

Specific measures to response pandemic of COVID-19 in China: a systematic review

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Abstract. Contemporarily, the novel Coronavirus (SARS-CoV-2, abbreviation for COVID-19) has raged around the world in a short time, which attracts the attention of countries around the world. This virus is spreading fast with a considerable impact, posing a huge threat to global public health. The challenges COVID-19 presented require a robust response. As the world's best country in epidemic control, China has done a lot of control measures. These measures include laboratory confirmation, social distancing and vaccine. Evidences have proved that these measures taken by China have effectively reduced the incidence and mortality of COVID-19 in China. This article will provide a systematic review of these control measures in China, in the hope of providing information for global infectious disease control.

1 Introduction

In late December 2019, a new pneumonia was discovered. Some experts conducted genome sequencing of the virus isolated from the alveolar lavage fluid of patients with pneumonia and found that the pneumonia was related to a new RNA virus strain from the coronavirus family. On January 12, 2020, the World Health Organization (WHO) temporarily named the new coronavirus "2019-nCov". On February 11, 2020, the World Health Organization (WHO) named the new coronavirus-infected pneumonia "COVID-19". Meanwhile, the International Virus Classification Committee named the new coronavirus "SARS-CoV-2" [1]. This sudden epidemic has brought unprecedented and powerful challenges to the life and economy of every country.

The symptoms and severity of COVID-19 vary from person to person. There are asymptomatic infections in the disease, and most symptomatic patients are mostly mild. The performance of most patients is dominated by influenza-like symptoms. Fever is the most common symptom of COVID-19 disease, which may be a high or low fever. The patient will develop a fever at a particular stage, accompanied by cough symptoms, which may be a dry cough or an expectorant cough. Other common clinical manifestations of COVID-19 include fatigue, weakness of limbs, shortness of breath, nasal congestion, muscle and joint pain, sneezing, runny nose, hemoptysis, sputum coughing, etc. COVID-19 also has some other

rare symptoms, including gastrointestinal diseases such as loss of appetite, diarrhea or nausea, as well as symptoms (e.g., sore throat, headache, and dizziness). Serious complications include acute respiratory distress syndrome (ARDS), septic shock, systemic inflammatory response syndrome, difficulty to correct metabolic acidosis, acute myocardial injury, blood coagulation dysfunction, and even death [2].

The harm of covid-19 to society and the population reminds the importance of public health and risk mitigation measures in the COVID-19 pandemic in China. Public health is a public undertaking related to the health of the people of a country or a region. The aim is to ensure that everyone enjoys a standard of living adequate for the maintenance of a healthy life and achieve a healthy birth and longevity of the individual through the development of social institutions. As the world's best country in epidemic control, China has done a lot of control measures. These measures have effectively reduced the prevalence of COVID-19 in China. The purpose of this study is to review these measures in order to provide a guideline for other countries or regions.

2 Identifying the patients

The crucial aspect of infectious disease prevention and control is the early detection of cases [3,4]. Identifying those who carry the virus not only reduces the risk of transmission to a larger scale, but also allows patients to receive effective treatment in time as well as reduces

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morbidity and mortality. At the beginning of the outbreak, screening measures usually concentrated on people who tested positive for nucleic acid in China. The authority tracked their routes to locations and publicized information via the media, which let people who had visited these locations could perform nucleic acid testing voluntarily. At the same time, testing and isolation measures were mandatory for people who had intimate contact with these patients.

In spark period, it is also important to understand the structure and characteristics of this virus, which is useful to develop accurate, rapid detection methods. The variations in the genetic sequence at the nucleotide level of an important virus (e.g., SARS-CoV-2) can help us in understanding and unfolding important facts and knowledge about its virulence [5]. The similarity between SARS-CoV-2 and the conserved structural domain of replicase of β -coronavirus genus was nearly 90%. Moreover, the results of phylogenetic analysis and amplification of β -coronavirus genus-specific genes also indicated that SARS-CoV-2 belonged to β -coronavirus genus [6,7]. The mutations of SARS-CoV-2 were then analyzed by the University of Cambridge in the UK and the University of Münster in Germany, using as the origin the bat coronavirus highly similar to SARS-CoV-2 discovered by the team of our researcher Zhengli Shi [8]. It was found that the mutations could be divided into three types, A, B and C [8]. Afterwards, all of the countries, which experienced epidemics can be classified into six clusters [9]. (Figure 1) Currently, there is no other new type of coronavirus has been found, scientists focused on study the structure of these three types. Besides, they try to prevent the emergence of more mutated types and develop the method of laboratory confirmation.

The clinical symptoms of COVID-19 are mostly presented in the respiratory system, and then those patients infect others through droplet transmission and contact transmission. Therefore, in order to reduce transmission, the government has to determine which people carry SARS-Cov-2 accurately and quickly.

There are three main methods have been used commonly. Thereinto, nucleic acid test is the most used one, which gives direct evidence of the presence of the virus as well as serves as a criterion for the diagnosis of novel coronaviruses. The other two methods, antigen testing and antibody testing, are not widely used because of the relatively high rate of false negative results or the low sensitivity of the test substance. than 0.25 point.



Figure 1. The scatter plot of six distinct clusters in the world. The light blue, dark blue, green, red, pink, and yellow represent Cluster I, Cluster II, Cluster III, Cluster IV, Cluster V, and Cluster VI, respectively. The base color of each country is decided by the color of the dominated Cluster [9].

2.1 Screen

Novel coronavirus nucleic acid testing includes nasal swabs, pharyngeal swabs, blood, anal swabs, and stools. The pneumonia caused by the new coronavirus is a lower respiratory tract infection. As a consequence, lower respiratory tract specimens are preferred for nucleic acid testing in patients with existing symptoms and CT changes in the lungs. Besides, upper respiratory tract specimens taken during different courses of novel coronavirus pneumonia can also detect viral nucleic acids [10].

The pharyngeal swabs are always used in daily testing, because it is easy to operate. The sampler used a sterile saline-wetted cotton swab to scratch across the root of tongue and wipe on both sides of pharyngeal tonsils for sampling. The swab tip needs to be dipped into a test tube containing 2-3 ml of virus preservation solution and the cap screwed tightly to prevent contamination of the sample. However, this method also cannot guarantee complete accuracy, i.e., sometimes multiple tests are still needed to determine whether the person has been infected.

In spark period, the protection of the pharyngeal swab sampling process is mainly focused on the protection of the medical personnel themselves [11] (e.g., wearing N95 masks, protective clothing and strict aseptic operation), but neglected the efforts in reducing the infectiousness of the patients themselves [12]. Nowadays, more and more people are wearing masks and responding to the call for nucleic acid testing actively. Thus, the spread of the new coronavirus has nearly been stopped in China.

2.2 RT-PCR technology

Real-time fluorescent reverse transcription polymerase chain reaction (RT-PCR) is another novel detection scheme. The fluorescent dye can be integrated on the product synchronously during the amplification process. Afterward, the researcher can detect it in time by the intensity of the fluorescent signal [13].

According to the current researches, RT-PCR is still the relatively accurate standard in nucleic acid testing, but it requires a high level of staff expertise, which maybe the only limitation. Therefore, it is the preferred method for laboratory determination. The method requires that specimens be pre-treated with virus inactivation at 56°C

for 30 min prior to processing before subsequent processing. The principle of sample selection was to collect respiratory samples from the early stage of the disease. After collection, the specimens were sent to the laboratory immediately according to the relevant requirements. Specimens that can be tested within 24 h can be stored temporarily at 4°C, while those that cannot be tested within 24 h should be stored at -70°C or below [14].

RT-PCR has the characteristics of high sensitivity, accuracy, easy operation and safety. Especially in the spark period where the government needs to test a large number of people, RT-PCR can improve the efficiency of detection. Moreover, accelerating the expansion of nucleic acid testing is conducive to prevention and control, maintenance of public health. Besides, it helps to rationalize the movement of people as well as promote the socio-economic and productive life in order in the future.

3 Social distancing

Social distancing, also called “physical distancing”, means keeping a safe space between yourself and other people who are not from your household. To practice social or physical distancing, stay at least 6 feet (about 2 arm lengths) from other people who are not from your household in both indoor and outdoor spaces.

Process in Social Distancing has continued steadily in recent years, it didn't come up because of the COVID-19. It's also necessary to distance yourself socially when there is no epidemic. Psychologists believe that in general social activities, people who maintain a distance of more than 1.2 meters between people will feel comfortable. It is hoped that everyone can still keep this distance when we are waiting in line after this pandemic.

The Centers for Disease Control (CDC) of China states that social distancing is “staying away from mass gatherings and keeping a distance of 6 feet or 2 meters away from other people” [15]. Social distancing has two meanings, one is to avoid schools, workplaces, shopping malls, cinemas, and other crowded places, while the other is to keep a safe distance from people when you have to go out.

For example, Anthony Fauci, director of the US National Institute of Allergy and Infectious Diseases, told Fox News: "Don't go to crowded places, be careful about long-haul air travel, don't take a cruise...Now it's social distancing." Social distancing in this sense means "social isolation" -- people try to stay at home and avoid gathering in groups [16]. From stopping work to closing schools and businesses to lockdown, the aim was to enforce such social distancing.

The another meaning of social distancing involves more details -- to "stay away from people" as long as you are in the crowd, in case droplets spread the disease.

3.1 The methods

We selected topics by reviewing the current clinical and scientific areas of interest at scientific meetings of China, American, and British public health groups. We also

reviewed published reports by database and journal scanning and discussed ideas with partners. Now let's consider the following tips for practicing social distancing when you decide to go out.

3.1.1 Wearing masks

When going out in public, it is very important to wear a mask to slow the spread of COVID-19. Because there are many asymptomatic infected-person, oneself and the people around him do not know that one has been infected. Therefore, asymptomatic infections will become an important source of infection of novel coronavirus if he does not wear a mask. The CDC also recommends mask use for patients as source control to prevent infectious respiratory droplets from reaching others [17]. In fact, it actually made a huge contribution to the control of COVID-19.

3.1.2 Prepare for Transportation

There are lots of social distancing options to travel safely when running errands or commuting to and from work, whether walking, bicycling, wheelchair rolling, or using public transit, rideshares, or taxis. When using public transit, one is ought to keep at least 6 feet from other passengers or transit operators, e. g., waiting at a bus station or selecting seats on a bus or train. Besides, when using rideshares or taxis, one need to avoid pooled rides where multiple passengers are picked up. Besides, it is better to sit in the back seat in larger vehicles so you can remain at least 6 feet away from the driver.

3.1.3 Limit Contact When Running Errands

In order to keep save, one only visits stores that sells household essentials when you absolutely need to, and stays at least 6 feet away from others who are not from your household while shopping and in lines. If possible, delivery services should be used to limit face-to-face contact with others. Maintaining physical distance between yourself and delivery service providers during exchanges and wearing a mask are necessary.

3.1.4 Keep Distance at Events and Gatherings

It is safest to avoid crowded places and gatherings where it may be difficult to stay at least 6 feet away from others who are not from your household. If you are in a crowded space, it is necessary to keep 6 feet of space between yourself and others at all times and wear a mask. Masks are especially important in times when physical distancing is difficult. Pay attention to any physical guides, e.g., tape markings on floors or signs on walls, directing attendees to remain at least 6 feet apart from each other in lines or at other times. Besides, allowing other people 6 feet of space will be favourable when you pass by them in both indoor and outdoor settings.

3.1.5 Stay Distanced While Being Active

As for a walk, bike ride, or wheelchair roll in your neighbourhood or in another safe location, you must maintain at least 6 feet of distance between yourself and other pedestrians and cyclists. If you decide to visit a nearby park, trail, or recreational facility, it will be better to first check for closures or restrictions. If it will be open, then you should consider how many other people might be there as well as choose a location where it will be possible to keep at least 6 feet of space between yourself and other people who are not from your household.

Besides, social distancing should be practiced in combination with other everyday preventive actions to slow the spread of COVID-19 [18]. To be more specific, it includes wearing masks, avoiding touching your face with unwashed hands, and frequently washing your hands with soap and water for at least 20 seconds.

3.2 Perspectives

Social distancing needs our collective efforts, not just the regulations of government or appealing from related institutions. The COVID-19 is closely related to everyone. We all need to try our best to do well in anti-epidemic measures before the epidemic is completely controlled.

4 Vaccine

On June 7, 2020, China issued a white paper entitled "China's Action against the COVID-19 epidemic", pointing out that China's fight against the epidemic is now in the normalization of national epidemic prevention and control (since April 29th) World Health Organization (WHO) said that China has entered the stage of remission. China's experience is helpful for other countries fight the epidemic.

At this stage, our main task is to monitor sporadic cases, gradually establish herd immunity by vaccinating the public, and further develop targeted drugs. Vaccination against COVID-19 is the most convenient and effective means to prevent infection during the normal epidemic prevention and control period [19].

4.1 Vaccine immune

4.1.1 Principles

After the coronavirus invades the human body, its genetic material is released, replicated and reassembled in the host. Subsequently, it released outside the cell to be swallowed by antigen-presenting cells and present antigens. i.e., activates helper T cells and triggers immune responses. On this basis, B cells produce corresponding antibodies, and cytotoxic T cells recognize and destroy cells infected by the virus.

The goal of the vaccine is to expose the body to antigens that do not cause disease, trigger an immune response, and produce corresponding antibodies and memory cells. Later, once the human body is infected by the virus, it will immediately trigger an immune response,

i.e., blocks or kills the virus. At least eight types of vaccines are used against coronaviruses, which depend on different viruses or different viral parts, e.g., coronavirus DNA or RNA, coronavirus spike protein and so on [20-23].

4.1.2 Types

COVID-19 vaccine can be roughly divided into three categories: traditional vaccine (e.g., weakened or inactivated virus vaccines), subunit vaccine (adenovirus vector vaccine), nucleic acid vaccine (DNA vaccine, RNA vaccine). Next, we will focus on inactivated vaccines and adenovirus vector vaccines.

Inactivated vaccine is a classical form of vaccine, which "kills" and purifies coronavirus SARS-CoV-2 cultured in vitro. The inactivated virus does not have the ability to cause disease, but it can still stimulate the body to produce immune response and produce antibodies in the body. Inactivated vaccine has good safety and efficacy, which has been widely used in the vaccine production of other viruses.

Adenovirus vector vaccine belongs to the vector vaccine of the new type of vaccine, which installs the nucleic acid fragments of the virus into the safely treated adenovirus and then injects it into the human body. After injection, the immune system will recognize the virus antigen and activate the immune response of the body to obtain immunity, which can maximize the antigenic activity of viral nucleic acid and stimulate the immune effect of the body.

The two vaccines are different in principle and preparation methods, but the final immune effect is about the same [24,25].

4.2 Application in China

So far, four independently developed COVID-19 vaccines have been approved and put on the market, including three inactivated vaccines-- two from Sinopharm Group, one from Beijing Kexing, and one adenovirus vector vaccine, which was jointly developed by Kang Xi Nuo and Chen Wei academician team.

On March 14, 2021, a total of 64.98 million people had been vaccinated against COVID-19. At present, vaccination is being organized in accordance with the principle of orderly progress among key groups, high-risk groups and other groups, to steadily increase the coverage of COVID-19 vaccine population.

4.3 Effect

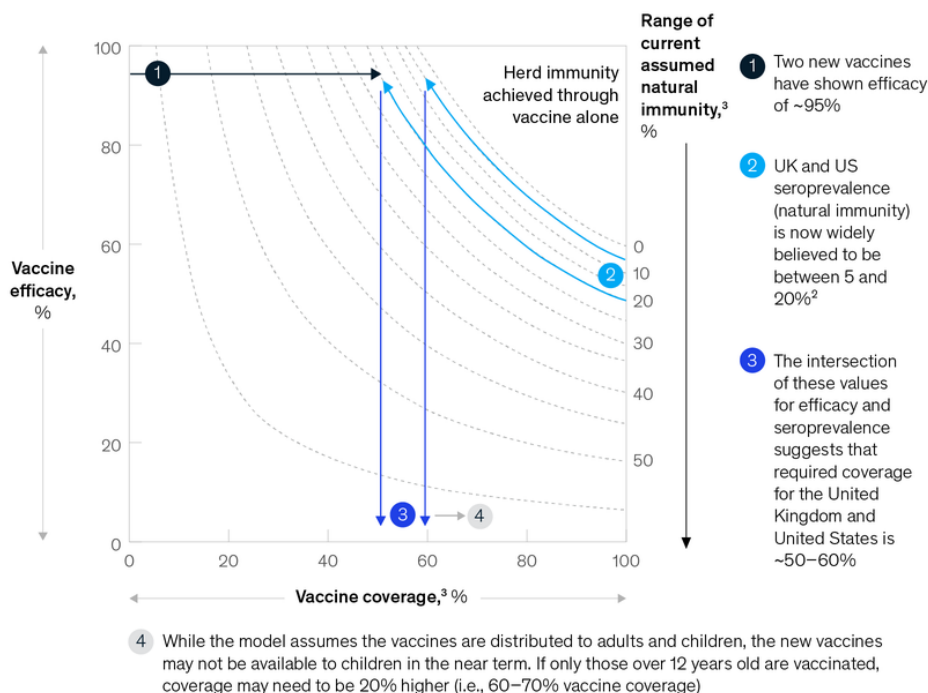
Clinical trials of vaccines on the market in China show that these vaccines are well tolerated and there are no safety risks related to vaccination. The adverse reactions were relatively mild, and there was no severe event or severe adverse events (SAE). However, for vaccines, the most important evidence is the protection of people. Therefore, the specific protective effect of the vaccine still needs a large sample size to draw the conclusion that the error is small.

4.4 Relationship with herd immunity

If the protection of the vaccine is permanent and the effective rate is 100%, the vaccination rate required to establish herd immunity is 60%-72%. Whereas, if the

vaccine efficiency is less than 80%, then all people need to be vaccinated to establish herd immunity [26].

Therefore, there is still a long way to go before the establishment of herd immunity, and personal protection still needs to be done after vaccination [27-29]. (Figure 1)



¹COVID-19 herd immunity achieved once total immune population reaches 58%, using a basic reproductive number (R0) of 2.4; herd-immunity threshold calculated as $1 - (1/R0)$. The model assumes that each member of a population mixes randomly with all other population members. In reality, people mix mostly with others whose patterns of interaction are similar to their own. Subpopulations with fewer interactions have lower thresholds for herd immunity than do those with more interactions.
²Summary statistics, SeroTracker, January 11, 2020, serotracker.com. Our model assumes that test seropositivity correlates with natural immunity. Research is ongoing to validate this. If US seroprevalence continues to rise, then minimum vaccine coverage levels required will decrease.
³Assumes vaccine is equally available to entire population, regardless of whether they have had COVID-19.
 Source: Moderna; Pfizer; SeroTracker; US Census Bureau

Figure 2. UK and COVID-19-immunity scenario [30].

4.5 Responses to 2019 novel coronavirus mutation

Wang Junzhi, academician of the Chinese Academy of Engineering, said that at present, it has not been found that the mutant of novel coronavirus has a significant impact on the protection rate of COVID-19 vaccine on the market in China [31].

Wang Junzhi believes that it is necessary to plan and actively prepare to effectively deal with the impact of virus variation. Generally, there are two aspects of work that are very important. First, we need to close monitoring, real-time monitoring, collection as soon as possible after discovery, determination after collection, timely detection of its impact on the vaccine. Second, strengthen the construction of vaccine platform. Through the deployment of five technical routes, China has established a very strong vaccine research and development platform. At the same time, actively study the new generation of vaccine. Once the virus mutation causes the immune effect of the vaccine to disappear or greatly reduce, we can develop a vaccine for the mutant strain in the shortest time.

4.6 Comparison of vaccines at home and abroad

At present, the mRNA vaccine of German BioNTech and American pharmaceutical company Pfizer has been approved for use in more than 40 countries, including the United Kingdom, the United States, the European Union, Canada, Bahrain, Saudi Arabia and so on. Its efficiency is 95%. The mRNA vaccine of Moderna, a US company, is the second COVID-19 vaccine approved for use in the United States, with an effective rate of 94.1%. The traditional inactivated vaccine is less effective than the new mRNA vaccine. Does this mean that the traditional vaccine is relatively bad? The answer is, of course, no. Whether the vaccine is good or not needs to be comprehensively evaluated [32].

4.6.1 Validity

On January 7, 2020, the government of the state of Sao Paulo, Brazil, announced that the effectiveness of domestic Sinochem vaccine was 78%, of which the effectiveness for moderate and severe prevention was

100%. It far exceeds the 50% effectiveness threshold for vaccine development set by the World Health Organization.

4.6.2 Security

Both BioNTech/ Pfizer and Moderna mRNA vaccines have adverse reactions to allergies (even cause anaphylactic shock) and facial paralysis, but the data are within the expected range. However, considering that mRNA vaccine is a new technology, it still needs to be further observed in phase IV clinic in the future. There are no reports of serious side effects after inactivated vaccination [33].

4.6.3 Accessibility

The mRNA vaccines of Pfizer and Moderna are extremely demanding in storage temperature and need to be stored at -70 °C and -20 °C. The inactivated vaccine can be preserved in an ordinary refrigerator at 2-8 °C, which greatly enhances the universality of the vaccine, especially for developing countries that cannot meet the preservation conditions.

4.6.4 Affordability

mRNA vaccines are relatively expensive because of their high cost. Whether foreign vaccines or Chinese vaccines are better needs to be evaluated comprehensively in combination with various aspects. At the present stage, inactivated vaccines are more popular around the world and are more likely to make important contributions to preventing the pandemic [34,35].

5 Conclusion

In summary, the measures for the sake of dealing with COVID-19 in China are systematically reviewed here. Based on the analysis, identifying timely is the key to interrupt the spread of the coronavirus. Through testing the relevant population and studying the characteristics of the virus, it is feasible to achieve this target. Meanwhile, laboratory confirmation is useful to distinguish the virus-carrying population out of the uninfected population quickly in order to manage them respectively, which is also important to stop the expansion of the epidemic. Since the World Health Organization (WHO) confirmed the COVID-19 "pandemic", the outbreak has rapidly worsened in many countries around the world. In such a severe situation, China's experience in fighting the epidemic was widely recognized. One of the most important reasons was social distancing. Therefore, it is necessary to promote the use of social distancing to stop the spread of the epidemic. At present, there is no targeted drug for COVID-19, and the effect of vaccine is impossible to achieve 100%. Furthermore the establishment of herd immunity is not an overnight work. At the moment, it is necessary to get more people vaccinated while continuing routine protection, so as to

protect the health of the population to the maximum extent possible.

Public health is the science and art of preventing disease, prolonging life and promoting physical and mental health through evaluation, policy development and safeguards. Facts have proved that these measures taken by China have effectively reduced the incidence and mortality of COVID-19 in China, providing noble experience for human prevention and control of the epidemic. Perhaps these experiences and information will support the development and implementation of epidemic prevention methods in some countries. Hopefully, in the wake of this outbreak, the international community will be more vigilant, both in terms of their own public health response mechanisms and in terms of international coordination and response.

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