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Summary and Recommendations of Development of Public Health and Disease Prevention and Control

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Abstract

The COVID-19 epidemic in 2020 is an emergency public health event rapidly spreading and hard to prevent and control, causing catastrophic loss of life and almost paralyzing the society. In the absence of specific antiviral drugs and vaccines, China has effectively curbed the spread of COVID-19 by taking non-medical intervention actions decisively and precisely, with the multidepartmental collaborations and involvement of all communities and individuals. However, in the process of combating the epidemic, problems and shortcomings have also been clearly shown in the disease control system and the emergency response system. This review tried to address the weaknesses and issues presented in the COVID-19 epidemic regarding the current system of disease prevention and control, laws and regulations related to public health, and public health emergency management. Also, detailed recommendations were made, including the reform of the CDC system, the development of science and technology, as well as the boost of public health professionals training.

Keywords

COVID-19; public health; disease control and prevention; system

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Summary and Recommendations of Development of Public Health and Disease Prevention and Control

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Abstract: The COVID-19 epidemic in 2020 is a public health emergency rapidly spreading and hard to prevent and control, causing catastrophic loss of life and almost paralyzing the society. In the absence of specific antiviral drugs and vaccines, China has effectively curbed the spread of COVID-19 by taking non-medical intervention actions decisively and precisely, with the multidepartmental collaborations and involvement of all communities and individuals. However, in the process of combating the epidemic, problems and shortcomings have also been clearly shown in the disease control system and the emergency response system. This review tried to address the weaknesses and issues presented in the COVID-19 epidemic regarding the current system of disease prevention and control, laws and regulations related to public health, and public health emergency management. Also, detailed recommendations were made, including the reform of the CDC system, the development of science and technology, as well as the boost of public health professionals training. **DOI:** 10.16418/j.issn.1000-3045.20200717003-en

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The coronavirus disease 2019 (COVID-19) epidemic is a public health emergency characterized by the fastest spreading, the widest range of influence, and the severest difficulties in prevention and control since the founding of the People's Republic of China [1–3]. As of August 29, 2020, a total of 90 314 confirmed cases and 4 725 deaths had been reported in China. In the absence of specific antiviral drugs and vaccines, general secretary Xi Jinping personally commanded and deployed the combat against COVID-19. With the collaborations and involvement of all communities and individuals, China has effectively curbed the spread of COVID-19 by timely detection, reporting, isolation, and treatment of all the patients and suspected cases. The effective and rapid control of this epidemic in China has gained valuable time for the global prevention and control [4–6].

The Centers for Disease Control and Prevention (CDCs) at all levels have played an important role in the China's non-medical intervention against COVID-19. However, problems and shortcomings have been exposed at the same time. This paper addressed the weaknesses and issues presented in the COVID-19 epidemic regarding the current system of disease prevention and control, laws and regulations related to public health, and public health emergency management, in combination with the strategic goal of Healthy China in the new era. Furthermore, we put forward detailed recommendations including the reform of the CDC system, the development of science and technology, as well as the boost of public health professionals training.

1 Problems of the current public health and CDC systems and corresponding recommendations

1.1 CDC system

The outbreak of severe acute respiratory syndrome (SARS) in 2003 and the COVID-19 pandemic have demonstrated that the public health safety has become an important part of national security and stability and the CDC system should be taken as the core of the public health system [7]. The shortcomings of China's CDC system, exposed during the COVID-19 epidemic, have already existed for a long time, which are mainly reflected in the following three aspects.

(1) Marginalization. The CDCs were derived from sanitation and anti-epidemic stations at all levels around 2000 due to the separation of supervision and monitoring functions. CDC is taken as a technology-based public institution with disease prevention and control as well as public health technology management and services as core functions. In 2009, China started to deepen the reform of the medical and health system, and incorporated the basic public health services with stronger constraints into the primary health system. The CDCs at all levels, which were classified as public welfare institutions, could not provide market-oriented services, and the staff salaries and operating funds were all supported by the government finance. The salaries of CDC staff were lower than those of staff in public hospitals of the

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same level and public servants. The cancel of chargeable technical services and the imperfect performance-based salary system failed to manifest the professional value of health technical personnel. With the implementation of zero value gap of vaccines, cancel of chargeable preventive physical examination, and free commission detection in the reform of public institutions in 2017, the income of CDCs dropped sharply. In some underdeveloped regions, the insufficient guarantee of government finance, together with the lack of compensation mechanism, challenged the operation of CDCs.

(2) Inadequate development. Although the Provisions for the Construction of Disease Prevention and Control System were issued in 2004, it has not been well implemented. The manifestations included the unsmooth coordination of national, provincial, city-level and county-level CDCs and primary preventive healthcare system, the unclear responsibilities of medical and health institutions in disease prevention and control, the imperfect response mechanism for public health emergencies, and the weak professional team of primary disease prevention and control institutions. The CDCs at all levels have unclear positioning and tasks, fragmented institutional settings and resource management, and overlapping functions and resource allocation. The responsibility detachment of the national-level CDC with the provincial, city-level, and county-level CDCs, as well as the overlapping work deployment and tasks of provincial, city-level and county-level CDCs, cause resource wasting, unclear development direction, and obscure function focuses [8].

(3) Insufficient professional leadership and weak ability of coordination in response to emergencies. In the face of major public health emergencies, the CDC system does not exert the speaking right or administrative power of professional leadership and coordination. In the overall management of the emergency response headquarter, CDC is in parallel with other departments (such as medical department, community department, public security department, and transportation department), and thus difficult to implement scientific prevention and control. China has established a joint prevention and control mechanism for public health emergencies led by the health department and participated by more than 30 departments, which strengthens the information sharing among different departments, military sections, regions and nations, and realizes the coordination across departments, regions, and nations. However, in the COVID-19 epidemic, the CDC system did not play a key role in the whole chain of epidemic research, decision-making, collaborative implementation, and emergency communication. The unsound mechanism of labor division and cooperation and the lack of information sharing between public health and medical institutions lead to the separation of prevention and control with treatment [9]. More attention is paid to disposal and clinical treatment while less to prevention, which results in the weak ability to deal with public health emergencies and the unsmooth integration of prevention and control with treatment.

In view of the above problems, we put forward the following recommendations. Firstly, we should confirm the compound public welfare and administrative functions of CDCs at all levels as soon as possible, and implement the operation mechanism of first-class public welfare institutions guaranteeing and second-class public welfare institutions managing. Their funds should be fully supported by government finance. The income of CDC personnel should be improved, and part of the income obtained from scientific research and services can be included in the basic wage and performance pay. Secondly, it is essential to reform the mechanism of training, certification, salary, assessment and incentive of public health professional team, expand the staffing size (especially technical professionals), optimize the resource allocation and functional stratification of national, provincial, city-level and county-level CDCs, and improve the coordination mechanism and labor division of CDCs, primary preventive healthcare system and disease control departments of medical institutions. Thirdly, through laws, regulations and policies, the CDCs should be established as the main body of professional leadership and coordination in the response to public health emergency, and become the secondary sector of information sharing between emergency response headquarter and other departments, decision-making and action, and overall planning, so as to maximize the efficiency, scientificity and coordination of health emergency management.

1.2 Laws and regulations related to public health

General Secretary XI Jinping instructed that we should always put people's life safety in the top priority and insist on the joint prevention and control of diseases according to laws and sciences from the perspectives of legislation, law enforcement, administration of justice, and law abiding in the article "Comprehensively Improve the Capacity of Prevention, Control and Treatment of Diseases According to Laws, and Promote National Public Health Emergency Management System." The prevention and control of disease according to laws has been put in the first place, whereas the construction of relevant laws and regulations supporting the major epidemic prevention and control mechanism and the national public health emergency management system still has some shortcomings.

(1) Unsound laws. Up to now, there is no mother law for public health in China. The basic rules, policies and principles of public health defined by law remain not clear. The current health laws and regulations are mostly formulated from the specific functions of food health, child and adolescent health, radiation health, environmental health, and occupational health in the past. The Law of the People's Republic of China on the Promotion of Basic Medical and Health Care approved at the 15th Session of the Standing Committee of the 13th National People's Congress at the end of 2019 included health in law for the first time and came into force on June 1, 2020. However, this law focuses more on the

specific provisions of medical service system, medical security system and drug supply system, and barely mentions the public health system institutions which are most directly related to the basic medical and health. Moreover, the specific provisions are not consistent with functions of CDCs which are currently classified as technology-based first-class public welfare institutions.

(2) Unsmooth connection of different laws. The various laws and regulations related to public health in China have poor connection, systematic balance and unity (Table 1). For example, the Law on Prevention and Treatment of Infectious Diseases, the Emergency Response Law, and the Regulation on Responses to Public Health Emergencies have the characteristics of rigidity, lag and inabilities in response to major public health emergencies with unknown causes.

(3) Lack of timely revision. The reform and development of China's public health system lags behind that of not only economy and other social undertakings but also medical service system, medical security system and drug supply system which also belongs to the national health system. The global major public health events have occurred frequently, and China's current laws and regulations of public health cannot meet the growing health needs of the people.

(4) Failure of law relying and slack law enforcement. The frequent changes of law executors, the frequent separation and integration of administrative departments' responsibilities, and the adaptation and running-in of health commissions at all levels after the establishment in 2018 make it difficult for the enforcement of public health laws and regulations. In the combat against COVID-19, it is common for administrative leaders to be held accountable, which exposed their inadequate understanding of and inadequate attention on as well as slack enforcement of public health laws.

In view of the above problems, we have the following suggestions. Firstly, China should formulate the basic law of public health as soon as possible to specify the basic rules, policies and principles, and build a multi-dimensional legal system involving public health service law, medical security law, health promotion law, public health supervision law, public health emergency management law and international public health law [10,11]. Secondly, the Public Health Law (to be formulated), the Biosecurity Law (to come into force) and the Emergency Response Law (to be revised) can be taken as the legal support for public health, national security and emergency management in the national public health emergency management system [12]. Thirdly, it is necessary to further clarify the main functions of different subjects and institutions before, during and after health emergency management in the laws and regulations. In order to adapt to the rapid progression of public health emergencies at present and in the future, the laws and regulations should give CDCs certain administrative decision-making power. For example, the national, provincial and county-level CDCs can be empowered to release epidemic information and collect evidence. Fourthly, the laws and regulations related to public health should be timely revised. In addition, the subject of law enforcement should be clear, and the law training should be strengthened.

Table 1 Examples of laws and regulations in China's public health system

Category	Examples
Laws	Law of the People's Republic of China on the Promotion of Basic Medical and Health Care
	Law of the People's Republic of China on Prevention and Treatment of Infectious Diseases
	Animal Epidemic Prevention Law of the People's Republic of China
	Emergency Response Law of the People's Republic of China
	Food Safety Law of the People's Republic of China
	People's Republic of China on Maternal and Infant Health Care
	Food Hygiene Law of the People's Republic of China
	Law of the People's Republic of China on Blood Donation
	Pharmaceutical Administration Law of the People's Republic of China
	Law of the People's Republic of China on the Prevention and Control of Occupational Diseases
	Law of the People's Republic of China on Red Cross Society
Administrative regulations	Regulation on Responses to Public Health Emergencies
	Measures for the Implementation of Law on Prevention and Treatment of Infectious Diseases
	Regulation on the Administration of Sanitation in Public Places
	Measures on the Use of the Sign of Red Cross
	Regulations on Domestic Communications Health Quarantine
	Regulation on AIDS Surveillance
	Regulations on Radiation Protection of Radioisotopes and Nuclear Radiation Devices
	The Regulations on Labor Protection in Workplaces Using Toxic Substances
Normative documents released by the State Council	Contingency Plan for Emergencies
	Contingency Plan for Public Health Emergencies
	Contingency Plan of Medical Rescue for Public Health Emergencies
Normative documents released by the National Health Commission (including the former National Health and Family Planning Commission and the Ministry of Health of China)	Emergency Disposal Scheme for Group Diseases with Unknown Causes
	Provisions for the Construction of Disease Prevention and Control System
	Measures for the Administration of Pre-examination and Separation of Patients with Infectious Diseases by Medical Institutions
	Health Emergency Response Specifications of Medical Institutions in China (Trial)
	Health Emergency Response Specifications of Disease Prevention and Control Institutions in China (Trial)
	Measures for the Administration of Information Reporting on Monitoring Public Health Emergencies and Epidemic Situation of Infectious Diseases
Technical documents released by the Chinese Center for Disease Control and Prevention	Regulation on the Urgent Handling of Public Health Emergencies
	Classification Standards for Public Health Emergencies
	Guidelines for Health Emergency Responses to Natural Disasters
	Technical Guidelines for Prevention and Control of Infectious Diseases Caused by Natural Disasters
	Emergency Disposal Scheme for Group Diseases with Unknown Causes (Trial)
Public health conventions (treaties)	International Health Regulations
	Declaration of Alma-Ata
	Global Strategy for Health for All by the Year 2000
	World Declaration on the Survival, Protection and Development of Children
	Convention on Psychotropic Substances

1.3 Policy support for public health emergency management

There are many uncertain and complex factors in the early emergency management of COVID-19. Therefore, the efficiency of prevention and control measures is considered as the priority at this stage. However, some grass-roots CDCs show tardy health emergency response, weak capabilities and poor management. The sound policy support is the premise of legal, scientific, rapid and effective health emergency management, which is not the case.

(1) Imperfect support mechanism. The current health

emergency management system has the problems of unclear public health service of CDC, unsound government financial support mechanism, and insufficient fund. In the response to COVID-19, the reporting and information publish follow the flow of county-level CDC→county-level health management organization→county-level government→higher-level government or city-level/provincial CDC→city-level/provincial health management organization→city-level/provincial government. Due to the implementation of hierarchical financial support and hierarchical responsibility system, the communication among departments in the same administrative region, the reporting of lower-level department to the higher-level department, and the feedback of higher-level department to the lower-level department, the first-hand information collected by the grass-roots department cannot be timely transmitted to the central government.

(2) Unclear support mechanism of finance and emergency supplies. The unified planning-management-deployment system of emergency material reserves is absent in China. Especially in the fight against COVID-19, problems such as poor information sharing, inefficient distribution and lagging feedback of emergency supplies are serious. The poor efficiency of relevant institutions in integrating government reserves, private reserves and production capacity hinders the effective utilization of social resources and the donation of money and supplies. Besides, the existing conditions do not match with the actual needs of management and rescue of public health emergencies [12].

(3) Insufficient support for health emergency management system. The Ministry of Emergency Management and emergency management departments at all levels established in 2018 are responsible for the guidance of response to production emergencies and natural disasters. This system is not well integrated with the emergency management system of public health, and has weak comprehensive coordination and support ability of health emergency response.

In view of the above problems, we bring forward the following suggestions. Firstly, the government should clarify by laws and regulations the allocation mechanism of financial expenditure and working funds before, during and after major public health emergencies. This will ensure the normal operation of emergency headquarter and the involved departments by straightening out the relationship between headquarter and subdivision, superior and subordinate, as well as management and profession. Secondly, the prevention, control and treatment of major public health emergencies necessitate the establishment and improvement of the emergency support mechanism with rapid resource collection, allocation, mobilization and information sharing within regions, across regions, and for civil-military integration as the core content. Thirdly, more specific management measures and technical specifications need to be formulated to clarify the scope of personnel authority and specific requirements of work, give local governments certain autonomy, and implement management by objectives, performance evaluation and reward and punishment, so as to ensure the quality of work [13].

2 Construction of the public health and CDC system in the new era

2.1 Development of emergency management functions of CDC system

The emergency management of major public health emergencies is the comprehensive embodiment of national governance system and governance capacity. The COVID-19 epidemic exposed the problems (e.g., inefficient operation, lack of epidemic awareness, delayed warning, inaccurate research and judgment, weak emergency management ability, and insufficient guidance ability for social public opinion) in some public health departments and CDCs. In view of these problems, the functions and tasks of CDC in the new era should focus on the following three aspects.

(1) Warning of major public health risks. On the basis of the traditional reporting and monitoring systems for death, disease, nosocomial infection, infectious disease, and public health emergencies, as well as the epidemiological investigation and analysis technology, CDCs at all levels should develop and utilize new data and information technologies. This will strengthen public health monitoring from regional level to global level, and improve the national monitoring and warning, infectious source identification and case tracing for major diseases, emerging diseases and major epidemics, thereby realizing the efficient, intelligent and digital monitoring of public health risks.

(2) Professional research on the occurrence and progression of major diseases. The national, provincial and city-level CDCs should develop intelligent prediction technologies, such as online risk identification, real-time warning, risk spatio-temporal evolution analysis, risk quantification, and adaptive prediction. These technologies will improve the CDC ability of major disease monitoring, emerging disease detection, and warning and prediction of sudden outbreaks. Further, they will facilitate the early identification of public health risks and understanding of the temporal and spatial distribution of diseases to provide scientific evidence for each stage of emergency management. In addition, the CDCs at all levels should have a certain comprehensive analysis ability to make clear the infectious source, transmission route and susceptible population, major natural and social factors, as well as the infectivity and main risk factors of transmission in communities and hospitals.

(3) Public opinion analysis and risk communication. In the new-media era with developed We-media of social network and rapid information dissemination, the public opinion analysis and response ability of government is insufficient [9]. During the epidemic, the government should well communicate with the public and the media and make full use of

the public health public opinion dynamic monitoring and warning system of CDCs for the public opinion monitoring, warning, analysis, response, guidance, release, and feedback on different platforms at home and abroad. This will avoid the malignant fermentation of negative event information in the network and play an active role in guiding network public opinion [14]. In the future response to major public health emergencies, we should convey the correct knowledge of the measures taken in each stage and the possible deployment in the future, and encourage them to take effective prevention and control measures, so as to minimize the risk of public health emergencies. At the same time, prediction and warning should be conducted for the hot issues that may trigger the discussion of the public.

2.2 Modernization of science and technology

The modernization of the disease control and prevention system is backed by basic research, public health and clinical application research and translational research for major infectious diseases and chronic non-infectious diseases. Science and technology, especially the research support for rapid detection technology and products, virus etiology, transmission dynamics and epidemiology, have become a powerful weapon in the combat against COVID-19. However, for a long time, the CDCs at all levels have insufficient input in research, inadequate professionals, and weak research ability, and their incentives of research are in need of government financial support. In the future, it is necessary to introduce modern research system and mechanism, technical equipment and facilities, and scientific management system for the CDCs in the response to and control of major public health emergencies, as well as in the building of the epidemic monitoring and warning system, laboratory detection system, decision support system, and command system that meet the needs of modern disease prevention and control [7].

(1) Modern information system for epidemic monitoring and warning. A complete, sensitive, transparent and nationwide modern epidemic monitoring and warning system is in urgent need to make full use of big data, artificial intelligence, blockchain, cloud computing and other advanced technologies. In this way, the information of monitoring, research, services and emergency responses of CDCs at all levels can be integrated, which promotes the resource sharing of collaborating departments (e.g., medicine, public security, transportation and communication) to improve the accurate interpretation of professional information. At the same time, the research and development of portable rapid detection reagents and efficient digital epidemiological investigation technology should be fostered to improve the tracing ability of major epidemics and support the health emergency prevention and treatment as well as resource allocation.

(2) Regional laboratory testing system with different protection levels. At the beginning of COVID-19 epidemic, the inadequate primary medical institutions qualified to detect the virus and the limited nucleic acid detection reagents restricted the demand for rapid and large-scale nucleic acid detection. Therefore, promoting the construction of CDC laboratories at different levels in different regions is conducive to the preliminary study of public health emergencies and the response to the epidemics of unknown causes.

(3) Rapid and accurate decision support and command system. In the response to major public health emergencies, the rapid and accurate decision and command system is the basis for the professional leading position of CDC. In the future, we should study the mechanism and method of evidence-based decision-making, including policy research, epidemiological investigation, evidence retrieval, expert consultation and involvement of all interested parties. The study can be supported by the accurate and all-dimensional big data real-time collection system, disease monitoring and epidemic law AI deep-learning system, big data cloud computing intelligent warning and prediction system and emergency support unified resource management and deployment system. In addition, according to different types of evidence, we can study the integration methods to generate clear decision support information.

2.3 Reserve and modernization of professionals

The brave personnel of CDCs at all levels have conducted great work for the combat against COVID-19. However, the CDC at all levels has some problems such as the shortage of personnel and staffing support, the unreasonable structure of professional team, the loss of technical professionals and the serious shortage of compound talents, which is related to not only the current discipline system and personnel training but also the talent evaluation mechanism and policy guidance. It is urgent to strengthen the professional talent reserve and modernization of public health institutions and CDCs. In the new era, disease monitoring and warning, health emergency response and epidemic prevention and control should be carried out by a professional team with rapid actions. Therefore, in the post-epidemic era, we need to fully understand the basic position of public health education in national security construction and improve it to promote the modernization of the professional team for the disease control and prevention system.

(1) Strengthening the modern public health education. Public Health 3.0 emphasizes cross-sectoral cooperation to change the health-related social determinants through actions involving environment, policy and system [15]. Therefore, the modern public health discipline should not be limited to the traditional biomedical and preventive medicine. Instead, it should integrate science, literature, engineering, law and management. Firstly, it is essential to systematically plan the cultivation of public health professionals in China at the level of big health and biosecurity. The education-based stratified professional training should be schemed according to the goal of the modernization of national public health governance system and capacity. Secondly, colleges and universities should give policy, fund and personnel support to key

discipline distribution, academic platform construction, practice base construction, and special program of research talents. They need to focus on the development of weak disciplines such as infectious diseases, epidemics and public health emergency management, and increase investment in core areas including public health education, enrollment and teacher team construction [16].

(2) Adjusting the focus of cultivation of modern public health professionals. At present, the current cultivation of public health professionals and compound talents as well as their practical training, postgraduate education and continuing education in China need to be improved. In terms of talent cultivation mode, the gap between public health and clinical medicine needs to be bridged to solve the disconnection between disease prevention and treatment. Attention should be paid to the innovation of teaching contents and methods, the construction of practice base, and the integration of teaching and practice. In terms of ability training, efforts should be made to foster the leadership as well as the abilities for emergency response and big data application. Secondly, we should establish a national professional certification system for public health, strengthen the effectiveness of certification, establish withdrawal mechanism of non-certification, and ensure the education certification at the three stages: medical college education, postgraduate education and continuing education. In terms of professional training, we should give priority to primary and scarce medical care professionals, formulate targeted or flexible employment policies, guarantee salary guarantee, and balance professional supply and demand. At the same time, the doctor of public health (DrPH) education should be promoted for the cultivation of compound public health professionals who can meet the current demands [17].

3 Summary

The outbreak of COVID-19 challenges the major public health emergency management, national security governance and comprehensive national strength of China. The modernization of public health and CDC systems in the new era will be a systematic project, which examines the coordination mechanism of social fine management and the "combination of peacetime and wartime." On February 10, 2020, when investigating the prevention and control work against COVID-19 in Beijing, General Secretary Xi Jinping stressed that we should take the construction of CDC system as a fundamental work, improve professional cultivation and training, research and legislation and promote the modernization of CDC system. At the 12th Session of the Comprehensively Deepening Reform Commission of the CPC Central Committee on February 14, General Secretary Xi Jinping reiterated that we should reform and improve the CDC system, implement the health policy with prevention as the priority, adhere to the principle of unremitting preparation, move the prevention gateway forward, and avoid minor diseases leading to major epidemics. At the 73rd World Health Assembly on May 18, he proposed that in view of the weaknesses and deficiencies exposed by the epidemic, we should improve the public health management system, accelerate the responses to public health emergencies, and establish global and regional reserve centers for epidemic prevention and control supplies. Therefore, the public health and CDC systems in China should be reformed and improved from three aspects of disease prevention and control, laws and regulations related to public health, and public health emergency management. In the post-epidemic era, it is urgent to expand the new emergency management functions of CDC system, develop key technologies, and promote the reserve and modernization of public health professionals. These measures will facilitate the improvement of China's public health, social and economic development, public safety and justice, and further the construction of a global community of health for all.

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