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Pre-emptive low cost social distancing and enhanced hygiene implemented before local COVID-19 transmission could decrease the number and severity of cases.

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Summary

China appears to have constrained transmission of COVID-19 outside of Hubei Provence through rapid and intensive containment and mitigation interventions. Most countries only attempt social distancing and hygiene interventions when widespread transmission is apparent. This gives the virus many weeks to spread with a higher basic reproduction number (R0) than if they were in place before transmission was detected or widespread. Pre-emptive, low cost, hygiene enhancement and social distancing in the context of imminent community transmission of novel coronavirus COVID-19 should be considered. Early interventions to reduce the average frequency and intensity of exposure to the virus might reduce infection risk, reduce the average viral infectious dose of those exposed, and result in less severe cases who are less infectious. A pre-emptive phase would also assist government, workplaces, schools, and businesses to prepare for a more stringent *phase. Countries, and subregions of countries, without recognised COVID-19 transmission should assume it is present and consider implementation of low cost enhanced hygiene and social distancing measures*.

Rationale for Pre-emptive Interventions

It is estimated that approximately two thirds of COVID-19 cases exported from China from 1st to 13th of January have gone undetected globally.[1] Most of these exported cases will be mild and may only be detected after several hundred cases have accumulated and severe or fatal cases are recognised 5 to 8 weeks later, as has likely occurred in the recent COVID-19 outbreaks in Iran, South Korea, Italy, and Seattle in the USA.[2]

The spread of novel coronavirus COVID-19 transmission globally has been very rapid. The basic reproduction number is estimated at between 2 to 3.[3,4] The mode of transmission is thought to be droplet and contact infection, although opportunistic or close range airborne infection may be involved.[4]

The transmission dynamics of the early cases of COVID-19 were significantly different to those during the SARS epidemic. In particular the proportion of cases from healthcare settings was low and the proportion with no known risk exposures was high.[4] Another significant factor is that viral loads in nasopharyngeal and respiratory secretions are highest soon after symptom onset in COVID-19 cases[5] compared to a peak of around 10 days in SARS cases,[6] making transmission before entering health care facilities more likely.

Even though the understanding of transmission dynamics is at an early stage, they do suggest that the step-wise introduction of stringent measures will be necessary to control this epidemic and highlights the importance of early community control.

Quarantine, city “lockdowns”, complete childcare, school, university and work closures, and cancellation of mass gatherings/events have significant social and economic impact and are unlikely to be implemented until significant transmission is confirmed – when it may be less effective. However, there are a range of lower level, potentially cost neutral, pre-emptive interventions that could be considered when transmission is only suspected or anticipated. Here we explore whether low cost pre-emptive enhanced hygiene and social distancing should be implemented prior to confirmation of community transmission in countries without, or with minimal, confirmed person-to-person transmission of COVID-19.

The purpose of pre-emptive interventions is to slow the transmission of disease and limit the impact on health services, particularly hospitals and intensive care units, to ensure access to high level care when needed.

The concept of pre-emptive deployment is based upon the following assumptions which require further exploration and are elaborated upon below:

1. Community wide COVID-19 transmission may be occurring undetected or may only be recognised after containment is no longer feasible.
2. Interventions implemented after community wide transmission is detected will be less effective.
3. Reducing the force of infection, particularly early, will delay the epidemic peak, blunt the epidemic peak, spread cases over a longer time, and help to limit the potential for critical care services to be overwhelmed, which may be lifesaving.[7,8]
4. Enhanced hygiene and social distancing interventions should:
    a. Decrease the total number of cases per week but extend duration of the epidemic
    b. Decrease the severity of cases through reducing viral inocula.

Figure 1 below illustrates the concept of limiting the peak in cases so that health services are less likely to be overwhelmed (red dashed line) and there is less unmet health service need. Unmet need may include inability to admit patients to a hospital or to provide hospitalised patients in critical condition access to intensive care. Interventions to reduce infection lead to longer, but less peaked, epidemics. A slower evolution in the epidemic also allows time for health care staff to provide better care, for recovery of infected health care workers, for learning and adapting to the evolving situation by administrators, and for vaccines and treatments to be developed. Although we have not validated this principle for COVID-19 epidemics it is sufficiently validated in simulations for influenza that it would appear a reasonable assumption in response to this emergent disease.[9]

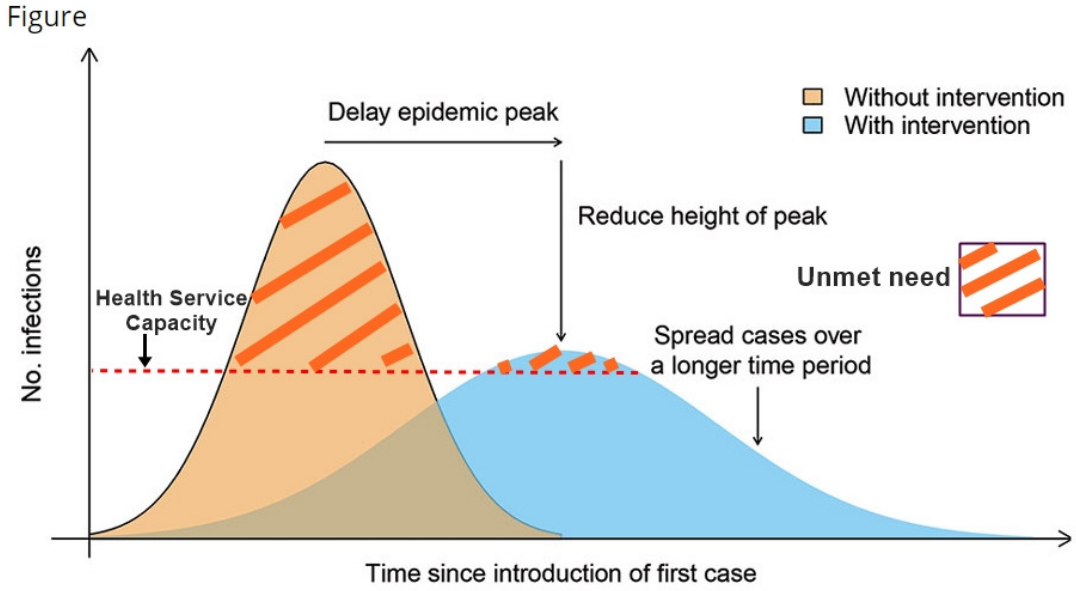

Figure 1: Intended impact of enhanced hygiene and social distancing measures on the COVID-19 pandemic adapted from Fong.[8]

Enhanced hygiene and social distancing measures may reduce both numbers of cases and severity of cases through several mechanisms.

We suggest that a pre-emptive implementation of low cost interventions prior to detection, but in imminent expectation of community transmission should be considered because it may decrease both the total numbers of cases and severity of cases. This principle applies equally well to subregions of countries that have not as yet detected community transmission events.

The basic reproductive number (R0) is the average number of secondary cases of an infectious disease that arise from cases in a totally susceptible population, and reflects the epidemic potential of a pathogen.[10] R0 is a function of the number of contacts an infectious person has, the risk of transmission per contact, and the duration of infectiousness.

Social distancing mostly acts on the first factor, by reducing the number of contacts each person makes. Hygiene measures mostly act on the second factor, as they reduce the risk of transmission if a contact occurs. There are epidemiological observations from the outbreak in China that might indicate the effectiveness of pre-emptive implementation of the measures in the community. The WHO-China Joint Mission on COVID-19 determined that widespread community transmission and outbreaks occurred in Wuhan prior to the implementation of comprehensive control measures.[4] However in other parts of China, community transmission has been limited and most transmission has occurred in families. For example, among 344 clusters involving 1308 cases (out of a total 1836 cases reported) in Guangdong Province and Sichuan Province, 78%-85% have occurred in families.[4] This is likely due to the intense quarantine and social distancing measures implemented in areas outside Hubei prior to the establishment of widespread community transmission.

Community wide interventions may decrease the average viral exposure dose encountered in the community. People exposed to a higher viral dose (inoculum) are more likely to become infected and suffer more severe disease. Animal models for other coronavirus infections demonstrate that increased viral inocula lead to more severe disease and higher viral loads in the lungs and other organs/fluids.[11] The Amoy Gardens SARS outbreak in 2003 provided evidence that cases with presumed higher exposure to the index case had higher nasopharyngeal viral loads and more severe illness.[12] Modelling of the 2009 influenza pandemic also supported a hypothesis that severe illness was due to a higher infectious dose of the virus mediated by the number of simultaneous infectious contacts.[13] Viral loads in severe MERS cases were higher than those in a mild group and the patients in the severe group had more prolonged viral shedding in respiratory secretions, beyond 21 days after the onset of symptoms, whereas viral RNA was no longer detected by 21 days in the mild group.[14]

Therefore, it is proposed that early measures that lower the number of contacts, the likelihood of transmission, and average viral infective dose in an area of new transmission could have a multiplier effect leading to less cases, and less severe cases who are less infectious. This early reduction of the R0 would result in fewer cases overall and have a significant negative multiplier effect on the overall impact of the epidemic, including the number of deaths (Figure 2). The higher case fatality rate in Wuhan, compared with other provinces in China may partially relate to health-care resource availability and shortages in the face of overwhelming community transmission, as well as greater severity of disease due to higher infection doses.[7,12] These interventions will be particularly important for people over 60 years of age and those with underlying medical conditions.

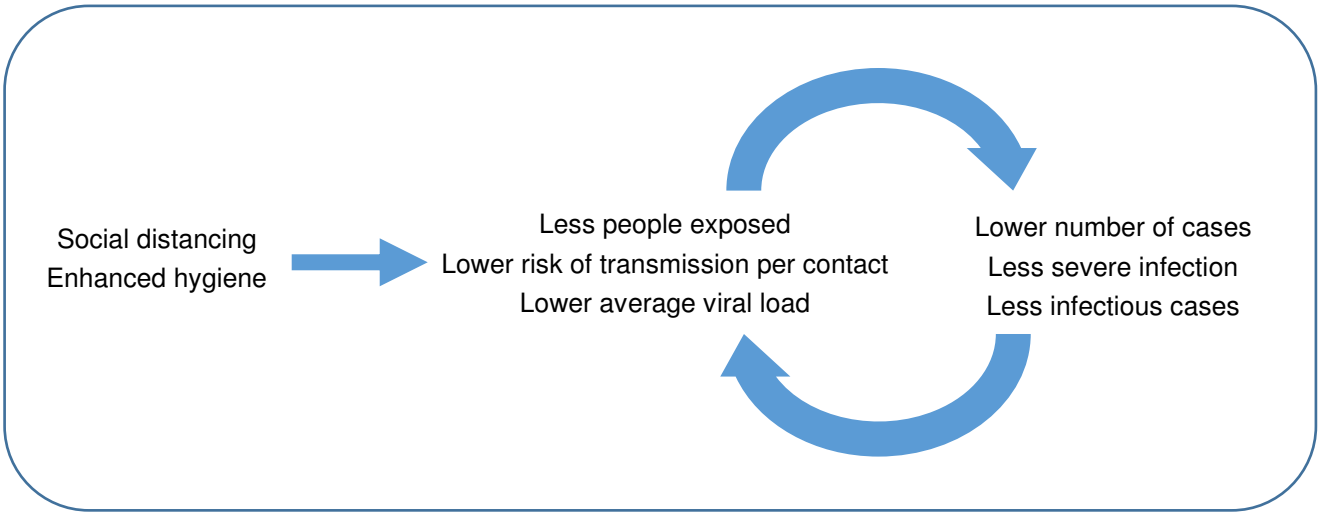

Figure 2: Conceptual model of how pre-emptive interventions with a negative multiplier effect could impact an impending epidemic

Low cost Hygiene and Social Distancing Interventions

Box 1. Workplace Interventions

- No handshaking policy
- Promote cough and sneeze etiquette (but focus is on excluding ill staff)
- Videoconferencing as default for meetings
- Defer large meetings
- Enforced sanitisation of hands at entrance
- Regular hand sanitation schedule reminders via email
- Lunch at desk rather than in lunch room
- Gamifying hygiene rules e.g. to discourage touching face
- Ill* people stay at home and ill workers immediately isolated
- Hold necessary meetings outside in open air if possible
- Staff with ill household contacts should stay at home**
- Disinfect high touch surfaces regularly and between users
- Work from home where possible and consider staggering of staff where there is no loss of productivity from remote work
- Consider opening windows and adjusting air conditioning***
- Limit food handling and sharing of food in the workplace
- Assess staff business travel risks****
- Enhance hygiene and screening for illness among food preparation (canteen) staff and their close contacts.
- Analyse the root cause of crowding events on site and prevent through rescheduling, staggering, cancelling.

Box 1. Notes: *"Ill" person refers to someone with an undiagnosed respiratory illness or fever, who is not yet under investigation for COVID-19 but nevertheless could be an unrecognised case. ** This could be costly unless used judiciously while awaiting exclusion of COVID-19 in the case and should be introduced based on likelihood of local transmission. *** Evidence that low temperature and low humidity in air conditioned environments may

enhance the survival of coronaviruses such as SARS.[15] **** Sites such as the CDC travel risk assessment site may be useful https://www.cdc.gov/coronavirus/2019-ncov/travelers/index.html

Box 2. School Interventions

- Supervised sanitisation of hands at entrance and at regular intervals
- Defer activities that lead to mixing between classes and years.
- Promote cough and sneeze etiquette (but focus on excluding ill persons)
- Strict stay at home policy if ill
- Gamifying hygiene rules e.g. to discourage touching face
- Regular handwashing schedule
- Disinfect high touch surfaces regularly and between users
- Outdoor lessons where possible
- Consider opening windows and adjusting conditioning
- Enhance hygiene and screening for illness among food preparation (canteen) staff and their close contacts
- Review after-school care arrangements that lead to mixing of children from multiple classes and ages

Box 3. Household-based Interventions

All Households

- Enhanced hand sanitisation
- Gamifying hygiene rules e.g. to discourage touching face
- Disinfect high touch surfaces regularly
- "Welcome if you are well" signs on front door.
- Increase ventilation rates in the home by opening windows or adjusting air conditioning
- Promote cough and sneeze etiquette

Households with ill members (in addition to measures above)

- Ill household members are given own room if possible and only one person cares for them
- The door to the ill persons room is kept closed*
- Wearing simple surgical/dust masks by both infected persons and other family members caring for the case.
- Consider extra protection or alternative accommodation for household members over 65 years or with underlying illness.

* Reference Wein.[16]

Box 4. Commercial/entertainment/transport setting Interventions

- Sanitisation of hands at building entrance encouraged
- Tap and pay preferred to limit handling of money.
- Disinfect high touch surfaces regularly
- Avoiding crowding through booking and scheduling, online pre-purchasing, limiting attendance numbers.
- Enhance hygiene and screening for illness among food preparation staff and their close contacts.
- Enhance airflow and adjust air conditioning
- Public transport workers/taxi/ride share – vehicle windows opened where possible, increased air flow, high-touch surfaces disinfected.

Organisational capacity benefits

A pre-emptive phase would assist organisations to build capacity for future implementation of more stringent social distancing interventions including allocating responsibilities, consulting with staff and adapting protocols and practicing implementation. WHO is supportive of pre-emptive interventions to prevent COVID-19 in work places.[17]

The Costs of Pre-emptive intervention

The suite of low cost pre-emptive interventions, other than a working from home policy, is unlikely to affect work productivity and may provide the community with some re-assurance that all is being done to prevent the epidemic. Some may see it as an over-reach but thus far communities seem to accept or voluntarily adopt low cost interventions and acceptance may be enhanced through consultation and trust building.[18,19]

Influenza co-benefits

For regions approaching their influenza season, optimal prevention and control of seasonal influenza, such as vaccination, in the face of potential COVID-19 co-circulation is also crucial, to minimise the double burden on health services. The measures discussed here (enhanced hygiene and social distancing) are also effective against influenza, resulting in potential co-benefits for both pathogens.

Limitations

Most of the research on mitigation is based on influenza control and it is clear that SARS-CoV-2 transmission dynamics will be different, however, droplet, contact and airborne precautions and the interventions deployed in China align with recommended influenza transmission controls. The assumptions should be modelled to better understand the costs and benefits. The use of masks outside of health settings is controversial and it is important that masks not be diverted from health care supplies. However, surgical masks are protective of large droplet spread and have approximately half the effectiveness of N95 mask for small droplet transmission, and are suggested to be cost saving in some modelled pandemic influenza scenarios.[20] They may have a limited role in the community setting prior to widespread transmission if there are adequate supplies and should be considered for use in households caring for COVID-19 cases at home.[16]

Conclusion

Given the ongoing global dissemination of COVID-19, as of early March 2020, it would be sensible for most countries and regions to assume they have had an importation of at least one case of COVID-19 and that the disease is spreading locally whether recognised or not. We believe these practices should be implemented in all countries as soon as possible.

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