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Efficiency of preventive and control measures of COVID-19

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Abstract

Background and objective: *COVID-19 emerged in Wuhan, China in December 2019. The situation with this virus is evolving rapidly, and to date there are no clinically approved antiviral drugs or vaccine for this infection. So, this paper aims to provide the efficiency of the available non-pharmaceutical interventions for COVID-19 to maximize health gain under budget constraints with feasible measures.*

Methodology: *publicly available information on COVID-19 and similar infection epidemics, such as SARS, MERS and Influenza was reviewed to identify the contents related to the efficiency of preventive and control measures of COVID-19. The period of the study was from February to July 2020, Sciencedirect database was searched using the keywords "novel coronavirus", "2019 novel coronavirus", "2019-nCoV" or "COVID-19".*

Results: *Single non-pharmaceutical public health measures need some improvements to be more efficient and to be used in balance with other public health measures to limit the impact of the epidemic efficiently. Development of novel diagnostic assays and defining the animal source may ensure high efficiency rates. But these are not enough to find vaccine or antiviral drugs. "One Health" teams and international cooperation may improve the general efficiency of public health measures.*

Conclusion: *for efficiency of COVID-19 preventive and control measures, Single non-pharmaceutical public health measures should be improved and used in balance. Vaccine and antiviral drugs should be prepared. "One Health" teams and global collaborations should be applied.*

Keywords: Efficiency; COVID-19; Preventive and control measures; Epidemic; Community.

INTRODUCTION

Since the emergence of COVID-19 in December 2019 in China, the situation with this disease is evolving. Covid-19 infection reached over 1 million and deaths over 50 thousand at the time of writing on April 2, 2020. Now the epidemic in almost all countries has become pandemic as declared by WHO on March 11, 2020. This infection also caused a high economic impact.

The coronaviruses belong to the family coronaviridae, subfamily Coronavirinae and genera betacoronavirus. Coronaviruses were so named because of the unusually large club-shaped peplomers projecting from the envelope, which give the appearance of a solar corona. The virion is spherical and can range in size from 60 to 220 nm. It has a tubular nucleocapsid which composed of two proteins, N & M and a very large heavily glycosylated envelope glycoprotein S. The genome consists of a single linear molecule of ssRNA of positive polarity, about 30kb in size, which is 5` capped and 3` polyadenylated and is infectious. The family coronaviridae includes over a dozen major host-specific pathogens of mammals and birds (Ow and Frank 1994, 451-452). Although most human coronavirus infections are mild, the epidemics of the two betacoronaviruses, severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), have caused more than 10000 cumulative cases in the past two decades, with mortality rates of 10% for SARS-CoV and 37% for MERS-CoV (Huang et al 2020, 497). In December 2019, a novel coronavirus (2019-nCoV) was first isolated from three patients with pneumonia, connected to the cluster of acute respiratory illness cases from Wuhan, China, and genetically closely related to SARS-CoV, which spread in China in 2003 (ECDC 2020).

Epidemiologically, 2019-nCoV is highly infectious, with generally incubation period after infection of 4-8 days. All age groups are susceptible to the virus, of which elderly patients with comorbidities are more likely to experience severe illness (Han et al 2020). The people who are asymptomatic and in the incubation period may be source of infection, which is of critical significance to the

epidemic prevention and control, respiratory droplets (aerosols) are the major route of transmission by contact over short distance (1.5 m) and through fomites contaminated by said aerosols (Trilla 2020, 154-175). The host factor is not fully understood (Trilla 2020, 154-175; Khan et al 2020).

Common symptoms at onset of illness are fever, dry cough and myalgia or fatigue (Han et al 2020; Huang et al 2020, 500). Less common symptoms are sputum production, headache, haemoptysis, and diarrhoea. Some laboratory tests could provide some hints about the early forms of the disease, such as lymphopenia. Complications included acute respiratory distress syndrome, RNAaemia, acute cardiac injury and secondary infection. Patients develop acute respiratory distress syndrome, have a high likelihood of admission to intensive care, and might die (Huang et al 2020, 500). The diagnosis is based on the epidemiological risks, clinical features and laboratory tests. Although several therapeutic options have been experimented in 2019-nCoV infected patients, there are still no specific therapies (Han et al 2020). Also there is currently no vaccine to protect against COVID-19. The best way to prevent infection is to take everyday preventive actions, like avoiding close contact with people who are sick and washing hands often (CDC 2020).

Historically, believed that public health interventions delay international spread of pandemics, but do not stop them; delaying disease spread can flatten the epidemiological peak, thus distributing cases over a longer period of time. Having fewer people ill at a given time increases the likelihood that medical and other essential services can be maintained and reduces patient surge capacity needs, as interventions are instituted, some cases of illness will be delayed and others are prevented (Clements and Casani 2016, 397-405). However, preventing the transmission of infectious diseases is a core goal of contemporary public health and infection prevention and control (Barratt et al 2019, 170). The use of traditional non-medical public health measures to contain an infectious disease outbreak; those decreasing contact between infectious and susceptible people, such as travel restriction, quarantine and increased social distance, and those decreasing effective contact, like washing hands and wearing masks. The likelihood of these measures working depends on the characteristics of the disease and the affected population. This includes the mode of transmission, incubation period, degree of

infectiousness, age group most affected and contact behavior of the population (Smith 2006, 3115–3116).

COVID-19 is an emergency public health problem of international concern posing a high risk to countries with vulnerable health systems, as declared by WHO On 30th January 2020, and stated that the ability to control local transmission depends on the application of the principles of rapid identification, prevention, and control, followed by patient isolation, rapid diagnosis, and contact tracing (Purcell and Charles 2020, 111; Sohrabi et al 2020, 71). Strategic objectives of WHO include means of ascertaining clinical severity and the extent of transmission, and optimizing treatment options. A key goal is to minimize the economic impact of the virus and counter misinformation on a global scale. In light of this, various bodies have committed to making articles pertaining to COVID-19 immediately available via open access to support a unified global response (Sohrabi et al 2020, 71). So this study aims to provide the efficiency of the available preventive and control measures for limiting the epidemic, then increase their efficiency, or find alternatives and assist health authorities and people strengthen their capacity to respond to this health disaster and remain prepared for future pandemics by helping them prioritize the selection of interventions that maximize health gain under budget constraints with feasible measures.

Methodology

The study was a review of publicly available information and studies on the interventions for the outbreak of the disease in December 2019 and previous studies on similar infection epidemics, such as SARS, MERS and Influenza. The study period was from March to July, Sciencedirect database was searched for articles published in English-language, using the keywords “novel coronavirus”, “2019 novel coronavirus”, “2019-nCoV” or “COVID-19”, and taken search results that were deemed important. About 120 number of literature from these search results, and some text books, articles and WHO reports were reviewed. The results of the search were first screened by title and abstract, and then the full texts of relevant articles were examined. References were selected critically by identifying the contents related to the efficiency of preventive and control measures

of COVID-19. Then, the efficiency was analyzed by efficacy, saving cost and the feasibility of the measures. Efficacy was the main parameter that judges the efficiency. There may be limited information about the efficiency of COVID-19 outbreak preventive and control measures; given this limitation, the study was done based on the information became available. Ethical approval or individual consent was not applicable, as this is a review and discussion paper.

RESULTS

Public health measures need to be used in balance to limit the impact of the epidemic efficiently. For single measures, travel control is more efficient than travel restriction, as travel ban and restriction may impose a significant economic burden above the direct costs of the infectious outbreak. In travel control, travelers must be educated and encouraged to adopt preventive and control measures when traveling, with governments' suspension of travel when there is a high peak of epidemic. Screening passengers may be more efficient in the early stage of outbreak at which no more cases in a specific country, exit screening is slightly more efficient, and the influenza vaccine may save some costs for entry screening. Repeating and using different samples for RT-qPCR and combining with Computed Tomography scans in the diagnosis of suspected individuals may enhance the efficiency of the diagnosis measure. Deployment of drugs and deployment, training and control of health workers would be efficient. Quarantine needs to be fully implemented; otherwise it will be less effecient, but this may cost much amount that some low economic countries cannot afford. Also social distancing may cost invisibly by opportunity cost. Using social distancing measures judiciously without delay may be efficient, and other restrictive measures such as isolation and quarantine would boost its efficiency. Well compliance of some lifestyle and behavioral changes would be efficient, and people must be educated to help them comply. Hand hygiene would be the most efficient when used correctly, through systemic strategies, including access to the appropriate supplies and community education. Wearing gloves may improve hand wash practices. Wearing medical masks by healthy people in the community setting is not efficient, but using it by symptomatic patients and their contacts or healthcare workers may be efficient, cloth masks are less efficient

for them, and healthcare workers must use respirators instead of medical masks in case of aerosol generating procedures. Healthy people must use non-medical masks for potential source control in areas with known or suspected widespread transmission or no capacity to implement other containment measures, but vulnerable populations must use medical masks to protect themselves. Dissemination of timely and clear health information through various channels may show efficiency. Vector control is less efficient unless we identify the host and intermediate host. "One Health" teams and international cooperation may improve the general efficiency of public health measures.

DISCUSSION

There are a variety of community measures that can be taken during a pandemic to reduce the risk of exposure and subsequent results, but a balance is needed when taking interventions, because no intervention is without some economic or social cost (Clements and Casani 2016, 405). Some studies found that only public health interventions blocking over 60% of transmission would be really effective in controlling and containing the coronavirus outbreak (Tang et al 2020, 253).

There is strong evidence of the inefficiency of travel restriction (Heymann et al 2015; Findlater and Bogoch 2018; Gilbert et al 2020, 395: 875), but travel control has probably declined in Wuhan during late January, 2020, coinciding with the introduction of travel control measures, as more cases arrive in international locations with similar transmission potential to Wuhan before these control measures (Kucharski et al 2020; Pan et al 2020, 86-91). The revised International Health Regulations (IHR) recommends travel and trade restrictions only when these are deemed necessary, as people have demand for risk experience like their demand for preventive care (Pan et al 2020, 86-91). So travel control is more efficient than travel restriction. One of the ways of travel control is that travelers must leave travel unless is necessary and adopt other preventive and control measures when it is necessary, and must have a valid certificate of Influenza virus vaccination to rule out differential diagnosis and seek immediate care if symptoms appear (SLAMVI 2020; FIP Health Advisory 2020). Governments must also encourage

travelers for that and suspend migration at times of high peek of epidemic (Heymann et al 2015).

One of the alternatives for traffic restriction may be screening passengers for early detection of symptomatic patients to prevent exportation of the disease, but it does not detect asymptomatic patients, so its effectiveness is limited (ECDC 2020; Findlater and Bogoch 2018). Screening at entry points is costly and has a low yield, so it is not efficient. Screening at exit points is slighter efficient, as the costs of traveling will not spend. Also, Influenza vaccine will save some costs, as some costs like diagnostic and quarantine costs will be saved and lower discourage of travel for those unwilling to risk travel for the chance of being quarantined. By analogy with SARS, one may argue that entry screening is justified in light of the major economic, social and international impact that even a single imported SARS case may have. However, new imported SARS cases need not lead to major outbreaks if systems are in place to identify and isolate them efficiently. Rather than investing in airport screening measures to detect rare infectious diseases (Wilder-Smith 2006, 56; Wilder-Smith 2016). So screening may be efficient in the early stage of the outbreak and no more cases in a specific country. But during the outbreak, investing in other measures, such as monitoring and isolation is more important.

Diagnosis of suspected travelers is more effective than travel restriction (Heymann et al 2015); generally early identification followed by other control measures is the gold standard for the struggling with COVID-19 (Hemida and Ba Abduallah 2019). But the most common for the diagnosis of COVID-19 is RT-qPCR method, and the false-negative result of this method is very high (Bai et al 2020; Li et al 2020), it might be better to make a diagnosis combining the Computed Tomography scans and the nucleic acid detection together (Xie et al 2020). A study suggests that both nasopharyngeal and oropharyngeal swabs test of SARS-CoV-2 RNA should be performed to reduce the false negative rate. More tests, more specimens, and more methods could be considered (Chen et al 2020). Thus, repeating, using different samples, and combining with Computed Tomography scans might be better to reduce false negatives, but will also remain less efficient for the same reason, until accurate, rapid and cheap tests are obtained.

Treatment of confirmed patients is secondary to the need to control of the disease; nevertheless, patient care can change the evolution of an epidemic (Burdet et al 2017), prompt treatments in appropriate health facilities with highly trained professionals may relieve patients as well as prevent transmission to healthy people effectively (SLAMVI 2020, 508). Patients with mild symptoms may be given care in the home as hospitals may be full, in isolation to reduce the risk of further transmission (Yang et al 2020). Unfortunately, the absence of specific treatment makes the condition very saddening; instead there are some helpful medicines with the need for close monitoring. Therefore, deployment of drugs and deploying, training and controlling health workers would be efficient, as it may save time for treatment and increase the effectiveness of treatment procedures. But more research should be done to produce medicines or develop vaccines.

Quarantine of the exposed persons to monitor their symptoms and ensure early detection of cases proved very effective in stopping or reducing the entry of pandemics into a country (Ow and Frank 1994, 303; Lombardi A et al; and Khan et al). However, quarantine needs to be fully implemented; otherwise it will be less effective. A study has estimated that only a quarantine rate of infectious population higher than 90% would enable the effective control of corona virus outbreaks (Tang et al 2020, 253), and this may cost much amount, which some low economic countries cannot afford (Khan et al 2020). Although quarantine has a higher cost, the outcome is very high if implemented properly and this can make it efficient. With the onset of air travel and the consequent arrival of passengers before the end of the incubation period, quarantine became much less effecient, because the differentiation between those exposed and not exposed is difficult.

Another type of quarantine is quarantine of persons with no known exposure or making them avoid all places that make them in contact with other persons such as public gathering places, and stay at home as far as possible, or in other term social distancing. Social distancing is effective in mitigating disease epidemics (Heymann et al 2020), but usually multiple policies, including more restrictive measures such as isolation and quarantine—are implemented in combination to boost effectiveness (Heymann et al 2020). The level of development in e-commerce can fully overcome logistical obstacles (Pan et al 2020, 89). Economic protection measures and social

consequences need to be considered. Social distancing interventions may be important to public health, but must be used judiciously. On the other hand, if interventions are established too late, they may be ineffective. Social distancing may cost invisibly by the opportunity cost that some economic countries cannot afford (Clements and Casani 2016, 405); instead low economic countries can use strict policies for travel controlling and monitoring and isolation of the individuals (Khan et al 2020). Therefore, using social distancing measures judiciously without delay may be efficient, and other restrictive measures such as isolation and quarantine would boost its efficiency. But it may be inefficient for low-economic countries, instead they can use strict policies for travel control and monitoring and isolation of individuals.

A change in lifestyle to reduce the incidence and prevalence of the infection, like not sharing clothes, sittings or eating dishes, and cleaning dishes with soap or detergent after eating, and covering the mouth and nose during coughing or sneezing using medical masks, cloth masks, tissues or a flexed elbow, followed by hand hygiene should be practiced by all, especially ill persons, at all time (FIP Health Advisory 2020). Lifestyle change may be difficult to comply, such as not to handshake (Ow and Frank 1994, 303; Yang et al 2020); but health education may help compliance (Smith 2006, 3116). Also lifestyle or behavioral change not costly, unfortunately some alternatives of these behaviours for contact and droplet precautions have still some risks like elbow using instead of hand shake. However, maintaining a distance between people whenever is possible would be more efficient for this measure than other life style change practices if well complied.

Hand hygiene with alcohol-based handrup is globally recommended as one of the most effective and low-cost procedures against SARS-CoV-2 cross contamination. Good hand hygiene programs are dependent on systemic strategies, including access to supplies and education of people (Peteres et al 2020). It should be performed by applying the correct technique recommended by the WHO and using either soap and running water or an alcohol-based hand sanitizer (FIP Health Advisory 2020). Hand hygiene does not cost much. Thus, hand hygiene would be the most efficient single measure when used correctly. Wearing gloves may improve hand

wash practices by reducing the touching of transmission route parts of the body, thus the hand wash frequency.

Wearing a medical mask is one of the prevention measures to limit the spread of certain respiratory diseases, including SARS-CoV-2 from an infected person to someone else and potential contamination of the environment by droplets. Wearing medical masks by healthy people who are not in contact with symptomatic patients to protect them from droplet particles is not required, as no evidence for disease transmission from healthy people, it may take masks away from symptomatic patient contacts and healthcare workers in short supply times, may cause unnecessary cost and a false sense of security. However, minimizing the transmission of respiratory disease through protective mask use leads to better outcomes for healthcare workers, caregivers or those sharing living space with persons suspected of COVID-19. Cotton cloth masks are not considered appropriate for healthcare workers (WHO 2020), and respirator masks are specifically required for aerosol generating procedures (WHO 2020). The potential advantages of using masks by healthy people in the general public include: reduced potential exposure risk from asymptomatic persons, so healthy people should use non-medical masks in areas with known or suspected widespread transmission or no capacity to implement other containment measures for potential source control. This will reduce stigmatization, remind people to be compliant with other measures and encourage availability of masks and create a source of income for manufacturers. Vulnerable populations must use medical masks for protection (WHO 2020). In these sentences, we can say that medical mask use is not efficient for healthy people in community settings; instead non-medical masks may be efficient for them. However, if medical masks are used by patient contacts combined with other measures in a perfect way, the result will be better. For example, if they are used with adequate hand washing, it helps to keep hands away from mouth and nose until washing hands. But using it incorrectly when wearing, removing and disposing hampers its effectiveness. Specifically respirator masks may give good efficiency result for healthcare workers in aerosol generating procedures. Anyways, using medical masks is simple and cheap and their use by symptomatic patients and their contacts or healthcare workers may be efficient in preventing the spread of COVID-19.

Health education motivates people to protect themselves from infections as well as to protect others if they themselves are infectious (Barratt et al 2019, 173). Health education needs a lot of work to empower people to adopt preventive behavior and improve their understanding of the infection and how to prevent and control its spread (Barratt et al 2019). Studies have shown that dissemination of timely and clear health information through various channels has worked well in in some epidemics (Yang et al 2020). Without health education, almost preventive measures will be meaningless, dissemination of timely and clear health information through various channels, such as using media technologies, like social media, may show efficiency as people have part of social responsibilities.

Vector Control: is not very useful to prevent this epidemic effectively, as there is no any valid information about primary and intermediate hosts, although some studies have tried to give information without any reliable evidence (Khan et al 2020; Trilla 2020, 175). Thus, disease control with this measure would be difficult, and extensive research is needed to be done to identify the vector in order to prevent the disease from the source with greater efficiency (Zhang et al 2020). However, most patients worked at or lived around the local Huanan seafood wholesale market, where live animals were also on sale (Chen et al 2020, 507–13). Therefore, now all possible preventive measures should be taken when dealing with animals and their products. WHO's standard recommendations for the general public to reduce exposure to and transmission of COVID-19 and other respiratory illnesses include: when visiting live markets in areas currently experiencing cases of novel coronavirus, direct unprotected contact with live animals and surfaces in contact with animals and the consumption of raw or undercooked animal products should be avoided. Raw meat, milk or animal organs should be handled with care, to avoid cross-contamination with uncooked foods, as per good food safety practices (FIP Health Advisory 2020).

Lastly, Chinese doctors have efficiently controlled the outbreak of COVID-19 in China, and limited the mortality rate to less than 3% only (Anderson and Gray 2014). So other countries must learn from them and ask them help, and countries must apply "One Health" teams and international cooperation for the prevention and control of COVID-19. "One Health" is an approach that can improve the effectiveness of public health response and interventions, which offers

unique diversity in expertise (Kucharski et al 2020), and international cooperation is a key element in preventing, detecting, and extinguishing epidemics early (Heymann et al 2020).

CONCLUSION

No single measure can show effeciency alone, but incorporation of all preventive and control measures in a balanced way can effeciently limit the epidemic with lower expense. Early recognition of the problem, early identification of infected patients and early mobilization of healthcare resources are critical in limiting morbidity and mortality. Thus, there is an urgent need for the development of novel diagnostic assays that enable the early detection of the virus, help screen a large number of people and animals and testing of travelers from at-risk regions. Then, proper treatment and control should be in place as early as possible. In addition, the preparation of vaccine and antiviral drugs should be done to ensure high efficiency rates. Additional efforts should also be made to find the animal source, including the natural reservoir and any intermediate amplification host, to prevent any new epidemic foci or resurgence of similar epidemics. "One Health" teams must be developed and collaboration must be implemented. "One Health" teams can work to identify sources of emerging pathogens and ways to reduce the threat of outbreaks. The implementation and development of "One Health" collaborations on a global scale are critical in reducing the threats of emerging viruses.

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