

## Lessons Learned from COVID-19 on the Continuity Planning

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**Abstract:** Efficient control of pandemic as COVID-19 calls for strategic continuity plan. This review evaluates lessons learned from mitigation measures during the COVID-19 pandemic. Essential parts of an effective continuity plan facing potential infectious emergency have been discussed, including hospital plans, food supplies, personnel training, leadership, implementation strategies and financial support. Mitigation approaches that executed efficiently and brought positive impact in China have been extensively discussed which may provide reference value for other governments.

### 1. Introduction

The COVID-19 disease was firstly reported in Wuhan, China, in December 2019. To date, there have been 4,976,000 deaths, 2,450.3 million confirmed infections and 2, 2230. 6 million cured cases worldwide. The disease is spread by droplets and is highly contagious, with the World Health Organization (WHO) issuing an estimated R0 of 1.4 to 2.5 [1]. (Basic reproduction number, or R0, is an epidemiologic average of the number of people infected with an infectious disease who are at risk of transmitting the disease to others without intervention and without immunity.) Various countries have taken different measures to respond to this incident, and this paper examines a long-term continuity plan applicable to China. Continuity plan definitions policy coordination broadly as "the result of pursuing coherence, consistency, harmonious and compatible policies". Public policy coherence should be understood as a process of sidestepping conflict and facilitating synergies between and within different policy areas to achieve outcomes related to mutually agreed policy objectives. The purpose of this review is to discuss the lessons learned from this public health emergency and to compare the situation across countries to build a better continuity plan for tackling future public health emergencies.

### 2. Coronavirus

#### 2.1 Basic introduction to COVID-19

The outbreak of novel infectious disease coronavirus closely related to the acute respiratory disease COVID-19. COVID-19 is defined as the epidemic outbreak induced by infection of the coronavirus SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2). This is a critical period in human history, since emergency of SARS-CoV-2 has marked the third introduction of the highly pathogenic coronavirus into the human population. The spike proteins on the surface of SARS-CoV-2 are considered to be the primary protein that play a leading role for the viruses to get into the host cell. ACE2 (angiotensin-converting enzyme 2) has been discovered to be the functional host receptor for SARS-CoV-2. The spike proteins of virus dictate tissue tropism using the angiotensin-converting enzyme type (ACE-2) receptor to bind to cells [3].

## 2.2 Virology & Diagnosis

Notably, the SARS-CoV-2 is one of the highly pathogenic  $\beta$ -coronaviruses which infected people. Each step of diagnosis of COVID-19 is essential for the prevention and control of the disease.

The most common diagnostic tools concerning COVID-19 include molecular methods, serology, viral culture, and antigen test. The most recent technology for diagnosing the COVID-19 is the CRISPR-based method. The RT-PCR (real-time Polymerase chain reaction) is known as the most reliable and accurate test for confirming the COVID-19. The RT-PCR testing takes the mucus sample from the nasal cavity, the back of the throat, or saliva by a swab [2]. The genetic material of SARS-CoV-2 was tested to evaluate the existence of the virus in the host. In this RT-PCR test, RNA from the virus will be firstly reverse transcribed to DNA and after amplification of the DNA, the genetic code corresponding for SARS-CoV-2 can be detected if the virus exists in the sample.

## 2.3 Treatment

The typical manifestations of COVID-19 include fever, sore throat, fatigue, and cough. Most patients with COVID-19 have the mild or moderate disease. However up to 5-10% patients present life-threatening disease course [4]. Currently, supportive care measures such as ventilation oxygenation and fluid management remain the standard of care. Hence, there is a pressing need for the effective treatment of SARS-CoV-2. Up to reported date, many institutes have worked on the drug discovery and several agents have gone through phase III clinical trials.

The agents for the COVID-19, including chloroquine, hydroxychloroquine, favipiravir, monoclonal antibodies (an antibody produced by a single clone of cells or cell line and consisting of identical antibody molecules), antisense RNA, vaccine, and tramadol are all been evaluated. Tramadol has been reported to significantly reduce lactate dehydrogenase levels and also provide the cardio-protective effect. The COVID-19 patients with acute respiratory failure present severe hypercoagulability due to hyperfibrinogenemia result in increased fibrin formation. Polymerization may predispose them to thrombosis. It has been known that tramadol has a hypercoagulable effect on the blood of women with gynecologic malignancies. Consequently, tramadol may be helpful for patients who tend to be at a hypercoagulable status and with thromboembolic complications. Moreover, tramadol could affect hemostatic parameters in favor of bleeding tendency in rats. Currently, tramadol has also been used to relieve moderate to moderately severe pain, because tramadol is similar to opioid analgesics. It works in the brain to change how your body feels and responds to pain. It acts in the central nervous system (CNS) to relieve pain[5].

## 3. Before the epidemic

### 3.1 Hospital Plan

The plan of hospital human resource mobilization should be done ahead of time and related training should be carried out to prevent the need for staff retraining which may lead to inefficiency in accomplishing the task. In the beginning the epidemic, many hospitals in China had faced the scenario of lacking professional staff coping with infectious emergency. The hospital management department in China has fully performed its functional authority and established a three-level sustainable support echelon which can allocate human resources dynamically, organize pre job training, formulate positive incentive measures and supervise key work connections [7]. At the initial stage of infectious diseases, the following systematic similar plans would be of great value. This triage plan is adapted from the one from European Li è Ge University Hospital (Figure 1) [8]:

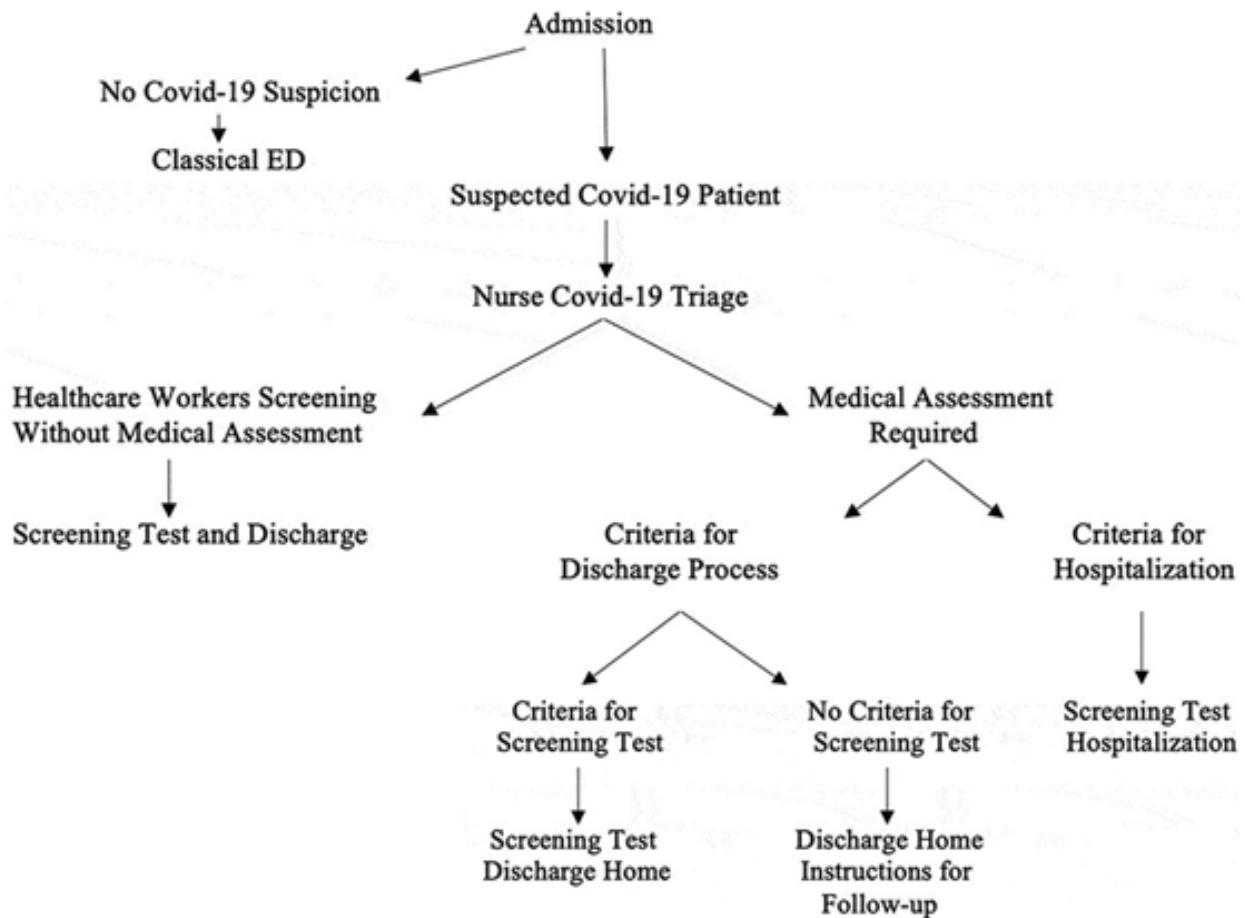


Fig 1. European Liège University Hospital's triage plan.

### 3.2 Food Supplies

In order to meet the basic needs of the population during a public health emergency, food supply strategy should be included in a continuity plan. The corresponding food supply source and transportation strategies needs to be included in the sustainability plan to secure daily necessities. Otherwise the panic of food shortage induced by the emergency might develop into panic purchase which add another layer of strain on pandemic control [9]. The State Food Administration can be involved in time to organize a specialized market to prepare and dispense food supplies. Take the epidemic in India as example, it is shown that the remote food supply chain was affected most. The arrival volume of vegetables and fruits in the Mantis area in India's free market has been reduced by an average of 60 tons per day after the blockade ( Figure 2) [10]. The shortage of food supply has not only negative affected the life quality there, it also placed obstacle for pandemic control as panic buying inevitably caused gathering. And lacking of vegetables and fruits would not support the healthy lifestyle which is essential for patients' recovery and infection prevention.

### 3.3 Capital Reserve

Material and finance resources allocation strategy is essential to cope with the public health challenge. Local governments need to have special reserves to face such incidence. These reserves will play vital role when the national special funds cannot be delegated in time during an emergency. Similarly, it is important for the municipal governments at all levels to be able to arrange special funds and have green channel for allocating them [11].

## Food supply in Mantis before and after lockdown

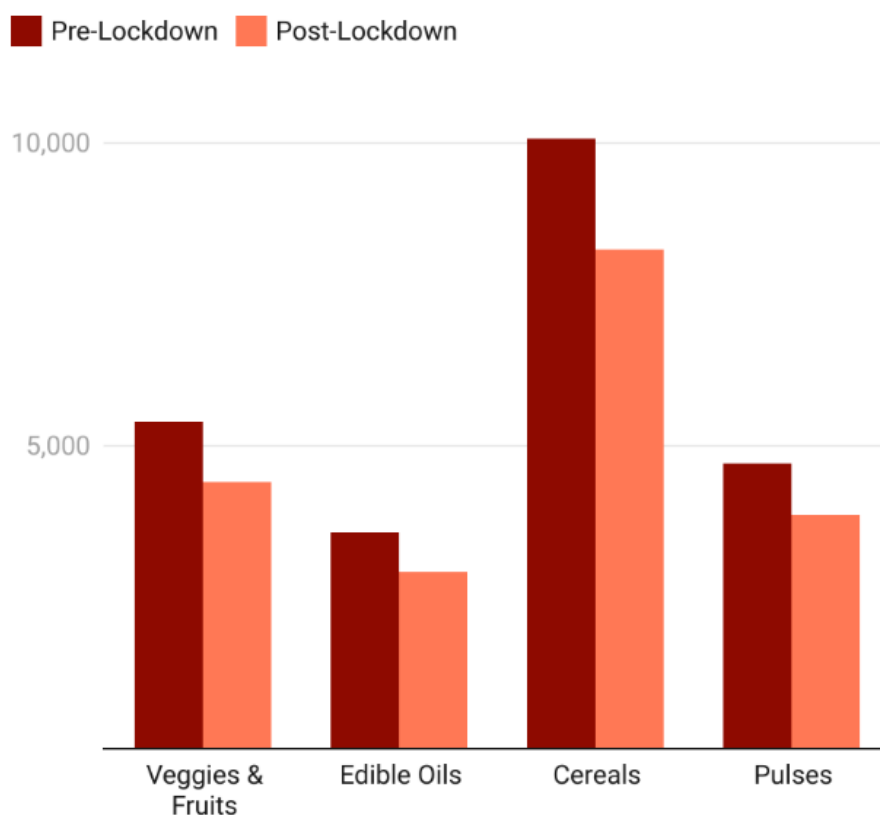


Chart: Chen canyang • Source: Mahajan K, Tomar S. COVID-19 and Supply Chain Disruption: Evidence from Food Markets in India†. *Am J Agric Econ.* 2020 Oct 25;10.1111/ajae.12158. doi: 10.1111/ajae.12158. Epub ahead of print. PMID: 33230345; PMCID: PMC7675588. • Created with Datawrapper

Fig 2. Food supply in Mantis before and after lockdown: India, 2020.

The sustainability plan should include the policy of the Finance Bureau to open fund-raising channels in time to raise funds from the society to help the country tide over the difficulties.

### 3.4 Public Space

Confronting with the infectious disease transmitted through person-to-person interactions, strategies to limit interactions among people should be taken, including closure of public spaces and facilities, restriction on social distance and banning of gathering [12]. Meantime, it is important to implement the corresponding management policies and execution plan. Grade classification has been wide applied in general health care system. The similar grade system has been adopted in the emergency diagnosis and triage in China where patients were classified into four levels according to their condition [13]. Infectious diseases into Grade A, B and C according to their infectivity and harm degree.

Level III Alert: small-scale public health events for which recreational gathering activities are restricted with closure of restaurants, cinema, and chess room etc.

Level II Alert: medium-range public health events which limit all gathering activities, close non-essential public spaces and facilities, including offline meetings, offline large-scale group teaching, all entertainment places and large markets.

Level I Alert: large scale public health events which strictly confine social distance and limit people's movement and promote home quarantine.

### 3.5 Medical Ability Assessment

To prepare for the surge of critically ill patients hit by high infectious disease such as COVID-19, cities at all levels in the world need to regularly evaluate the total number of beds in local hospitals, the reserves of hospital related medical materials especially ventilator for critical care, the availability of green channel, healthcare professionals especially intensive care unit practitioners and nursing professionals. The pandemic may cause mismatch between patients demand and hospital administration capacity especially in the beginning of the outbreak when most hospitals did not have plan for the emergency. Taking the case in Japan as example, Figure 3 shows comparison between the number of beds in 7 regions in Japan and the actual COVID-19 patients. The data shows the number of COVID-19 cases per 100000 people and the number of hospital beds owned by the region. The number of infected people at the peak of the epidemic accounted for almost 650% of the total number of designated people [14] which indicates the patient administration capacity of hospitals in Japan, 2020 is far lower than the actual number of COVID-19 patients. Figure 5 shows the data on stock of medical supplies in Minnesota [15] [16]. The adequate collection of medical materials in Minnesota has prepared local hospitals to cope with the challenge. The Minnesota government has established financial strategies to secure the funding for medical supplies stocks, including the funding from federal government, and social fund-raising. Their emphasis on management on medical supply has effectively reduced total consumables cost and risk of potential medical accidents due to the lack of supplies.

#### Number of cases and beds per 100,000 population

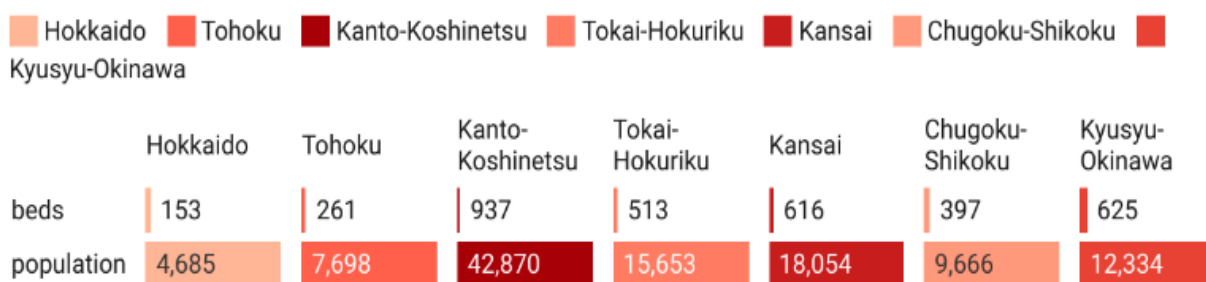


Chart: Chen canyang • Source: Yosuke Fujii, MD \*, Kiichi Hirota, MD, PhD Critical care demand and intensive care supply for patients in Japan with COVID-19 at the time of the state of emergency declaration in April 2020: a descriptive analysis (which certified by peer review) Doi:<https://doi.org/10.1101/2020.06.20.20136150> • Created with Datawrapper

Fig 3. A comparison of the number of hospital beds and the number of patients in seven regions: Japan, 2020.

In addition, comparison of medical healthcare professional reserves across countries (Figure 4) has shown that countries with larger population of clinical practitioners and nurses have better capability to cope with emergencies as the COVID-19 pandemic continues [18]. In countries with fewer doctors and nurses per capita, the existing workforce was even more stretched to meet the nursing needs arising from the COVID-19 crisis. Likewise, we can identify the patient treatment capacity of countries in dealing with public health incidents from this horizontal comparison. This assessment cannot only be used for planning, but also serve as a comparison tool between nations to identify where improvements can be made.

## Comparison of doctors and nurses per 1000 residents in 2020 or the latest year in many countries.

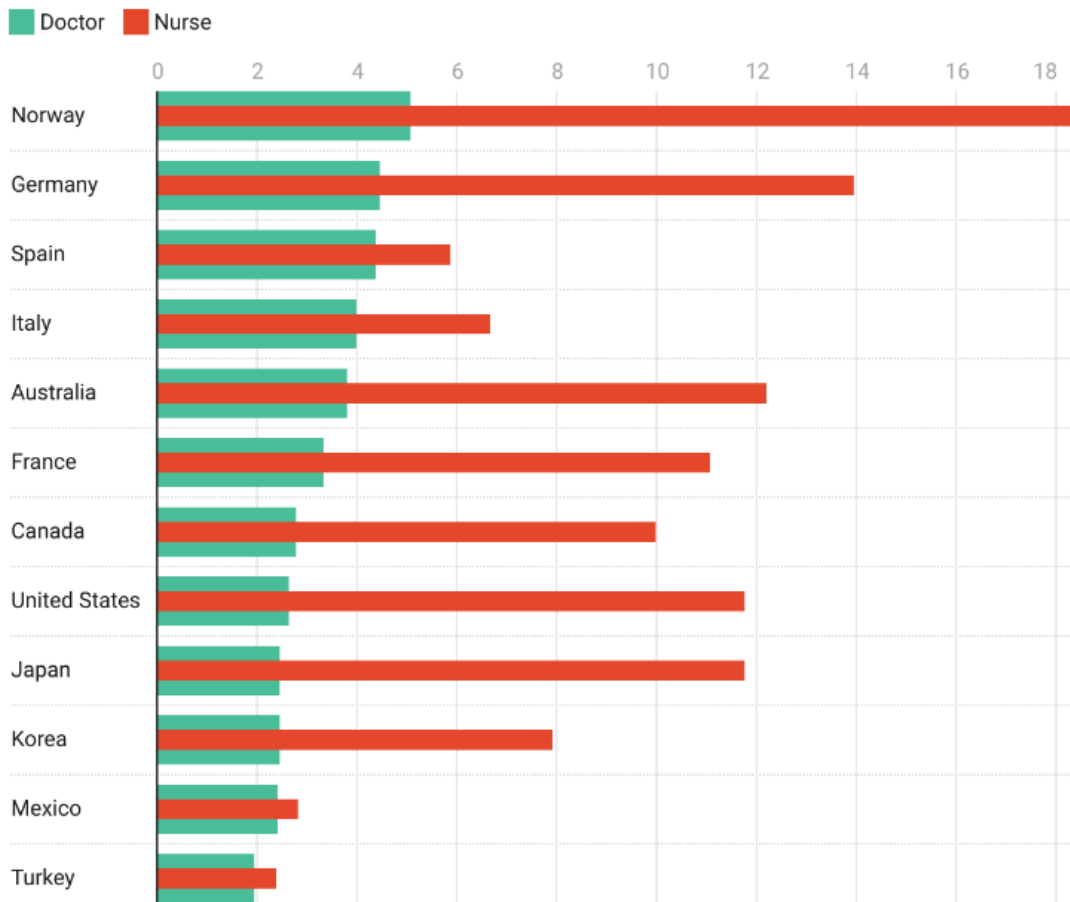


Chart: Chen canyang • Source: OECD (2021), "Nurses" (indicator), "Doctors" (indicator), (accessed on 23 August 2021). • © OECD Terms & Conditions; <https://www.oecd.org/coronavirus/en/data-insights/number-of-medical-doctors-and-nurses> • Created with Datawrapper

Fig 4. Comparison of doctors and nurses per 1000 residents in 2020 or the latest year in many countries.

## Comparison of medical supplies and people's needs in Minnesota during COVID-19

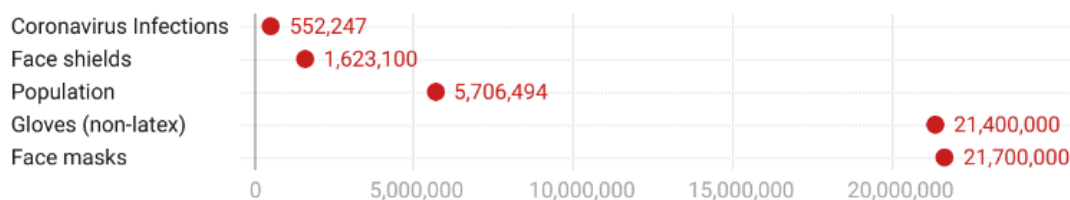


Chart: Chen canyang • Source: <https://mn.gov/covid19/data/response-prep/critical-care.jsp> & The 24th United States Census • Created with Datawrapper

Fig 5. Chart of quantity of medical supplies versus population and number of Coronavirus infections in Minnesota: United States, 2021.

### 3.6 Evaluation Information Sharing

Local health authorities should establish effective and transparent reporting system to inform the society and decision makers. The outbreak of SARS in 2003 has revealed hidden problems in the

monitoring and reporting system of infectious diseases in China. Thereafter, the Ministry of health of the State Council has proposed an open epidemic information network which is comprised of a vertical and horizontal information reporting network to assist the connection between clinics and public health information centers. This system also corresponds for instant information sharing, hygiene habits and mitigation measures promotion.

Top Authority Leadership on National Level

### 3.7 Organization setup

The top-down "leading group" has established an institutional foundation for authoritative decision-making on epidemic prevention and control in China.

China announced COVID-19 cases officially for the first time on Dec. 27, 2019. On Jan. 20, China declared the state of emergency and locked down Wuhan from Jan, 23, 2021. China Central Government COVID-19 Working Committee was set up on Jan. 25, 2020 with a central steering group dispatched. The joint prevention and control mechanism of The State Council was urged to play its coordinating role. As an important institutional arrangement for "solving the authoritative problem of interdepartmental decision-making" in China, the top-down "leading group" has established an institutional foundation for authoritative decision-making on epidemic prevention and control in China.

The significance of central leadership can also be demonstrated by the case from Germany. Figure 6 shows a comparison of daily new confirmed cases between Germany and United States from January, 2020 to October 2020 [17]. At same time period, German has one tenth of newly infected cases as in United States. Quickly after the first case reported in late January 2020, Germany has set up a crisis team under the auspices of the Ministries of Health and the Interior Affairs. In mid-March 2020, strict measures were announced such as travel bans and border closures. The mission of the crisis team is to ensure the health safety of the population and the response to COVID-19 as fully as possible. By institutionalizing the exchange of information, Germany remains alert and respond to disease progress in Germany, Europe and the world in a timely manner.

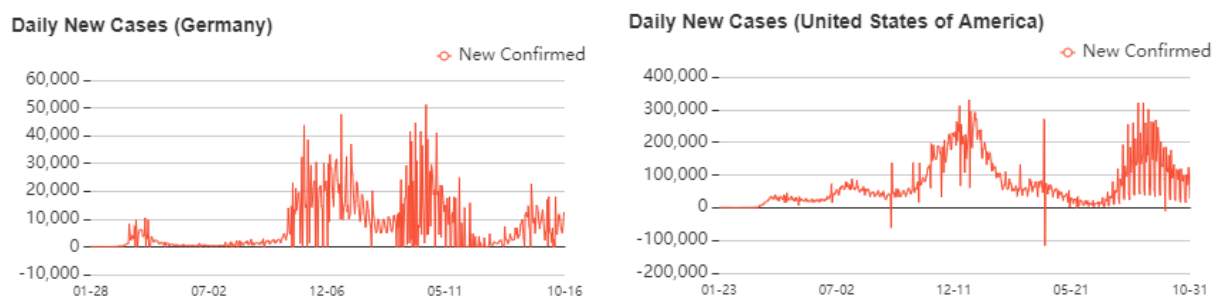


Fig 6. Comparison between Germany and US on Daily Infected Cases.

### 3.8 Complete and rigid legislation system to sustain all pandemic actions and achievements.

Legislation system need to be established once the emergency handling organization was setup. Public policies and regulations launched in China since the COVID-19 outbreak have been reviewed. 119 relevant laws and regulations have been launched specifically for the fight of COVID-19 in China with a tight timely manner. These laws are classified into 13 different categories including laws on strategic planning (5 published before pandemic), epidemic prevention and control (14 in total with 9 published/edited after pandemic break out), emergency management (8 published before pandemic), health care (17 in total with 15 published/edited after Pandemic break out), personnel management (9 in total with 4 published/edited after Pandemic breakout), market supervision (8 all published after pandemic Breakout), transportation & tourism (10 in total with 7 published/edited after pandemic break out), customs & quarantine (7 in total with 3 published/edited after pandemic break out), financial support (10 all published/edited after pandemic break out), public welfare and charity (5 in total with 2 published/edited after pandemic break out), ground-level personnel management (7 in total

with 6 published/edited after pandemic break out), labor protection (8 in total with 7 published/edited after Pandemic break out) and legislation (11 all published before the pandemic[18]

71 new regulations/laws have been released between January and early February 2020, within around one month after China declaring the COVID-19 National Emergency. This not only discloses one important success factor in China's pandemic control, but also shows the importance of a strong national central government in emergency.

### **3.9 Take the whole country into account**

Public health crisis calls for a coordinated and timely response for the whole nation, if not possible for the whole world. Therefore, it could only be the central government's responsibility to balance the interests of all provinces and take the whole country into account.

In late January 2020, soon after the outbreak of COVI-19 in Wuhan, the Chinese central government quickly activated the whole country to provide support. 29 provinces, autonomous regions and municipalities, and the military service were organized to delegate over 330 medical teams and 41,600 healthcare practitioners to assist the Wuhan city under lockdown.

In contrast, lack of centralized leadership in coping with the emergency has seriously impacted Italy's performance in the beginning of outbreak of COVID-19. Compared with other European countries, the Italian government was quite proactive and took early measures. The Italian government has prompted strong measures to prevent the virus from spreading after the large-scale outbreak. However, Italian government has failed to contain the disease effectively mainly due to low efficiency in executing the control measures and lack of centralized allocation and leadership [19].

### **3.10 Free treatment on COVID-19 infection under public health Medical Insurance structure**

A relatively complete medical insurance system is one of the essential factors to provide financial security for the society during the pandemic control.

Immediately after the official announcement of the pandemic, China quickly proposed the scheme to cover all COVID-19 related checking, treatment, medicines and operations under the public medical insurance schemes.

German government has introduced timely COVID-19 testing, and treatment under public health insurance scheme, so that residents have no financial pressure to get tested and see a doctor. In contrast, there are 30 million uninsured people in the United States. In U.S. early testing is not free. Many people have to bear the burden of illness. Therefore, there has been no "intestinal obstruction" phenomenon in the detection and treatment of Germany, and the denominator of confirmed cases can represent the test well, while the denominator of the United States, Italy and other countries may "shrink", because a large number of infected people are not included.

### **3.11 Local authorities as key stake holders on pandemic control and treatment**

All the policies made by the Central governments needs to be implemented on the ground. Hereby the local authorities at province / city / regional level needs to take the responsibility as stake holders on the implementation deployment, resources allocation and performance evaluation. One most important reason behind China's success is all the principal leader of the local authorities are held as stake-holder thus responsible for pandemic control and prevention.

In specific, in January 2020, COVID-19 Working Committees were setup at all government levels in China, from province, city, and districts to communities. The subsystem was quickly rolled out. All the number principal leader of the relevant government bureau takes extensive responsibility in case of any failure. This mechanism successfully cornered the key government officials to try their utmost on pandemic control and prevention. The resources and personnel in need have been quickly allocated under the local leadership.

The well-known "Health Code" technology was quickly developed under the centralized leadership. On February 7, 2020, "Shenzhen love you-Health Code" was launched successfully, making Shenzhen the first city in China to travel by "code". The city mandated residents to show health



code in Wechat mini program when entering and exiting the community. Half a month after the launch, the cumulative number of registered users has exceeded 8 million [20]

Following up the Shenzhen You-Health code, on February 11, 2020, Hangzhou city of Zhejiang Province has implemented the "green code, red code and yellow code" model. This system, registered through Alipay app, provide citizens their health information and contact history with confirmed or suspected COVID-19 cases within past 14 days. The big data has been collected and integrated into artificial intelligence platform in government data center which can valid the info and issue a color code to individual accordingly his personal contact history. A large number of returning workers applied for health codes on Alipay, and 10 million visitors registered the app on the first day[20].

This Hangzhou model became popular very soon and many other local governments adopted the same system for their own tracing app. Although there is difference in the format and name between each local tracing app developed by different province, all these apps can be recognized mutually. Within 2 months, every individual administrative unit in China have launched their own Health Code app which turns out to be one of the most powerful measures in fighting against COVID-19.

### **3.12 On the ground communities as implementor plays crucial role.**

Execution is essential to achieve the expected result which demand well organized team and disciplined individual. The ideal scenario for pandemic prevention and management should be the full transparency on every individual and the smooth implementation of the government policies. The pandemic mitigation process in China shows a great example on this. Working committees against COVID-19 were quickly setup in every district, village and community. Every organization and enterprise also established the corresponding epidemic control office. Therefore, every instruction or decision from the government/experts would quickly be implemented to all ground levels.

Labor unions, Communist Youth League organizations, women's federations and other people's organizations also mobilized their team to actively participate in epidemic prevention and control. Vast population of volunteers were involved in resources delivery, psychological consultation, and social security assistance.

Neighborhood committee take responsibility to supervise and provide support to local residents. Up to the year 2019, there are about 633k such local committees which form the front line of integrated mitigation measures and control [21].

With the clear instruction, sufficient financial support and healthcare resources, all strategies to contain the virus have been implemented efficiently. Any mistake is also easy to be tracked and corrected in time.

Consequently, this type of assessment cannot only be used for planning in advance within nations, but also serve as a comparison tool between nations, in order to see where improvements can be made.

## **4. Conclusion (Heading 5)**

The pre-public health emergency part of the continuity plan (planning ahead and implementing in the country's daily life) consists of the following seven aspects: Personnel Training, Hospital Plan, Food Supply, Capital Reserve, Public Space Management, Medical Ability Assessment and Evaluation information sharing. To cope with challenges during public health emergencies successfully, it is vital to train medical personnel in advance to avoid delay and treatment rush. Sufficient food supply, prepared transportation route, financial reserves at different government level are also essential to support the mitigation measure. Regular assessment and record of hospital administration capacity is an organic part of the continuity plan. The evaluation includes but is not limited to the number of beds, ventilation supplies, the availability of the green channel and the amount of healthcare professionals. In addition to active containment, it is also important to make case data public, so that national governments and global health organizations can be alerted in a timely manner.

Pandemic requests for continuity plan on public health. Successful stories from China reveals the crucial role of a powerful, effective and coordinated organization and operational mechanism. Professionalism and technology secured the success of the pandemic prevention and control. China's

successful story may not be able to be directly applied for other countries owing to different political and culture background. The essence of the continuity plan, disciplined execution and efficient response with clear responsibility delegation has reference significance.

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