PERSPECTIVE

Public health measures to slow community spread of COVID-19

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COVID-19 was initially identified in an outbreak of viral pneumonia in Wuhan in December 2019, and has now been recognized in 77 countries with over 90,000 laboratory-confirmed cases and over 3,000 deaths as of 3 March 2020 [1]. The epidemiology of COVID-19 has recently become clearer as incident cases continue to rise and researchers refine estimates of the severity, transmissibility, and populations affected. Based on available data, COVID-19 is efficiently transmitted in the community, and the proportion of infections leading to severe illness is particularly high among adults ≥50 years of age and among individuals with comorbid health conditions. Although rare, severe cases have also been reported among younger individuals. Thus far, the estimated basic reproductive number (R_0) of COVID-19 is higher than that of influenza [2], as is the case fatality risk for adults and older individuals.

An estimated 80% of COVID-19 cases are mild [1]. This is not a glass half full statistic, as 20% of infections result in clinically severe cases that have the potential to overwhelm already overburdened health facilities. Given the lack of vaccines and effective antivirals, non-pharmaceutical interventions (NPIs) are the most effective available interventions for local and global control and mitigation of COVID-19. To date, measures aimed at slowing introduction of infection globally have included travel restrictions, isolation of confirmed cases, and quarantine of exposed persons. In the United States, NPIs have reduced the number of infected persons entering the country, but recent outbreaks in multiple US states make it clear that these measures have delayed but not prevented community transmission. In 2009, NPIs were able to delay large epidemic waves of pandemic influenza A(H1N1)pdm09 in some locations until after the summer, since influenza transmission tends to be reduced by higher temperatures and humidity. It is unclear whether COVID-19 transmission will be heavily affected by seasonal weather variation, given that transmission is now occurring in multiple tropical and sub-tropical locations.

Given many uncertainties regarding the potential for widespread community transmission of COVID-19, community mitigation measures to curb local transmission must be carefully considered and applied where possible. In the 1918/19 influenza pandemic, timely and sustained use of a broad set of NPIs including school closures, banning of mass gatherings, mandatory wearing of masks, isolation of ill persons, and appropriate disinfection/hygiene measures reduced mortality in a number of US cities [3]. These measures decreased transmission, spread the epidemic over a longer period of time, reduced the height of the epidemic peak, and reduced the overall number of infected persons and overall health impact. Here, we discuss NPIs that may be most effective given our current understanding of COVID-19 epidemiology (Table).

Personal protective measures and environmental measures

Personal protective measures such as hand hygiene and face mask use are included in public health guidelines for pandemic preparedness. Hand hygiene effectively reduces the transmission of respiratory infections through indirect contact in the community setting, and should be practiced by ill individuals, their contacts, and the larger population to limit the risk of transmission through fomites [4]. Most coronaviruses, including SARS-CoV-2, are inactivated by alcohol-based hand sanitizers and disinfectants such as bleach. Environmental disinfection with appropriate sanitizers is also recommended [4].

As hand hygiene does not affect direct transmission of COVID-19 by respiratory droplets or aerosols, face masks have been widely deployed by at-risk populations in China and some other locations in Asia, for example in Hong Kong and Taiwan. The efficacy of face masks among healthy individuals is unclear, but masks may protect others, particularly healthcare workers, from actively symptomatic individuals with COVID-19. The combination of masks and hand hygiene, however, has been shown to reduce transmission of respiratory viruses and serves to highlight that layering of NPIs is more effective at reducing disease transmission than any NPI alone [4]. Mask use could be recommended for ill persons, for uninfected persons who are caring for ill persons, and for those interacting in highly crowded settings where widespread community transmission is known to be occurring. If face masks are widely recommended, demand may quickly exhaust limited supplies that are most critical for reducing transmission in high-exposure settings such as hospitals and clinics. This balance requires careful attention. N95 masks should be preserved for medical personnel only.

Isolation of ill and quarantine of exposed persons

In some locations around the world, confirmed cases of COVID-19 are being medically isolated in hospitals, and their close contacts are being carefully traced and quarantined at home or in designated quarantine facilities. This requires excellent laboratory surveillance to pick up COVID-19 cases in the community, including cases with mild illness. To date (13 March), these containment measures appear to have been able to prevent sustained local transmission in Hong Kong, Singapore and Taiwan.

Medical isolation of cases has been feasible in outbreaks of SARS and MERS because infections are generally severe and of a limited number, but similar practices are less useful in influenza epidemics because of the huge number of cases and difficulties in identifying mild infections [5]. Quarantine of asymptomatic exposed persons has also been used to contain SARS and MERS outbreaks, but will not be feasible in designated quarantine facilities if there is widespread community transmission of COVID-19. Moreover, quarantine measures can be costly, challenging to enforce, and introduce location-specific ethical and legal challenges that may hamper control efforts. Perhaps the most important NPIs in this domain are strong, coordinated public health messaging to self-isolate when ill. Previous work has demonstrated that the speed with which infected populations are quarantined, through a combination of hospital-based isolation and self-quarantining, accelerates during epidemics of emerging disease like COVID-19 [6]. Public health messaging to leverage and augment this natural acceleration of isolation and quarantine practices may be critical in the context of widespread community transmission. Expanding access to surveillance and diagnostic testing is also critical to identify transmission clusters where isolation is most important.

Community mitigation measures

In most locations containment efforts are likely to be ineffective in preventing epidemics, and public health measures will be needed to mitigate the pandemic impact at a local level [7]. As local epidemics progress towards a peak in incidence there will be a surge in healthcare demand, and particularly the demand for intensive care, to a level that is likely to overwhelm the healthcare system. The aim of mitigation is to reduce this surge as much as possible. Community mitigation measures generally promote social distancing to reduce transmission, but can be extremely disruptive and have population-specific economic consequences [5]. Similar to influenza pandemics, mitigation measures that could be considered for COVID-19 include the temporary closure of schools and workplaces, cancellation of mass gatherings for a period of time to flatten the epidemic peak. Voluntary avoidance measures, where people choose to stay at home more often will also contribute to social distancing.

Careful consideration of the positive and negative effects of school closures in the US is critical, as prolonged closures disproportionately affect low income families and must include contingency plans for providing free meals and other programming to families that rely on school-based learning and economic support. Currently, it appears that children can be infected as easily as adults, but that the risk of severe disease is very low in this group. Given that children can be infected, it is reasonable to believe that they would also be contagious, although the importance of children in community transmission of COVID-19 has not yet been quantified. Closure of workplaces introduces similar ethical concerns, as low-income workers often have limited ability to work from home without loss of pay and other benefits. Careful evaluation should be given to the timing and duration of community mitigation measures to maximise the beneficial epidemiologic effects while minimising social and economic harm.

Conclusions

Given the evolving picture of the COVID-19 pandemic, the application of layered, multi-faceted, location- and population-specific NPIs will need to be considered and initiated quickly to curb widespread transmission. When NPIs are *reactive* to widespread transmission, instead of *proactive* to the potential for transmission, they often fail to reduce rates of illness. The types of proactive measures we describe here were successful in mitigating the 1918/19 influenza pandemic and may be just as valuable almost a century later.

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Declaration of Interests

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Table. Characteristics and transmission dynamics of COVID-19, SARS, MERS and influenza*

Characteristic	COVID-19 (SARS-CoV-2 infection)	SARS-CoV/MERS-CoV infection	Influenza virus infection (including seasonal epidemics and pandemics)
Clinical severity profile	Can cause severe disease, most infections mild	Causes almost exclusively severe disease	Can cause severe disease, most infections mild
Infection fatality risk[a]	Unclear but could be in the range 0.5% to 1%	10% to 30%	Seasonal: ≤0.1% 1918/19 pandemic: 2%
Incubation period	Mean 5-6 days, upper limit around 14 days	Mean 3-5 days, upper limit around 14 days	Mean 1 day, upper limit around 3 days
Basic reproductive number[b]	Thought to be around 1.5 to 3.0	SARS: 1.5 to 4 MERS: 0.5 to 1	Thought to be around 1.5 to 2.0
Modes of transmission	Not established but presumed to be mainly respiratory droplets and spread via fomites. Aerosols and fecal-oral might play some role.	Mainly respiratory droplets, some evidence of spread via fomites	Mainly respiratory droplets, may also spread through aerosols and fomites
Infectiousness profile	Most infectious around the time of illness onset, infectiousness may start slightly before illness onset	Most infectious 7-10 days after illness onset	Most infectious around the time of illness onset

Location of person-to-person transmission	Mainly community, can also spread in hospitals	Mainly spreads in hospitals	Mainly community, can also spread in hospitals
Importance of children in transmission dynamics	Unclear. Children can become infected but have mild symptoms.	Not important	Very important
Possible to contain an outbreak and avoid widespread transmission?	Unlikely[c]	Yes with careful isolation of cases, quarantine of their contacts, and appropriate hospital infection control	Not possible

[a] The proportion of infections that will ultimately be fatal (note, this is likely to vary by age)

[b] The expected number of additional cases that one case will generate, on average, over the course of its infectious period in an otherwise uninfected population (note that this can vary by location for a variety of reasons).

[c] As of writing in early March 2020 it appears that China has contained its first wave of infections, but only by using very extreme measures including mass isolation/quarantine outside the home and monitoring of social distancing based on cellphone and strict enforcement by local officials.

*SARS- Severe Acute Respiratory Syndrome, MERS- Middle East Respiratory Syndrome