A national fight against COVID-19: lessons and experiences from China

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A novel coronavirus pneumonia (World Health Organization announced it as COVID-19 on 11 February 2020) suddenly hit central China,[1] disrupted people's celebrations for Chinese New Year and challenged the wisdom of Chinese people[2] from various aspects. China has suffered many natural disasters during the past two decades, such as SARS in 2003 and the Wenchuan earthquake in 2008. Each time, the incurrence of natural disaster or public health emergency caused casualties and economic damage that brought Chinese people new problems and challenges.

In the beginning of the outbreak of COVID-19, it brought shadow and anxiety to the whole country. People's lives, especially those living in the centre of Wuhan, were tremendously affected. It quickly attracted concern from the World Health Organization (WHO) and other countries. Some countries started to take actions in an attempt to cut off the access of epidemic, such as restrict the entry of Chinese people, cancel flights and even block trade with China for a period of time. Meanwhile, COVID-19 showed a more infectious feature than SARS and was discovered to be highly contagious among human beings. Being the economic and traffic centre in central China, Wuhan is a metropolis with a high-density population (near 9 million residents). The spread of COVID-19 in Wuhan could be very dangerous and unpredictable. If we didn't act promptly and wisely, the potential damage of COVID-19 in China would be devastating.

However, Wuhan took the shot and started containment policy (the overall shut-down of the whole city) from 23 January 2020. This timely action followed "the

Abstract

Objective: This paper aims to review the public health measures and actions taken during the fight against COVID-19 in China, to generate a model for prevention and control public health emergency by summarising the lessons and experiences gained.

Methods: This paper adopts a widely accepted qualitative research and coding method to form an analysis on word materials.

Results: Although Chinese CDC didn't work effectively in the early stages on risk identification and warning, China was able to respond quickly and successfully to this medical emergency after the initial shock of the awareness of a novel epidemic with a swift implementation of national-scale health emergency management.

Conclusions: The success in fighting against COVID-19 in China can be attributed to: 1) adaptable governance to changing situations; 2) culture of moral compliance with rules; 3) trusted collaboration between government and people; 4) an advanced technical framework ABCD+5G (A-Artificial intelligence; B-Block chain; C-Cloud computing; D-Big data).

Implications for public health: This paper constructs a conceptual model for pandemic management based on the lessons and experiences of fighting COVID-19 in China. It provides insights for pandemic control and public emergency management in similar context.

Key words: ABCD+5G; public health emergencies; emergency management; COVID-19; pandemic

national emergency regulation for public health emergencies"[3] (revised in 2011 and hereinafter referred to as the "the emergency regulation") in 2006[4] and complied with other relevant laws and regulations on emergency management of public health emergencies (For example, the Law on The Prevention and Control of Infectious Diseases, Frontier Health and Quarantine Law and Animal Epidemic Prevention Law.[5] From this moment, the Chinese government initiated strong intervention actions and all Chinese citizens stood together and cooperated to enter the war of fighting COVID-19. The number of confirmed and suspected cases of COVID-19 in China began to decline day-by-day after peaking in the middle of February 2020.[6]

However, the spread of COVID-19 didn't stop there. While China began to see light at the end of the tunnel, the number of diagnosed cases began increasing all over the world, especially in South Korea, Japan, Italy, Iran, and the United States. The number of daily new diagnosed cases in these countries has surpassed those in China since 1 March 2020.[5] China's quick actions on epidemic prevention bought some time for other countries.[7] It has greatly contributed to global public health and was highly praised by the WHO and many leaders of other countries.[5] In addition, the WHO recommended that China's experiences were precious and needed to be learned by others.[8]

This paper summarises the evolution of COVID-19 and the continuing fight against pandemic in China. We discuss all measures taken for control and prevention and the experiences of public health emergencies management in China. We find that in the processes of emergent epidemic prevention and control, we have some factors that contributed significantly to the success. We have an adaptable governance that can adjust and upgrade to changing situations. We have a culture of moral compliance that can guide the people to obey the rules and stabilise communities.[9] We have a deep trust and collaboration between government and people.[10] Especially, we have integrated and applied ABCD+5G (A-Artificial intelligence; B-Block chain; C-Cloud computing; D-Big data;) technology that played a very important role as technical support in the fight against COVID-19. As a result, this paper constructs a conceptual model of public health emergency management based on ABCD+5G technology. This paper provides a new research perspective on the emergency management of public health in China and contributes to the relevant research in this field.

Research design and methods

Research design

According to the provisions of the emergency regulation,[3] all levels of governments in China may decide whether to establish a national and local emergency headquarters in response to public health emergencies. Their decisions are based on the practical work requirements and suggestions from the administrative departments of health. Therefore, Chinese governments at all levels are the leaders of the fight against COVID-19. They determine whether COVID-19 is a public health emergency or not based on the actual situation and their understanding of emergency regulation. In addition, they mobilise and guide people to fight the epidemic together.

During this process, the Chinese centre government takes leadership and makes a judgement based on the information. Their instructions will be quickly given to all levels of governments, health workers, communities and people. Time is the key in emergency management and the paper collection, sorting and reporting from the old information processing system no longer meets the requirements. According to Singapore's emergency management experiences on SARS and H1N1[10] and the emergency system developed by the United States for emergencies of infectious diseases,[11] the basic process of public health emergency management is the management of essential information flow, namely, the rapid information collection and sorting in response to emergencies.

Following the basic procedures of public health emergency management summarised by Chang Linghui et al. (2013)[12] and Singapore's experience in control and prevention of SARS and H1N1 epidemic summarized by Allen Yu Hung Lai & Teck boon Tan (2012),[10] this paper proposes a research framework as shown in Figure 1.

Research methods

In order to achieve our research purpose, this article adopts a widely accepted qualitative research method and coding method. As for the data sources, first we carefully reviewed the official documents regarding COVID-19 and its emergency management measures issued by governments, including national health and family planning commission of China and Hubei provincial health and family planning commission. Second, we analysed the reports and comments on the COVID-19 epidemic from authoritative news media such as Xinhua net, People's Daily online, People's Daily and Cankao Newspaper etc. Third, we studied relevant literature on public control measures for infectious diseases to verify our conclusions. Fourth, we analysed the public statements and speeches on COVID-19 from WHO officials and Chinese officials at and above provincial level. We did not use any data originating from or disseminated by Weibo and WeChat (two major social networking app in China) because of the lack of reliable information.

In view of the above, the research methods adopted in this paper and sufficient authoritative data used build a valid foundation for our research process and conclusions.
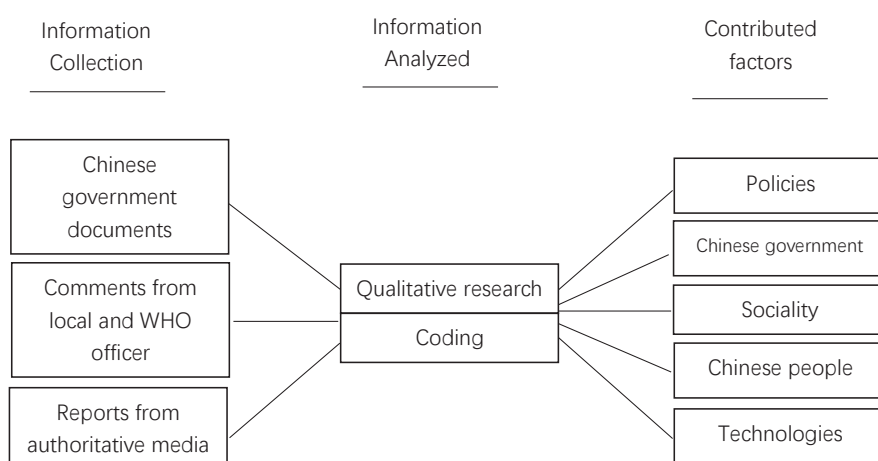
Review of the development of COVID-19

Period one: the appearance of first case to 22 January 2020

The first suspected case was recognised in Wuhan Jinyintan hospital on 1 December 2019, according to an epidemiological review in the academic journal *Lancet*.[13] On 8 December, the first COVID case was confirmed by Wuhan Health Committee. Zhang Jixian (the director of respiratory department of Wuhan hospital of traditional Chinese and Western medicine) reported the abnormal results of four patients to the hospital. This information was reported to the disease control department of Jianghan District on December 26 and to the Centers of Disease Control & Prevention (CDC) of district, at both municipal and provincial levels on 29 December.[14] The Health Commission of Hubei province and Wuhan city directed Wuhan CDC and Wuhan Jinyintan hospital to further investigate the situation.[14] Very soon, Jianghan CDC entered the hospital of traditional Chinese and Western medicine for epidemiological investigation.

On 31 December, the first group of experts from the National Health Commission arrived in Wuhan to investigate the unknown pneumonia. On 9 January, Xinhua News Agency announced that the genome

Figure 1: Research framework.

Information Collection — Information Analyzed — Contributed factors

Chinese government documents

Comments from local and WHO officer

Reports from authoritative media

Qualitative research Coding

Policies

Chinese government

Sociality

Chinese people

Technologies

of unknown pneumonia in Wuhan was identified as a new coronavirus.[14] The State Council considered the new coronavirus as a notifiable infectious disease on 20 January.[14] On the same day, academician Zhong Nanshan confirmed the human-to-human transmission of the epidemic in Wuhan.[13] On 21 January, the World Health Organization stated that the new coronavirus pneumonia may continue to be spread 'human-to-human'.[15] On 22 January, 15 medical staff in Wuhan were diagnosed as infected.

Period two: 23 January 2020 to 24 February 2020

At 10 am on 23 January, Wuhan started to shut down the city with no one allowed to enter or leave. Very soon, other provinces and cities successively started the first level response to the emergency of COVID-19. On 24 January, there were more than 1,000 confirmed cases in China. On 26 January, the National Health Commission stated that the outbreak of epidemic was in the early stage of transmission.[14] They further indicated that the incubation period of new coronavirus was up to 14 days. On 28 January, the number of confirmed cases exceeded 5,000, more than the total confirmed cases of SARS in 2003. WHO announced that the outbreak of novel coronavirus posed a high risk to the world on 29 January and declared it as a public health emergency on 31 January.[14] On 3 February, more than 20,000 cases were confirmed in China. Novel coronavirus pneumonia was named "COVID-19" by WHO on 11 February 2020.[1]

On 3 February, the Raytheon mountain hospital and Vulcan mountain hospital were launched. Without hesitation, a large number of Fang Cang hospitals were built and used. Social grid management (a thorough screening and prevention at community/plot/building levels) was launched. The government called for the "national fighting against epidemic" campaign.[16] In the middle of February, the number of confirmed cases reached a peak in China. Then, after a turning point, the number of confirmed and suspected cases dropped. On 20 February, 13 provinces and cities in China had no new confirmed cases. On 24 February, the head of joint expert group of China-WHO pointed that "China's measures are huge and flexible, which have helped to prevent and control the outbreak of hundreds and thousands of cases around the world".[17]

Period three: 25 February to 31 March, 2020 (no new cases confirmed)

Since 25 February, the number of confirmed cases in China continued to decrease and business activities were reactivated across the country, while the number of cases outside China continues to increase and the proportion of deaths exceeds that of China. On 3 March, Maria (the technical director of WHO's emergency program) praised China's measures toward this emergency at a press conference[8] and her words were supported by an investigation report from 25 members of WHO that stated China played a pioneering role in fighting this epidemic and provided important experiences for the world.[5] From 12 am on 25 March, the strict containment policy in Hubei Province was removed, except Wuhan, and traffic to the outside was operated in an orderly manner. From 12 am on 8 April, the lockdown of Wuhan city was unsealed and movement of the population from Wuhan was safely organised with a certificate of Hubei health code "green code".

In sharp contrast, the fight against COVID-19 around the world is increasingly severe. As of 31 March, the total number of confirmed cases in the United States, Italy and Spain had exceeded that in China respectively.[18]

Analysis and discussion

The early identification and emergency preparedness of COVID-19

According to Article 15 of the Emergency Regulation: emergency monitoring and early warning should formulate monitoring plans, scientific analysis, comprehensive evaluation on monitoring data based on the types of emergencies.[3] Potential hidden dangers discovered in the early stage and possible emergencies should be reported in a timely manner in accordance with the reporting procedures and time limit prescribed in these regulations. Following this instruction, we could identify some phenomenons and facts at the first stage of the development of epidemic as below.

 First, during period one from the recognition of the first case to 22 January 2020, the information of epidemic appearance had been processed internally more than 30 days by medical and disease control institutions. It reflects a weak awareness of the prevention of unknown threats and risks. Second, serious delaying and missing of reports were found in written forms from doctors at the primary

level and leadership level. It showed that this epidemic reporting system was not capable of early warning and monitoring of major infectious disease emergencies.[19] Third, during this period, Doctor Li Wenliang first suggested the possibility of an unidentified pneumonia, but no attention was aroused.[20] As academician Zhong Nanshan explicitly proposed in Guangdong on 27 February 2020[21] China CDC, as the entity of execution of the emergency regulations, was not authorised to effectively carry out epidemic prevention and control.

It can be found that the Emergency Regulation issued in 2006[3] and revised in 2011[4] did not effectively identify COVID-19 and take emergency preparedness measures in the early stage. The emergency regulation did not effectively provide early warning of COVID-19.

The process of fighting against COVID-19

(1) Adaptable governance

Judging from the early warning and emergency preparedness in period one, the Chinese government was clearly aware of the shortcomings of the emergency regulations. Since then, many measures of control and prevention have been taken based on the development of COVID-19 epidemic.

As the first reaction to cut off the infection of source, Wuhan city launched its first lockdown in hundreds of years' history to effectively isolate and prevent the spreading of the virus to other cities in China. Meanwhile, the Raytheon mountain hospital, the Vulcan mountain hospital and many other Fang Cang hospitals were built with rapid speed to ensure that all patients who were diagnosed or had suspicious symptoms would be treated in a timely manner.

Second, to prevent and stop the spread of an epidemic countrywide, all provinces and cities launched a level-1 emergency response to COVID-19. At the same time, many doctors and nurses from the PLA army hospitals and many city hospitals all over China come to assist Wuhan's overloaded medical system. According to statistics, more than 50,000 medical workers provided their assistance in Wuhan city.[22] As for the supply management, the emergent supplies transfer government made, and donations across the country, would ensure there was no shortage of emergency medical care and necessary living supplies.

Furthermore, all country-level ministries and commissions initiated prompt actions according to the changing situations. For example, the Commission of Commerce specified that all works in factories should be postponed on 1 February,[23] the Ministry of Education issued an emergency notice requiring school to suspend on 6 February and launched a country-wide online teaching program;[24] the Commission for Discipline Inspection quickly launched the accountability mechanism;[25] the Personnel Department adjusted appointments to ensure an effective fighting against COVID-19;[26] the Supreme Court, the Supreme Procuratorate and public security departments promptly investigated and dealt with all kinds of illegal events during the epidemic.[27]

It can be found that all these actions and measures were initiated, adjusted and implemented based on the needs of epidemic prevention and control. The governance couldn't be efficient, effective and thoughtful at one time. It requires a continued improvement in response to changing situations. In view of above, we call it an "adaptable governance", which is the core factor of success in fighting against COVID-19.

(2) Culture of Moral Compliance

In addition to the adaptable governance to changing situations, the rooted social culture of moral compliance also played a very important role in the fight against COVID-19.

Chinese people have a rooted traditional culture to comply with authority and social rules and conform to public moral standards. When local governments began to implement social grid management (a thorough and systematic population control with screening and prevention of suspicious cases from the minimum unit of residence

such as buildings, to an upper level such as communities or plots), the power of community based organisation was tested. They used slogans such as "staying at home is fighting against COVID-19, staying at home is your contribution to the country" to persuade people on a moral level.[16] Then 1.4 billion people were motivated and started self-quarantine except for medical staff and other community workers. Citizens even encouraged and supervised each other to follow the quarantine requirement and fight against COVID-19 together. From the developed cities such as Shanghai and Beijing to the remote villages in Tibet and Xinjiang province, all Chinese people actively joined the emergency management against the epidemic. They assisted their children at home to study online in accordance with government's requirements. They delivered supplies to keep hospitals and communities running. These normal people promoted many heroic stories during the fight against COVID-19. When the national and local media reported these stories, people were motivated and encouraged even more. As government required, all people wore masks. It protected them and also effectively prevented the spread of the virus. The 1.4 billion Chinese people have all been great fighters against the epidemic according to the State Council Information Office of China released white paper titled "China's Action in Combating COVID-19" on 7 June 2020.[28]

It can be found that an effective fight against an epidemic cannot be achieved without the people's cooperation. It is based on a deeply rooted social culture of moral compliance. Some slogans used as motivations in fighting against COVID-19 both in city and country side are shown in Figure 2.

Although slogans of moral compliance are somewhat unusual, they are adapted to the education level and social culture of

local residents. It seemed very practical and effective. The culture of moral compliance is a key factor to the success of fighting against COVID-19.

(3) Trusted collaboration

During period two, a lot of communication efforts between government and people were made. First, government informed citizens of the severity of the epidemic and released all information related to epidemic development and locations of diagnosed cases every day. Second, a national command regarding the prevention and control of epidemic were made, clearly stating that "All suspected and confirmed patients should be admitted to the hospital". Third, all provinces and cities set up feedback mechanisms and built a direct communication platform between people and government, on which citizens could report any problems regarding the epidemic and get help. By these means, people's anxiety toward this epidemic was effectively reduced. In return, people actively cooperated with government and voluntarily quarantined themselves to prevent any outbreak possibilities.

In addition, government strengthened the tracking of public opinions and made quick judgements to provide help to those self-quarantined citizens who needed assistance. The central and local media actively participated in the communication between government and people. They positively guided and strengthened the communication and interaction that integrated government and people into a substantial collaboration. This broad collaboration is based on a mutual trust between government and people that effectively improves the efficiency of fighting an epidemic.

Application of The ABCD+5G Technology

President Xi stressed: "we should encourage the use of big data, artificial intelligence, cloud computing and other technologies to play a supporting role in epidemic detection, virus traceability, prevention and control, resource allocation and other aspects".[29] The government and various ministries and commissions used ABCD+5G technology when they made adaptable governance. First, they quickly built a digital control platform to identify confirmed cases and their close contacts and to monitor the body temperature of people flow. Second, these technologies were used in strengthening

Figure 2: Slogans of fighting against epidemic.

Data source: Baidu network

The slogan on the left: To wear a mask is better than a ventilator; To lie at home is better than in an ICU. The slogan on the right: The purpose of not having dinner together is to be able to eat in the future; The purpose of not visiting is to have relatives in the future.

information processing, quickly realising efficient health management and launching health code. It significantly helped fighting against the epidemic and returning to work. Third, government promoted the online learning classroom and the work resumption of telecommuting. All of these measures and actions were based on the application of ABCD+5G.

In the aspect of moral compliance and trusted collaboration between government and people, the use of ABCD+5G technology is also inseparable. For example, cloud live broadcast allowed the timely disclosure of epidemic-related information. It largely improved communication and increased the credibility of government.[30] In addition, Wuhan government developed a small Wechat program of "Wuhan micro neighborhood" to provide help and treatment precisely.[31]

Various ABCD+5G technology has been used in this epidemic that effectively improved the efficiency of fighting against COVID-19. At first when abundant donations of goods arrived, Wuhan Red Cross Society and Charity society could not process it in a timely manner and distribute efficiently to the demand units. In response, some enterprises including Jiuzhoutong quickly adopted ABCD+5G technical assistance to solve this problem and achieve effective distribution within one day. It is evident that science and technology help improve the ability of emergency management.[16] There are many examples of ABCD+5G technology being used in fighting epidemics. For example, Unmanned Aerial Vehicles (UVA) can hover over highways to issue commands instead of manual command by people. AI robots can enter hospitals to help doctors for medical examinations like CTs, or even read CT's results directly. The infrared thermometer can imperceptibly measure the temperature of passengers at railway stations or airports. Some genome-wide detection and analysis platform can recognise potential patients. ABCD+5G technology is proven to be the guarantee of a successful fight against an epidemic.

The summary of coping framework

According to the above analysis of COVID-19 control and prevention in China, we summarise a conceptual model of public health emergency management based on ABCD+5G technology application as shown in Figure 3.

First, the control and prevention of public health emergencies require an adaptable governance from the government to adjust promptly in response to changing situations. With the fast development progress of country and society, the current laws and regulations of emergency management often lag of time and no longer meet the requirements of post-industrial development. Therefore, the government's adaptability plays a key role in the whole process.

Second, people need to keep the culture of moral compliance. Public education and effective communication are two indispensable components of health crisis management.[32,33] Moral compliance acts as a behavior guidance in this unusual situation – properly instruct people's activities to ensure the effectiveness of the above two. Just as people follow the traffic safety guide "stop at red light and go at green light", emergency management policies for public health emergencies should be embedded in people's daily life.

Third, the deep trust and collaboration between government and people are important factors to supporting the success of fighting an epidemic. Fighting against an epidemic requires close cooperation between multiple government agencies and the public.[34,35] Only when the relationship between government and people is deeply connected and bound with trust, can everyone work together to achieve the common goal of success in fighting against an epidemic. It fully reflects the character of "people's war" in this nationwide campaign.

Fourth, ABCD+5G technology are applied in all aspects from government adaptable governance, trusted collaboration to moral compliance. On one hand, government uses ABCD+5G technology to implement adaptable governance and carry out information dissemination and the promotion of moral compliance to people. As a result, they sufficiently communicate and understand each other and form a trusted collaboration. On the other hand, adaptable governance, moral compliance and trusted collaboration work better when they link together around ABCD+5G technology.

Conclusions

This paper introduces the lessons and experiences learned in fighting against COVID-19 in China. After review and analysis of the development of epidemic, we found that the emergency management of public health emergencies failed to initiate effective control and prevention at the beginning, and didn't provide early warning of an epidemic. Immediately, the adaptable government took a leading role and efficiently initiated a country-wide campaign. During the fight, people's compliance to various prevention and control measures government implemented was essential. In addition, the efficiency and effectiveness of pandemic control cannot be achieved without cooperation between government and the public. It is evident that people's compliance to these prevention measures was largely driven by a social culture of moral compliance and a trusted collaboration between government and people. During the process of epidemic control and prevention, ABCD+5G technology are indispensable. The technology support of ABDD+5G is needed in improving the adaptable governance, strengthening the public's moral compliance

Figure 3: Conceptual model of emergency management of public health emergencies based on ABCD + 5G technology.
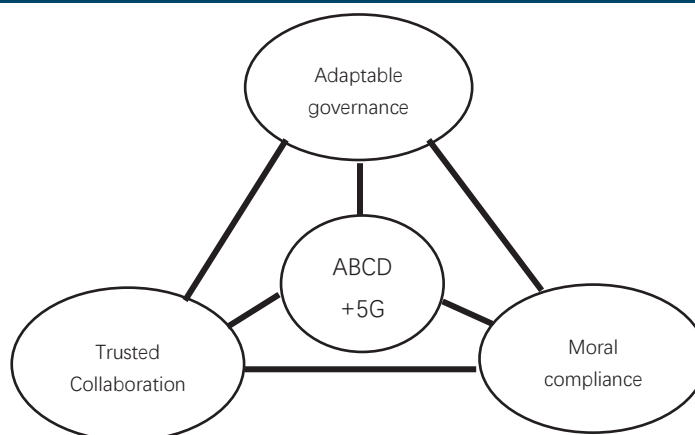
and enhancing the collaboration between government and people. Meanwhile, the application of ABCD+5G technology in various work of epidemic control and prevention is essential to improve the efficiency and effectiveness of the whole process.

Acknowledgements

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