A Review of the Mitigation Measures in China and Their Reference Significance

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Abstract: The outbreak of Coronavirus disease 2019 (COVID-19) first identified in Wuhan, China has spread around the globe at an unprecedented speed, resulting in high fatality rates and an increased burden on healthcare systems worldwide. As spikes and resurgents of new COVID-19 cases still bothering many parts of the world, China has adopted effective mitigation measures to successfully contain and even halt the COVID-19 epidemic within three months. This review summarizes China's unique prevention strategies and regulations by providing specific examples, hoping to provide references for other countries in terms of epidemic control.

1. Introduction

1.1 Overview of the COVID-19 pandemic

(1) COVID-19 pandemic definition

Beginning from December 2019, Coronavirus disease 2019 (COVID-19), a respiratory infection caused by a novel coronavirus named severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), has swept the globe. Coronaviruses (CoVs) are a group of enveloped, positive-stranded RNA virus [1]. Significant research conducted on this group of viruses beginning in the second half of the 20th century was due to their ability of causing severe diseases in livestock and pets, including cows, chickens, dogs, and cats [2]. In 2002 and 2003, an outbreak of severe acute respiratory syndrome (SARS) caused by SARS-CoV-1 happened in Guangdong, China, being the first time CoVs were detected in humans [3]. CoVs, from that time on, were considered as zoonotic viruses found in both humans and animal species, causing a broad spectrum of mild to severe enteric, respiratory, and systemic illnesses and fatalities.

Clinical symptoms of COVID-19 infection generally vary from mild malaise to severe or fatal illness, in which the most common symptoms are fever, cough and myalgia, and other minor symptoms include sore throat, headache, nausea, chills, and ageusia [4]. Severe and critical cases of COVID-19 are characterized by serious symptoms such as dyspnea, oxygen saturation less than 93%, respiratory failure, septic shock and/or multi-organ dysfunction/failure [4].

(2) How it started and where we stand now

On January 30, 2020, the WHO declared COVID-19 outbreak a global public health emergency, and soon, on March 11, 2020, the WHO declared COVID-19 a global pandemic, marking the initiation of another global pandemic since H1N1 influenza outbreak in 2009 [5].

(3) International and China demographic facts

At the time of writing this review, SARS-CoV-2 has caused a total of 249,743,428 confirmed cases and 5,047,652 deaths worldwide (as of 8 November 2021). In China, as of 8 November 2021, there have been 126,710 confirmed cases of COVID-19 and 5696 deaths [6].

1.2 The significance of non-medical mitigation measures during the pandemic

Given the fact that, currently, there is no panacea available for the treatment of COVID-19 infection, it seems that non-medical mitigation measures are the only choice left. Various research articles have simulated different scenarios with the currently available data and built mathematical

models to predict the effectiveness of non-medical mitigation actions in terms of restricting the transmission of COVID-19, and they point to a same conclusion that, with the wise combination of mitigation strategies such as contact tracing, social distancing, and quarantine, the spreading of COVID-19 could be contained within a relatively short period [7-9].

2. Methodology

2.1 Search strategy

A systematic literature review of mitigation measures in containing the transmission of COVID-19 within China was conducted by accessing online databases including PubMed, NCBI, and ScienceDirect without time range filters. Other official websites such as websites of Chinese embassy in the United States and Austria and China CDC Weekly and press media including BBC and Xinhua Net were also searched for additional information.

2.2 Keywords used during research

Keywords including “COVID-19”, “SARS-CoV-2 virus”, “China”, “mitigation measures”, “centralized isolation (Jizhonggeli)”, “health QR-code (Jiankangma)”, “vaccination confirmation code (Yimiaoma)”, “Five one policy (Wugeyizhengce)”, “circuit breaker (Rongduancuoshi)” were searched.

3. Regulations and policies implemented as a mean of curtailing the impacts of the pandemic

3.1 Contact tracing

(1) Application of symptom-based quick response (QR) codes

1) Domestic

According to the global census, China has been the most populous country in the world with a population exceeding 1.4 billion, which makes manual contact tracing an ineffective and impractical tool to be used in terms of controlling the transmission of COVID-19 within the nation. Adding on top of that, although the SARS-CoV-2 is less virulent that the SARS-CoV-1 in 2002, it has greater epidemic potential for subclinical infections through asymptomatic and presymptomatic transmission are difficult to identify and trace, complicating the operation of manual contact tracing in such a densely populated country [10].

Digital health surveillance approaches such as quick response codes, on the other hand, have the strengths of timely identification of suspected cases, accurate records of places suspected cases have been to, and serve as a dependable and intuitive tool for healthcare workers and security personnel to check the health status of the incoming patients, tourists, or customers. China was the first to adopt COVID-19 contact tracing apps (CTAs) as a means of curtailing the spread of the virus [11]. In February 2020, the Chinese government collaborated with its internet giants Tencent and Alibaba to roll out the “health code” program that users nationwide could access the program via Alipay or WeChat apps and receive their own health code after inputting their full name, ID number, and phone number [11].

The health QR-code programs can take many forms and are acknowledged nationwide, allowing each province or autonomous region to design the program in a way that is most suitable for their situations. For instance, Figure 1 presents a series of screenshots showing the functions of the health QR-code in Shandong province. When the user clicks on “show health QR-code” after filling out the required information, the auto-generated QR-code would provide information including the user’s name, social ID number, health status indicated by the color of the code, vaccination status, the most recent nucleic acid test result, and travel history in the last 14 days.

2) Foreign

Same symptom- and trip-based QR code were also applied to regulate every foreign passenger entering China. At the beginning of the outbreak, China-bound foreign passengers were required to

apply for the verification by signing the health declaration form and emailing it with a combination of files, including scanned copies of their negative nucleic acid and IgM anti-body tests results and their passport information page, to the mailbox of the Chinese embassy. After receiving the application, the Chinese embassy would examine the documents, and complete the verification by signing the lower part shown in Figure 2 (C).

Figure 1. Screenshots of the various functions of health QR-code program based on WeChat App (use Shandong Health QR-code as an example)

Starting from December 2020, the Chinese embassy launched the QR code with “HDC” mark for all China-bound foreign passengers, mandating every foreign passenger who are to fly from the U.S. to China to apply for the health QR code by logging on a website (https://hrhk.cs.mfa.gov.cn/H5/) via computer or smartphone. Figure 2 presents the appendixes in the notice of launching electronic health declaration certificate posted on the website of the Chinese embassy in Austria [12]. In order to receive a QR code with “HDC” mark, the passengers are required to fill in their identity information, declare their health status, and upload their nucleic acid test certificates, passports, and any other documents listed on the website. Once their applications are approved, the foreign passengers would receive their own QR code, which they would be asked to present either the electronic or printed version during boarding [13]. Different colors of the HDC-code, same as the health QR-code used in China, has different meanings, but instead of showing the health status of the individuals, it simply implies the status of their HDC-code application. The color-indicated meanings are shown in Figure 2.

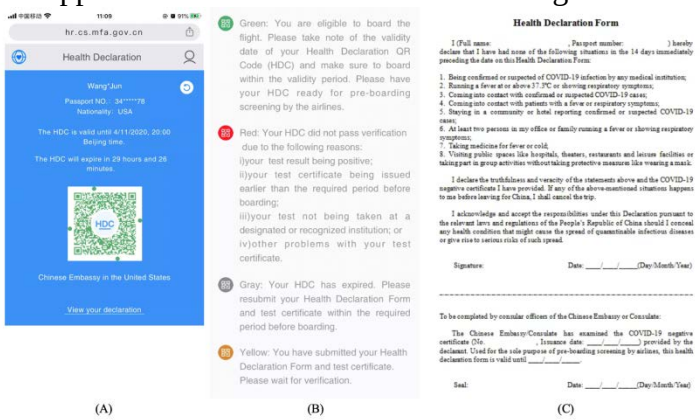

Figure 2. Electronic health declaration certificate for China-bound foreign passengers: (A) Electronic health declaration form or HDC-code; (B) Colors of the HDC-code and their explanations; (C) Health declaration form used before the launch of HDC-code in Austria

3.2 International flight regulation

On January 24, 2020, the beginning of a new year in Chinese lunar calendar, China implemented a national-scale lockdown that prohibited any individual from leaving home, shut down all public

places, and canceled every public activity including international flight, aiming to prevent both the spread and importation of new COVID-19 cases. As the spreading of the pandemic in China was gradually contained and the semblance of normality was returned, on March 26, the civil aviation administration of China made an announcement concerning the regulation of international flight, which required that each Chinese airline can only maintain a single route to any specific country with a single flight per week, and each foreign airline can only maintain a single route to China with a single flight per week, also known as Five "one" policy [14].

By the end of March 2020, Europe, instead of China, has become the new epicenter for the pandemic, thus, as a further precaution of the importation of COVID-19 cases, the civil aviation administration of China launched another "circuit breaker" policy, reward or cancel the international flight depending on the number of confirmed cases on the flight. According to the policy, based on the passengers' nucleic acid test results, if the flight of a specific airline had no positive nucleic acid test result for three consecutive weeks, the flight on this specific route is allowed to double its flight per week; but if the flight of a specific airline had more than five positive nucleic acid test results, the route of this airline is suspended for a week; and if there were ten positive results, the route of this airline is suspended for four weeks [15].

3.3 Centralized isolation and home quarantine

Although the utilization of health QR-code / electronic health certificate and the implementation of the regulations on international flights should be enough to prevent the importation of COVID-19 cases, the Chinese government continued their successful experience with centralized isolation and home quarantine to ensure that both asymptomatic patients and people who contracted the virus during their travel could receive proper medical treatments and that the transmission of COVID-19 is restricted.

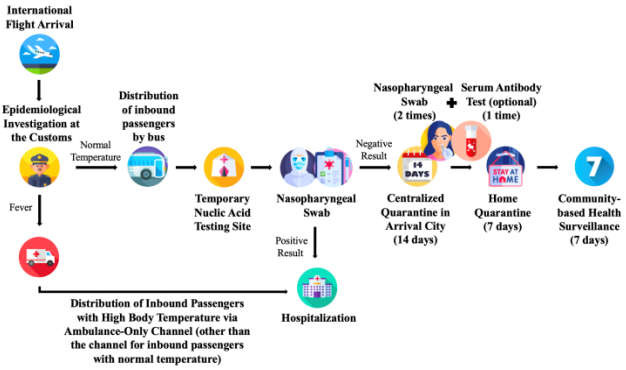

Figure 3. A flow chart of China's quarantine regulation on inbound passengers

Three types of facilities were used for centralized isolation in China: shelter (Fangcang) hospitals, refitted non-designated hospitals, and quarantine hotels [16]. This review specifically focuses on the quarantine hotels, as they were the most common facilities for centralized quarantine of international passengers, including people entered China by air, sea and land. Moreover, each quarantine hotel is carefully selected and rebuilt to be equipped with the hygiene conditions and functions required for centralized quarantine. For instance, in Pudong New Area, Shanghai, centralized quarantine sites are all detached buildings away from densely-populated districts with separate sewage treatment systems, and the buildings are separated into different zones to prevent the physical contact between the observers and healthcare personnel [17]. Each room has separate sanitary facilities, telephone, Internet access, necessities, and has meals delivered by the healthcare workers three times per day.

Figure 3 presents the whole procedure each international passenger would go through after their flight/ship/car has entered Chinese border and received a negative nucleic acid test result. In their first entry point cities, oversea passengers are subject to a 14-day mandatory centralized quarantine in their randomly assigned quarantine hotels, during which they would take nucleic acid tests twice, and some cities even require an additional test for serum antibody [17]. Only if the results of both

nucleic acid tests are negative, the observer does not develop any symptoms of COVID-19 by the end of the 14-day quarantine, the person is allowed to leave and the quarantine building would be fully disinfected, preparing for the next group of passengers [17].

3.4 Vaccine administration

(1) Graded vaccine administration by priority groups

Vaccination, as demonstrated by the World Health Organization (WHO), is a simple, safe, and effective way of protecting people against diseases employing the body's immune system to build resistance towards particular infections without actually contracting the virus or other germs [18]. Since the beginning of the COVID-19 pandemic caused by SARS-CoV-2 virus, an RNA virus that causes severe acute respiratory syndrome, various vaccines have been developed by different countries, working as a mitigation measure to cope with the disease. Three main approaches of designing a vaccine were adopted during the process of developing COVID-19 vaccine: (1) the whole-microbe approach, using killed, weakened, or inactivated forms of the germ or a safe virus to trigger an immune response, (2) the subunit approach, triggers immune response using a specific part of the virus that the immune system can recognize, and (3) the genetic approach, using a section of the genetic material, either DNA or mRNA, which provides instructions for specific proteins that the immune system could recognize and respond to [19].

In China, the most widely distributed and administered COVID-19 vaccines are Sinovac and Sinopharm, both of which have been approved by the WHO for emergency use and administered in dozens of countries[20]. Sinovac and Sinopharm vaccines employed the whole-microbe approach by using killed or inactivated viral particles of the SARS-CoV-2 virus, which is no longer capable of causing serious infection, to instruct the body's immune system how to increase the corresponding immune defense against the infection [20]. Due to the fact that the first dose of inactivated vaccines cannot help the body build up full immunity, the Sinovac and Sinopharm vaccines both require two to three doses to make sure a complete immunity is achieved [21]. According to the REUTERS COVID-19 tracker, by the time of November 10, 2021, mainland China has administered at least 2,217,563,000 doses of COVID-19 vaccines, which is enough to have vaccinated around 79.3% of the country's population assuming two doses for each person [22]. Therefore, the primary focus shifts to the effectiveness of each vaccine in terms of protecting vaccinated people against COVID-19 infection, hospitalization, and mortality.

Previous studies showed that, in vitro, the Sinovac vaccine successfully prevented symptomatic disease in 51% of those vaccinated and prevented severe COVID-19 cases and hospitalizations in 100% of the studied population for adults over the age 18 [20]. In Chile, the data published from an in vivo study suggested that the Sinovac vaccine is 67% effective in preventing symptomatic COVID-19 infection, 85% effective against hospitalizations, and 80% effective against deaths [23]. Sinopharm vaccine, additionally, has 78% efficacy in preventing symptomatic infection in studies done in UAE, Bahrain, Egypt and Jordan combined, and 70% efficacy in preventing hospitalizations [23]. Further real-world study is required to testify the effectiveness of Sinopharm vaccines, while studies in Bahrain showed the effectiveness of Sinopharm vaccine against symptomatic infection is around 90% [23].

In light of the fact that the exact effectiveness of COVID-19 vaccines has not yet been confirmed, hesitancy and doubt towards vaccination went sky high. Subsequently, it, once again, becomes crucial for the public health workers to stress the safeness and benefits of receiving the COVID-19 vaccines in terms of health, society, and economy. According to the US CDC, COVID-19 vaccine is safe, as the sciences behind its development are well-founded and have been around for decades. Besides, the approved vaccines all went through the required stages of clinical trials and are continued to be monitored for safety and effectiveness concerns [24]. Furthermore, the COVID-19 vaccines can largely reduce the chance of people getting and spreading the disease, keep people from getting seriously ill if people do get the disease, and protect people who cannot be vaccinated, including those immunocompromised and have chronic diseases [24]. Last but not least, COVID-19

vaccine is also effective in reducing people's risk of contracting the delta variant, a variant of SARS-CoV-2 that causes more infections and spreads faster than the original form [24].

Noteworthily, on March 17, 2021, a mild breakthrough infection was reported in Xi'an city: a female healthcare professional who has been fully vaccinated and whose work involves obtaining nasopharyngeal and oropharyngeal swabs of two returnees from Uzbekistan with strongly positive qRT-PCR tests was diagnosed with COVID-19 [25]. And according to the outbreak report provided by China CDC Weekly, the patients has completed two doses of COVID-19 vaccine by the beginning of February 2021 and her IgG and IgM antibodies were all very high, implying that she has been immunized against by the vaccines [25]. Although this particular breakthrough infection cannot be enough to prove that COVID-19 vaccines could prevent severe cases [26], it is in line with one of the benefits of the COVID-19 vaccine: vaccinated patients would experience mild and short illness [25].

(2) Vaccination confirmation code

As the rate of COVID-19 vaccination in China skyrocketing, the utilization of vaccination confirmation code based on the health QR-code program is also rising. Using Shandong health QR-code program as an example, as shown in Figure 1, the health QR-code of individual who completed COVID-19 vaccination would have a golden border, indicating that the person is fully vaccinated without the necessity to fetch another QR-code from a different program. Since July 2021, the sporadic outbreak of domestic COVID-19 cases in China starts to rise, an increased number of provinces and cities, including Jinan, Shandong, has tightened their prevention policy to require the citizens to show both health QR-code and vaccination QR-code when entering public places.

4. Discussion

Experiences of China's employment of various mitigation measures to successfully curtail the negative effects brought by the transmission of COVID-19 within two months have revealed the significance of adopting prevention strategies properly and timely at the beginning of an outbreak. The strategies are advantaged in ways including: (1) cooperate with domestic technology companies to develop contact tracing programs tailored for China's social conditions, (2) implement strict regulations on international flight to prevent any possible importation of COVID-19 cases as the epidemic has been contained, (3) unite and coordinate different facilities including hotels, and other public places to rebuild private properties as centralized quarantine sites and use centralized stockpile deployment to distribute healthcare and safety personnel to the quarantine sites, and (4) distribute free vaccines by priority groups and continue to encourage vaccination to ensure everyone has built full immunity against the virus.

Nevertheless, we cannot separate China's victory in combatting the COVID-19 pandemic from its unique social, political, and cultural environment. Chinese government and Chinese people have experienced the SARS epidemic in 2003, and during which they have built the well-known Xiaotangshan hospital for the temporary isolation and treatment of the patients [16]. And this allowed the Chinese government to respond quickly to the pandemic. Moreover, the Chinese people tend to prioritize collective interests when making decisions and are willing to temporarily sacrifice individual freedom in return of the realization of community achievement, which is also the reason why Chinese people were very supportive of the government's tight restrictions and strictly followed the new rules under pandemic, including home quarantine, wearing masks, and vaccination.

Consequently, it would be rather difficult for other countries to draw on or reproduce China's successful experience when coming up with mitigation strategies. Instead, future research should focus on which specific part of China's regulation strategy could be added on top of the existing regulations or help with propose new regulations, and make sure it is suitable for the political, sociocultural, and environmental conditions of the country. For instance, study has found that centralized isolation in China mitigated the pandemic economically, by effectively and promptly ensuring isolation, treatment, and quarantine for all cases and close contacts [16]. For developing countries suffering from an absence of healthcare infrastructure, a shortage of healthcare personnel

and a limited financial budget, adopting a centralized quarantine strategy is undoubtedly a choice worth considering.

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