and we need to be careful. The virus is still there, and it is still spreading, and it is in the environment. If you are in an open Rockland office, you really need to think about the risk (volume, people, and airflow). If you are in a pub that requires face-to-face talking or raised voice, yelling, you need to reason the risk.

If you are sitting in a well ventilated space, with few people, the risk is low.

If I can socially, and I walk past some people, I'm fine. "Hi and wave" needed for infection. You would have to be in their airstream for 1+ minutes for a chance of infection. Masks are important, they reduce the amount of virus being released, therefore the exposure time is also less due to their speed.

Hope this helps you make your own decisions, please don't forget outbreaks. Those infected respiratory droplets last a maximum 10 hours. Clean those high touch surfaces in your favor.

We are allowed to move around our communities more freely and be in contact with more people in more places more regularly, the risks to ourselves and our family are significant. Even if you are going for the reopening, or supporting your business as usual, do your part and wear a mask to reduce what you release into the environment. It will help everyone, including your own business.

This article was inspired by a piece written by Jonathan Kay in Quillette
"COVID-19 Transmission Science for Non-Scientists, Critical Thinking and Laymen

About the author

Erin E. Bromage, Ph.D., is an Associate Professor of Biology at the University of Massachusetts Dartmouth. His research focuses on the immunology of amphibians and Mammalian Sciences, James Cook University, Australia where his research focused on the epidemiology of, and immunity to, infectious diseases in animals. His Post-Doctoral training focused on the immunology of fish, and the immune response to parasites in the Comparative Immunology Laboratory of the Dr. Stephen Kaattari.

Dr. Bromage's research focuses on the evolution of the immune system, the immunological mechanisms responsible for protection from infectious diseases, and the design and use of vaccines to control infectious diseases in animals. He also focuses on designing diagnostic tests to detect biological and chemical threats to the environment and humans.

Dr. Bromage joined the Faculty of the University of Massachusetts Dartmouth in 2007 where he teaches Immunology, Vertebrate Physiology, and Vertebrate Histology. He has been working on the Biology of the Novel Disease which focused on the emerging SARS-CoV2 outbreak in China.

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Michelle Dunn Rosenberg 7 days ago

Hi Erin... I just looked but thank you for the heads up! Are you thinking of doing an analysis of the Italian situation (reopening, etc.)?
Thank again.
Gisela

0 Like · Reply

Erin Bromage ★ 6 days ago

Australia looks great. I will do something shortly. Aussies have handled this marvelously, and they are keeping their eyes on it.

0 Like · Reply

Amy 7 days ago

Thank you. I'm curious about the toilet flush example... you warning about being careful to settle before using a public restroom is generally solid advice for lots of reasons, but it was my understanding that the coronavirus didn't survive the digestive tract? Is there a transmission risk from human waste?

0 Like · Reply

Mary Rinaldi Gray 7 days ago

I am a teacher. I dread the reopening of public school this fall.

0 Like · Reply

angelagen 7 days ago

I'm curious whether this describes virus behavior and/or exposure data to specific to CV or if the information holds true for MERS, virus in general, etc.

0 Like · Reply

Erin Bromage ★ 7 days ago

Hi Erin - thank you for this thoughtful summary of what is known about transmission in enclosed spaces.

Can you expand on the point about public restrooms? This is the only piece of your post that comes off to me as a bit generic.

Yes, flushing a toilet puts particles into the air. And yes, RNA detection of the virus in sewage is well-known. But wouldn't contamination of surfaces be the biggest concern, or is transmission via toilet flushing particles between stalls or coughing in such a small space? Or is there evidence of transmission via sewerage and grey water? Thank you.

0 Like · Reply

Erin Bromage ★ 7 days ago

Hi Amy, the virus that you can detect considerable amounts of viral RNA in fecal material, but none is active. We don't have data either way to know whether it is or if it infectious.

It may just be non-infectious viral fragments (least outcome). But until we do know, put the seat down and then flush! Or use woodland behavior as described.

0 Like · Reply

Linda Bacon 7 days ago

Thank you for this informative article. I would like to know your thoughts regarding reopening schools in the fall. Do you think it is safe for children to return to school in light flexible hours, could enough of the particles from them sitting be infective?

0 Like · Reply

Erin Bromage ★ 7 days ago

Hi Chris, We know that you can detect considerable amounts of viral RNA in fecal material, but none is active. We don't have data either way to know whether it is or if it infectious.

It may just be non-infectious viral fragments (least outcome). But until we do know, put the seat down and then flush! Or use woodland behavior as described.

0 Like · Reply

Mary Rinaldi Gray 7 days ago

Hi Erin - I read the research on the toilet flush effect and exposure data to specific to CV or if the information holds true for MERS, virus in general, etc.

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gyms/exercise studios reopening. Specifically, the reformer Pilates studio that I frequent is reopening with additional precautions such as less people allowed per class (only 8 people to allow for 6' of space between everyone), sanitizing machines and studio between classes and requiring everyone to wear gloves (but not masks). It's a relative small space with air conditioning and high fans blowing during classes. The classes are 45 minutes and you def get your heart rate up and breath heavily. after reading your article, it seems to me despite the precautions, the risk of infection is significant if an unknowing, asymptomatic patron participated in a class. Thank you.

141

Erin Bromage 3 days ago

Hi Patrick. Prior Studies with enteric pathogens show that toilet flushing aerosolizes infectious microbes into the air and those microbes stay airborne for a few minutes.

We do know that there is SARS-CoV2 viral RNA in fecal material. But, we do not know if it is viral fragments or intact and infectious virus. We really need that data.

The early studies in hospitals (and cruise ships) show that bathrooms were heavily contaminated with viral RNA, the air and surfaces (toilet, floor, sink). They also showed that it persisted on bathroom surfaces for a long time. Again, They didn't test to see it was infectious... again, we really need this data.

Bathrooms are a black hole of knowledge with this virus. But the CDC is currently recommending that if you have an infected person in your house, they should have their own bathroom if possible.

I wasn't aiming for alarmist. It is just something I am being even more cautious about (in my life) until I have the data to guide my actions.

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Erin Bromage 3 days ago

References are now posted in the article. If I've missed any, just let me know.

141

Aliza Panitz 3 days ago

I know that droplets are a big issue, but most discussions of transmissibility also talk about shared-touch surfaces, like door handles and PIN pads. Was there a reason you left that out?

39

Erin Bromage 3 days ago

Hiking. 3 hours of drafting someone could potentially lead to infection. But, I tend to think that the outdoor environment rapidly dilutes infectious material and the risk would be low.

But there are many caveats. Some people release huge amounts of infectious material, others very little (that is assuming they are infected). Same with infectious dose, it's different for different people.

74

Lisa Stone 3 days ago

Hello, thank you for sharing this information. I have a question about risk associated with taking back our doggie clients. We have a dog daycare and many of our clients work in essential worker positions (some medical field) and we are considering taking on clients again but we will be seeing these people twice a day and have their dog in our house up to 12 hours times 7 dogs. We have heard dogs and cats have tested positive for COVID-19, none dying and no confirmation pets are spreading it. Our dogs come with a leash and collar from their homes. I would think our risk would be low. What do you think about our risks knowing that some owners work in potentially high risk situations?

56

Erin Bromage 3 days ago

Hi Aliza, I had written on that issue previously, but you are right, it should be added in here. I will add! Thanks!

31

Frank Mary Swartzwelder 3 days ago

Well done, Erin. Very informative and scientifically sound. I have a similar background in microbiology as Erin. I appreciate the time you took to do this analysis. I would add, if you are over 60 yrs and have complications, be careful. Another though after reading the comment about re-opening schools: I understand the concern, but I do think it is important to re-open schools taking care to protect older teachers and the elderly in the homes of children attending school. Herd immunity will eventually help stop this virus. We do have to reopen businesses to prevent the collapse of our economies (US, Australia and all countries). We just have to be smart and careful. Frank

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