The Anatomy and Physiology of Social Distancing During COVID-19 Pandemic: a global perspective.

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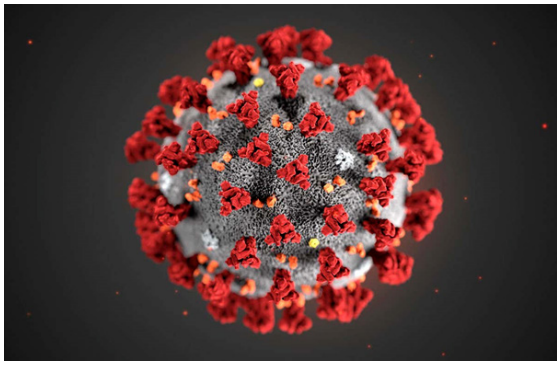
A global perspective

Globally, public health has experienced the burden of endemic, epidemic and pandemic infectious diseases with varying extends. Severe Acute Respiratory Syndrome coronavirus disease 2019 (SARs-CoV-2), Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) are recent example that have challenged public health resources. Although the virulence of these pathogens vary considerably, in sum they have contributed to thousands of lives lost and overwhelmed the public health response capacity. The untimely outbreaks have also exposed waning community resilience (i.e. the ability to quickly recover and resume normal duties) at peak incidence periods. During these crises, public health planning, resource allocation, and international communication and reporting of infectious diseases cease to exist in adequate quantities to properly guard the public health. Most importantly, infectious diseases do not respect geographic borders.

Covid-19

COVID-19 is a respiratory illness and is largely spread from one person to the other via droplets in the air. On February 11, 2019 the World Health Organization (WHO) announced that the official name for the disease caused by a kind of coronavirus which first originated in Wuhan, China in late 2019, would be COVID-19. This a shortened version of coronavirus disease 2019. This is not the formal name for the virus – the International Committee on Taxonomy of Viruses calls it the "severe acute respiratory syndrome coronavirus 2", or SARS-CoV-2, because it is related to the virus that caused the SARS outbreak in 2003. However, to avoid confusion with SARS the WHO calls it COVID-19 when communicating with the public. The virus that causes COVID-19 is known as SARS-CoV-2. The most commonly reported symptoms include a fever, dry cough and tiredness, and in mild cases people may get just a runny nose or a sore throat. In the most severe cases, people with the virus can develop difficulty breathing, and may ultimately experience organ failure. Recent insights have included additional symptoms to the lists namely loss of smell, stroke, and some patients reporting strange neurological issues that challenge our current understanding of the disease, and how to treat it. Some cases are fatal. Coronaviruses replicate their RNA genomes using enzymes called RNA-dependent RNA polymerases, which are prone to errors, but genomic analysis so far suggests that covid-19 is mutating slowly reducing the chance of it changing to become more deadly. There are currently no vaccines or specific drug treatments for coronaviruses, but efforts to develop a vaccine are underway. Other severe coronaviruses are the Middle East respiratory syndrome coronavirus (MERS-CoV) and severe acute respiratory syndrome coronavirus (SARS-CoV) – are known to cause severe symptoms.

Photo by New Scientist Journal 2020. An Illustration of COVID-19 Virus.



Due to COVID-19 pandemic threat and the absence of pharmacological treatment, non-pharmaceutical interventions are being deployed and implemented as part of suppression strategy. The last time the world responded to a global threat due to emerging pandemic of the scale of current COVID-19 with no access to vaccines and drugs was the 1918-19 H1N1 Influenza pandemic. While there is no agreed-upon standard on how to contain the spread of COVID-19, non-pharmaceutical interventions (NPIs) have focused on travel bans, contact tracing, case isolation, voluntary home quarantine, closure of schools, colleges and universities, and social distancing. Although, to some extend these measures have helped to control the spread of Coronavirus in some countries like South Korea, New Zealand and China, at the opposite extreme, many countries lack the testing and public health resources to mount similar responses which could result in unhindered spread and catastrophic outbreaks. The goal of non-pharmaceutical interventions is to slow the spread of infection and reduce the intensity of the pandemic ("flatten the curve"), thus reducing risk of overwhelming health care systems and buying time to develop treatments and vaccines. A potential case reduction strategy for COVID-19 is social distancing also known as physical distancing.

Overview of current Intervention Strategies during COVID-19 pandemic.

Globally, COVID-19 pandemic continues to cause substantial

morbidity, mortality, and a major strain on healthcare systems. As of 14June2020, there have been approximately 7,7 million reported cases and 430,173 deaths confirmed worldwide. Two fundamental strategies in managing viral infections are; Suppression and Mitigation. In suppression strategy, the aim is to reduce the reproduction number (the average number of secondary cases each case generates), R, to below 1 and hence to reduce case numbers to low levels or (as for SARS or Ebola) eliminate human-to-human transmission. The main challenge of this approach is that NPIs (and drugs, if available) need to be maintained – at least intermittently - for as long as the virus is circulating in the human population, or until a vaccine becomes available. In the case of COVID-19, it will be at least a 12-18 months before a vaccine is available. As of 3rd June 2020, five months after coronavirus pandemic began,10 candidate vaccines designed to prevent COVID-19 are already being tested in human population trials, and 114 are in pre-clinical phase/ early development. Furthermore, there is no guarantee that initial vaccines will have high efficacy. For Mitigation, the aim is to use NPIs (vaccines or drugs, if available) not to interrupt transmission completely, but to reduce the health impact of an epidemic, akin to the strategy adopted by some US cities in 1918, and by the world more generally in the 1957, 1968 and 2009 influenza pandemics. In the 2009 pandemic, for instance, early supplies of vaccine were targeted at individuals with pre-existing medical conditions which put them at risk of more severe disease. In this scenario, population immunity builds up through the epidemic, leading to an eventual rapid decline in case numbers and transmission dropping to low levels. Since the origin of quarantine in response to the 'Black plague' pandemic of 1347-1348, 1485 in Venice, Italy and the U.S experience in 1918-1919, epidemiological and modelling studies have proved the effectiveness of social distancing as a measure of reducing virus transmission.

Social Distancing

In response to COVID-19 pandemic, governments around the world are practicing the science of social distancing which is a is a central aspect of plans to limit the spread of the virus. What does social distancing mean and how do you do it?

Social distancing practices are the changes in behavior that can help to stop the spread of infectious diseases such as flu, Tuberculosis, MERS, SARS, and Ebola. The basic principle is to curtail social contact, work, social gathering, schooling, travel among seemingly healthy individuals, with a view to delay disease transmission and minimize the size of the outbreak.

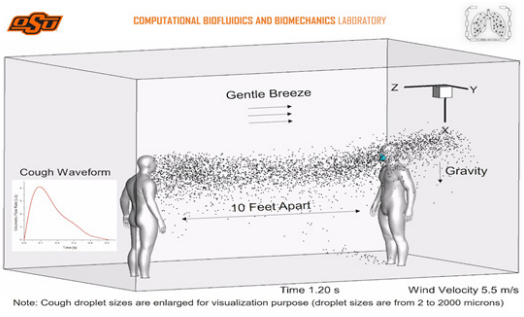


Figure 1. *Droplet visualization. Source; Getty images.*

The current practice at individual level includes avoiding public spaces and unnecessary social gatherings, working from home if possible, conducting virtual meetings, and avoiding unnecessary use of public transport. World Health Organization recommends maintaining a distance of at least one meter between yourself and anyone who is coughing or sneezing, avoiding physical contact with others in social situations, including hugs, handshakes and kisses. The goal is to "flatten the curve" to stay below a fixed health care demand and to delay the peak of the epidemic so that healthcare capacity can be expanded to support patients.

How Social Distancing works

Evidence from previous outbreaks, including the 1918-1919 Spanish flu pandemic and the 2014-2015 Ebola outbreaks, as well as disease outbreak simulations, shows that social distancing can effectively minimize the spread of infections. Since COVID-19 is a novel virus which we don't know exactly how it spreads, we assume it spreads in a similar manner predominantly through droplets emitted from the mouth and nose of infected person when they cough or sneeze, which can land on surfaces and people's hands.

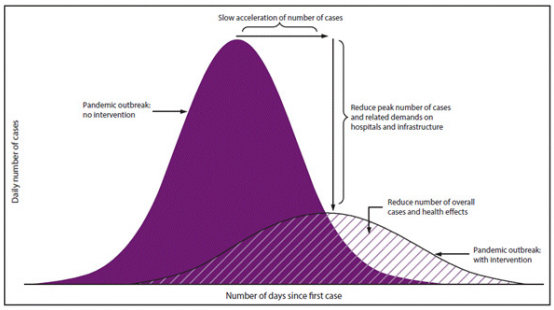


Figure 2. *Conceptual 'Flattening the curve' graph.*

'Flattening the curve' refers to community isolation measures that keep the daily number of disease cases at a manageable level for health care system.

The exact level of social distancing required to 'bend the curve' or to curb the SARS-CoV-2 pandemic in the context of seasonal variation in transmission remains elusive and unclear to public health experts. The historical observation that robust social distancing can lead to especially large resurgences is consistent with data from the 1918 influenza pandemic in the United States, in which the size of the autumn 1918 peak of infection was inversely associated with that of a subsequent winter peak after interventions were no longer in place. Whilst our understanding of infectious diseases and their prevention is now very different compared to in 1918, most of the countries across the world face the same challenge today with COVID-19, a virus with comparable lethality to H1N1 influenza. With majority of the world population confined to their homes to help curb the spread of SARS-CoV-2 (COVID-19), a fog lifting question on their minds is: "How long does social distancing need to last? Data science predictive analytics/modeling has proofed to be very effective in COVID-19 control. It has unpacked that one-time interventions will be insufficient to maintain the prevalence within critical care capacity in any part of the world,

developed or under developed. Seasonal variability in COVID-19 transmission will facilitate epidemic control during the summer months but could lead to an intense resurgence in the autumn. As per the influenza pandemic of 1918-1919, findings demonstrate a strong association between early, sustained, and layered application of NPI (Non pharmaceutical Interventions). Intermittent distancing measures can maintain control of the epidemic, but without other interventions, these measures may be necessary into 2021. In addition to social distancing, increasing critical care capacity could reduce the duration of the SARS-CoV-2 epidemic while ensuring that critically ill patients receive appropriate care. To keep critical care capacities from being overwhelmed, prolonged or intermittent social distancing may be considered necessary. However, the optimal timeline, duration, frequency, and intensity of social distancing remains unclear in the presence of seasonality. A case in point is China where early strategies to alleviate these challenges was to increase critical care capacity through rapid construction or repurposing of hospital facilities and consideration of increased manufacturing and distribution of ventilators and other PPE (Personal Protective Equipment). Increasing critical care capacity allows population/herd immunity to be accumulated more rapidly, reducing the overall duration of the epidemic and the total length of social distancing measures. While the frequency and duration of the social distancing measures is similar between the scenarios with current and expanded critical care capacity, the epidemic may circulate seasonally with winter peaks in subsequent years through 2021.

A call to Action

The goals of social distancing are to delay outbreak peak, decompress the peak burden on health care facilities, and to diminish overall cases and health impacts. To implement an effective intermittent social distancing model, it will be critical to expedite a widespread adaptive and intelligent surveillance to track when the incidence and prevalence thresholds that trigger the beginning or end of distancing have been crossed. In the absence of such surveillance, critical care infrastructure such as number of beds might be used as a proxy for prevalence, but this indicator is far from optimal since the lag between distancing and peak critical care demand could lead to frequent overrunning of critical care resources. Under some circumstances, intense social distancing may be able to reduce the prevalence of COVID-19 enough to warrant a shift in strategy to contact tracing and containment efforts, as has occurred in China, South Korea, and New Zealand. Within the realm of surveillance, still, countries that have achieved this level of control of the outbreak should prepare for the possibility of substantial resurgences of infection and a return to social distancing measures, especially if seasonal forcing contributes to a rise in transmissibility in the winter.

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