

# Construction of Emergency Prevention and Control System for Public Health Emergencies in China

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**Abstract:** Public health emergencies severely affect people's lives and health, national security, social stability, and economic development. Against the background of the 2019 coronavirus pandemic, this study analyzed the current status of China's public health emergency prevention and control system from the perspectives of its six major systems: monitoring, early warning, and evaluation; diagnosis and treatment; basic scientific research; personnel training; material, equipment, and industry support; and social mobilization and coordinated action. It was concluded that strengthening the system construction is a realistic demand for China in the new development stage. The public health system of China still faces challenges in institutional positioning, capacity building, hardware investment, and management systems. Therefore, the authors propose that China should establish a national overall coordination and emergency command mechanism; strengthen clinical, science, education, and industrial support capacity; and further promote international cooperation.

**Keywords:** public health emergencies; prevention and control system; integration of prevention and treatment; detection and early warning; industrial support

## 1 Introduction

Public health emergencies refer to major infectious diseases, group diseases of unknown origin, major food and occupational poisoning, and other events that unexpectedly occur, cause or may cause serious harm to public health as well as other events that seriously affect public health [1]. The outbreak of the novel coronavirus pneumonia in 2019 (hereinafter referred to as COVID-19) was a big test for China's public health emergency prevention and control system. The country quickly started a first-level response mechanism for public health emergencies, implemented strict control policies across the country, and constantly improved COVID-19 prevention and control measures through scientific methods, thus rapidly controlling the epidemic situation in China. As the epidemic has entered regular prevention and control, China is constantly recording experiences, gradually improving the social management mechanism, strengthening the abilities of resource mobilization, comprehensively improving and forming an efficient and complementary professional division of the labor system, and gradually improving and strengthening China's public health emergency prevention and control system [2].

The nature of the public health emergency prevention and control system is a comprehensive reflection of China's overall medical ability in prevention, diagnosis, control, treatment, and healthcare. The fight against COVID-19 has showed to some extent that China's public health emergency response capacity is still weak, and deficiencies mainly exist in the coordinated development of mobilization and emergency prevention and control systems, accurate

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perception and management of emergency prevention and control, standardization of epidemic prevention and control emergency mechanisms, and differentiation of prevention and control measures in urban and rural regions. Therefore, with the aim of maintaining and promoting public health, considering the capacity building as the main line, the talent team building as the foundation, and the scientific research and innovation as the support, it is imperative to constantly improve the emergency prevention and control system of public health emergencies in China. By analyzing the development status and existing problems of public health emergency prevention and control in China and objectively examining the root causes of the problems, this paper thoroughly analyzed the problems in China's public health emergency system from multiple dimensions. These included accurate perception and management of emergency prevention and control of public health emergencies, emergency rescue systems and mechanisms, support of emergency scientific and technological research systems, construction of epidemic prevention and control standardization systems, creation of wartime national defense mobilization strategies, and differentiation of regional prevention and control measures. We also learn from international advanced experience and put forward relevant policy suggestions for the modernization of the emergency prevention and control system and governance capacity of public health emergencies in China, thereby providing reference for forming a scientific, effective, systematic, and comprehensive emergency prevention and control system for public health emergencies suited to China's national conditions, to ensure people's health, national public safety, social and political stability, and national economic development.

## **2 Demand for strengthening the construction of emergency prevention and control system for public health emergencies in China**

### **2.1 The ruling orientation of people first and life first**

Since the beginning of the 21st century, with the intensification of economic and trade globalization, acceleration of population and material mobility, and changes in climate and environment, new infectious diseases have occurred instantly and frequently, which seriously threaten people's lives and health [3]. Accidents, such as chemical leakage and major explosions, have also put forward new requirements and challenges for emergency rescue. In the new stage of China's development, the Chinese government upholds the concept of people first and life first, clearly puts forward decision-making arrangements for implementing the Healthy China Strategy, strives to shift its focus from treatment to healthcare, and emphasizes the strategy of prioritizing the development of people's health and ensuring health in an all-round and whole-cycle way [4]. In May 2020, the National Development and Reform Commission announced the *Public Health Prevention and Treatment Capacity Building Program* [5]. It is necessary to address the shortcomings of public health that are exposed during the fight against COVID-19, especially the prevention and treatment of major epidemics, optimize the layout of medical resources, and strengthen the integration of Chinese and Western medicine. China is constantly recording experiences, gradually improving the social management mechanism, strengthening the ability of resource mobilization, and comprehensively improving the national overall medical ability level, thus forming an efficient and complementary professional division of labor system and gradually improving and strengthening the public health emergency prevention and control system.

### **2.2 Promotion of medical science and technology innovation and development**

Scientific development and technological innovation are weapons to compete with diseases. Under the layout of major national science and technology projects for the prevention and control of major infectious diseases, China has made great strides in the construction of infectious disease technology systems and the scientific and technological support capacity for some major infectious diseases, which has played an important role in dealing with COVID-19. In the new era, the prevention and control of new and unexpected infectious diseases are not optimistic; the cross-border and cross-regional flow of the population aggravates the risk of transmission of infectious diseases. Future research must address the screening for pathogens that cause the diseases from the massive pool of pathogens that are found. Simultaneously, with the development of China's social economy, health awareness of the people is constantly increasing, and their demand for social participation and high-quality life is gradually increasing, all of which have put forward higher requirements for medical and technological innovation.

### **2.3 Promotion of social and economic development**

Emergency products such as therapeutic drugs, diagnostic reagents, and vaccines, as special commodities, belong to industries with high technical barriers and have the characteristics of a long research and development (R&D) cycle,

large investments, and high risks. The industrial chain is highly dependent on innovation-driven industries. China's health R&D resources, especially key resources, are scattered across various enterprises and research institutes. The reduction in the sales income of enterprises leads to the inability of enterprises to invest a lot of money in R&D. Considering the entire industrial development chain of detection, prevention, and treatment, the shortage of technology supply has increasingly become the main shortcoming that restricts production, circulation, and use. Developed countries have initially formed a good multi-industry resource integration mechanism and business model of continuous innovation and health promotion services. Relying on the needs of public health prevention and control, building new industrial clusters, establishing characteristic professional service institutions and platforms for health promotion, and carrying out active health technology application demonstrations are new dynamic processes to lead and drive social and economic development.

#### **2.4 Promotion of human health**

The outbreak of infectious diseases endangers human health, and the fight against pandemics calls for solidarity among the people of all countries. China has been actively participating in global anti-epidemic actions, actively carrying out international joint prevention and control measures, and has accomplished remarkable achievements in sharing experiences, aiding with materials, and strengthening vaccine and drug support, clarifying China's ideas and putting forward propositions. General Secretary Xi Jinping emphasized that China will uphold the concept of the human destiny community, share experiences for global epidemic prevention and control, provide support within its capacity, and work with other countries to promote the development of global public health and build a human health community. In the new era, with China's economic and social development and increasing international influence, and the continuous implementation of the Belt and Road Initiative, China will adhere to the supply of health science and technology and public health products, strengthen personnel exchanges, take practical actions to fulfill its responsibilities for maintaining global public health safety, and be an example to the world of a responsible major country.

### **3 Construction status of public health emergency prevention and control system in China**

#### **3.1 Monitoring, early warning, and evaluation system**

Since the outbreak of severe acute respiratory syndrome (SARS) epidemic in 2003, by focusing on the disease control system and medical institutions, China began to gradually build a nationwide monitoring and evaluation system for new and unexpected infectious diseases. During its fight against COVID-19, China's public health emergency prevention and control system quickly obtained gene sequence and strain information, and identified COVID-19 as the cause of the unexplained disease, which provided scientific evidence supporting subsequent research on prevention and control strategies and shared data with the world, providing a valuable window period for the global response to this epidemic. The shortcomings of China's monitoring and evaluation system have been exposed to a certain extent in response to the epidemic. The testing ability of national, provincial, municipal, and county laboratories is unequal, the timeliness of information feedback is insufficient, the testing ability of clinical institutions is weak, and the monitoring and evaluation of the effect of preventive intervention measures are insufficient [6,7].

#### **3.2 Diagnosis and treatment system**

During the fight against COVID-19, China's clinical institutions have made full use of the scientific and technological innovations in diagnosis and treatment, and ensured that the multidisciplinary diagnosis and treatment teams coordinated efficiently, the treatment threshold moved forward, timely clinical diagnosis and treatment plans were released, and teams were constantly updated to promote the homogenization of diagnosis and treatment in the country. The shelter hospital constitution creatively solved the problem of "one bed is hard to find" in Wuhan, played the important functions of "isolation, triage, basic medical care, close monitoring and rapid referral, and basic life and social activities", created new public health emergency concepts under emergency circumstances, and became an important turning point in fighting the epidemic in Wuhan. The dialectical treatment with traditional Chinese medicine (TCM) promotes the unique advantages of "preventing diseases" and multi-target intervention. However, compared with the international diagnosis and treatment system, China's system still needs to be improved in terms of pathogen detection ability, high-level safety laboratory and domestic equipment and instruments, and the construction of

informatization and sharing mechanisms (such as electronic medical record systems in China's medical system, which still needs to be strengthened). The national platform of clinical institutions and the resources and R&D capabilities supporting the research of pathogenesis are insufficient, and there are shortcomings in TCM diagnosis and treatment systems, such as scientific research systems for major diseases, response mechanisms, and real-world data research.

### 3.3 Support system for scientific and technological research

Chinese scientists have conducted scientific and technological research on novel coronavirus test reagents, animal models, transmission routes, vaccines and antibodies, epidemiology and traceability, and pathogenic mechanisms. During the epidemic, virus detection was completed to determine the strain, and a detection reagent was developed and successfully applied. Based on the mobile surgical shelter, pathological autopsy shelter, and pathology laboratory meeting, the negative pressure filtration biosafety processes were established, pathological research was carried out in time, and clinical institutions carried out clinical trials on drugs and vaccines, which provided strong scientific and technological support for epidemic control. Researchers constantly explore Chinese diagnosis and treatment experience in terms of epidemiological behavior, clinical characteristics, isolation treatment principles, and public health policies. Clinical trials of drugs and vaccines provide strong support for the regular prevention and control of the epidemic. However, simultaneously, in the process of fighting the epidemic, the shortcomings of China's scientific research system were also exposed. China is backward in epidemiological research methods, support, analysis and processing, and forecasting and early warning capabilities. In the research of highly pathogenic pathogens, the lack a research bases with long-term sustained and stable support exists, and it generally falls behind developed countries in the basic theoretical research and R&D levels in vaccines and drugs. Medical devices for severe treatment depend on imports, and detection reagents lack technology and raw materials [8].

### 3.4 Personnel education and training system

China has gradually formed a scale of public health education and training system, a relatively complete undergraduate, postgraduate, and post-graduation training mechanism, and has delivered a large number of talented public health students to various universities, health institutions, and research units. However, there is a disconnection between public health education and clinical medical practice in China, and the separation of medical and preventive systems is still serious; the career development path of public health students after graduation is limited [9], and wages are affected, which directly leads to a brain drain at the grassroots level in the industry and a shortage of personnel reserves in the public health industry.

### 3.5 Material, equipment, and industry support system

China's perfect industrial system and the complete supporting capacity of the upstream and downstream industries have effectively guaranteed the supply of epidemic prevention materials and have become an important support in fighting the epidemic. The effective production capacity of vaccine manufacturers in China is increasing, and the products have also passed the World Health Organization (WHO) certification, which strongly supports international anti-epidemic cooperation. However, the industry transformation of medical achievements has the characteristics of a long cycle, large investment, and high risk, and the market demand for emergency product R&D is unstable compared with chronic diseases [10]. In the absence of long-term and effective government support and emergency industrial policy coordination mechanisms, enterprises have insufficient motivation to invest in R&D and insufficient technology accumulation, which leads to an urgent need to improve independent support and guarantee the ability to promote the rapid transformation of epidemic prevention technology.

### 3.6 Social mobilization and coordinated action system

After the SARS epidemic, China began to systematically and comprehensively promote the construction of an emergency management system and formulated an emergency management system with "one case, three systems" as the central concept. Various provinces and cities have set up special emergency response departments according to the guidance provided, and the system construction has gradually matured. The COVID-19 outbreak has formed an effective national, provincial, and municipal joint prevention and control mechanism that has been unified by the central government and synchronously adjusted by provinces in response to changes in the epidemic situation. However, from the perspective of improving governance capacity and systems, the institutionalization and stability of

China's emergency command system need to be strengthened; it is insufficient for local governments to use expert resources and professional advantages to carry out professional responses [11].

## **4 Challenges in the construction of the public health emergency prevention and control system in China**

### **4.1 The separation of prevention and treatment in the health system**

The national public health emergency prevention and control system is closely related to the ability of national holistic medicine in “prevention, diagnosis, control, treatment, and healthcare”. However, in the process of implementation, there is often a serious separation of “prevention and control”. At the end of 2019, the total number of medical and health institutions nationwide reached 1 007 545, including 34 354 hospitals, 954 390 primary medical and health institutions, and 15 924 professional public health institutions [12]. As a result, the system components of “prevention, diagnosis, control, treatment, and healthcare” is separated. Professional public health institutions should continue to strengthen the aspects of institutional positioning for supporting capacity building to meet the requirements of public health prevention and treatment in this new period. At the end of 2019, the number of beds in national medical and health institutions was 8 807 000, of which 6 867 000 (78.0%) were in hospitals, 1 631 000 (18.5%) were in primary health care institutions, and 285 000 (3.2%) were in specialized public health institutions. Professional public health institutions only carry out disease prevention, control measures, and specialized medical care during peacetime; their ability to undertake public health emergency prevention and control measures needs to be urgently improved, and close cooperation from general hospitals is urgently needed.

### **4.2 Heavy investment on hardware and lack of talent guarantee**

From the perspective of investment and supporting hardware, the absolute amount of government investment in professional public health institutions has increased from 32.85 billion CNY in 2009 to 114.32 billion CNY in 2017 ( $\times 2.48$ ). However, the number of personnel in professional public health institutions was 6.41 per 10 000 people in 2019 [12], which is still far from the requirement of 8.3 per 10 000 people in 2020 in the *Mid- and Long-term Talent Development Plan for Medicine and Health (2011–2020)* [13]. Regarding the talent gap, outpatient doctors and public health doctors lack the manpower to implement “segmented management” for patients, and medical and public health human resources lack effective cooperation and organic combination. The public health function of secondary and tertiary hospitals in China is not sufficiently clear, which leads to the fact that although there are many frontline clinicians, their unique advantages of direct contact with patients, trust, and high compliance between patients and the public are not fully implemented. Contrastingly, grassroots health practitioners can only engage in public health work, and their low wages lead to brain drain, which further aggravates the shortage of talented public health prevention and control professionals.

### **4.3 Risk early warning and social mobilization capabilities need to be strengthened**

From the perspective of data governance capabilities, China's early warning capabilities still need to be improved. There is no automatic early warning mechanism between the national network direct reporting system and the information system of medical institutions, and a multi-point triggering infectious disease pathogen detection system has not yet been formed; therefore, it is impossible to quickly discover, evaluate, and respond to the epidemic situation. During emergency command and information transmission, the division of powers and responsibilities between the central and local governments and departments should be further clarified. Simultaneously, the participation mechanism of social mobilization forces is still being explored, and the effective participation of social, medical, welfare, and foundation forces in the rescue of medical emergency institutions, logistics support, and material reserve emergency operation mechanisms still need to be continuously improved.

## **5 Suggestions on the construction of public health emergency prevention and control system in China**

### **5.1 Establishing a national overall coordination and emergency command mechanism system**

The need exists to establish a command mechanism for national and local coordination and a joint prevention and control mechanism of multi-sectoral cooperation to further improve the emergency plan system for major epidemics

and public health, form a linkage mechanism involving prevention, diagnosis, control, treatment, and healthcare, and improve the construction of the command and emergency response system for large-scale natural disasters and nuclear and radiation treatment. In particular, the monitoring and early warning threshold should be moved forward, authorization system for emergency use of medical supplies should be promoted, national normalized emergency drill team and mechanism should be built, reserve and use management of emergency equipment and materials should be strengthened, legislative work should be strengthened, and an institutionalized work system (including policy support, public opinion monitoring, popular science propaganda, and participation of the entire population) should be formed.

### **5.2 Strengthening scientific and technological support**

The construction of a national science and technology independent support platform, scientific research base, and biological information resource library need to be coordinated, including the orderly layout of high-grade biosafety laboratories and creation of a national emergency base platform information-sharing and service network. Implementing the pathogen group plan, determining the basic number, strengthening the forward-looking research and prevention ability for unknown infectious diseases, and building a multi-point automatic triggering early warning system is crucial. A strong focus should be on strengthening the innovation ability of basic research in China and on the material basis and mechanisms of TCM, and on improving the layout of interdisciplinary fields such as antiviral drugs, vaccines, antibodies, instruments, and equipment. The integration of third-party network big data applications should be strengthened, intelligent and information-based epidemiological investigation and statistics tools should be built, and a national flow data processing, monitoring, and analysis platform with the national database as the main index should be established.

### **5.3 Improving the ability of clinical institutions**

It is necessary to strengthen the hardware transformation of emergency detection and peacetime-wartime combination abilities of medical institutions, and to promote the normalization mechanism construction of emergency medical rescue teams. With regard to the excessive division of the public health system in China, strengthening the integration of medicine and prevention, would increase the public health functions of primary medical institutions, enhance the ability of high-level medical institutions to prevent and control diseases, improve the diagnosis and treatment system of traditional infectious diseases, and continuously strengthen the early warning and detection abilities of medical institutions for new and unexpected infectious diseases.

### **5.4 Reforming the medical education system**

To improve the general education of clinical medicine undergraduates, a strong focus should be on strengthening the training of talented master's and doctoral degree students in public health, promoting the standardized training of public health doctors, and strengthening the continuing education of public health professionals. It is necessary to strengthen interdisciplinary integration; effectively improve the concepts of big data governance, health policy, and management; and pay attention to cultivating compound talents with a multidisciplinary knowledge base, public health professional background, rich international vision, and leadership and decision-making abilities. A series of talent evaluation systems should be established, the career development path of public health students should be clarified, and the benefits to grassroots-level professionals should be improved.

### **5.5 Promoting the transformation of scientific and technological achievements**

Full support should be provided to the independent innovation capabilities of science and technology of important industrial enterprises and they should be encouraged to carry out innovative research on emergency drugs, diagnostic reagents, and vaccine products through normalized policy guarantees and financial support. Incorporating existing rescue equipment and medicines into the national reserve system, improving the supporting and dispatching capabilities of upstream and downstream industries, and building an R&D system for testing and protective equipment systems is necessary.

### **5.6 Strengthening international exchanges and cooperation**

Cooperation with international organizations such as the WHO, the World Bank, and the Food and Agriculture Organization of the United Nations should be strengthened, and a global health cooperation network should be built for

active participation in international standards research, policy formulation, and risk assessment in the field of health. Focusing on deepening cooperation with countries along the Belt and Road, effectively improving their emergency prevention and control of infectious diseases, formulating special international cooperation projects, carrying out international cooperation and research on acute trauma and radiation injury medicine, and strengthening research on pathogens with potential threats to biosafety and public health are required.

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