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Emergency Rescue System for Public Health Emergencies in China

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Abstract: This study discussed the important role of emergency rescue systems in handling public health emergencies, and from the perspective of building emergency rescue capacity, summarized the characteristics of China's fight against the COVID-19 epidemic. The research also reflected on the experiences and lessons regarding emergency rescue to combat the epidemic. Regarding China's emergency rescue system, the study summarized the main contents and characteristics of the three stages for development and analyzed the existing problems from three aspects: mechanism, resources, and the overall level. The results guided the proposal of several specific countermeasures and suggestions for the construction of the emergency rescue system for public health emergencies in China. The suggestions encompassed the aspects of handling modes, scientific layout and function promotion, talent team construction, emergency material support, grassroots capacity building, multi-disciplinary integration, scientific research–disease control–clinical treatment coordination, wartime mobilization mechanism, international cooperation, and action outline formulation. The findings are expected to help improve relevant national policies and systems, strengthen the health protection net for people, and maintain a sound environment for national security development in China.

Keywords: public health emergencies; emergency rescue; system construction

1 Introduction

The response to public health emergencies typically includes prevention, control, rescue and treatment, recovery, and other major stages in which emergency health treatment is a critical step [1]. Emergency rescue involves a series of rescue activities in response to devastating emergency incidents to control the occurrence and escalation of the incident, reduce the loss caused, and restore conditions to normal as quickly as possible [2]. It is a highly comprehensive rescue project that focuses on rescue and involves several aspects of prevention and control [3].

Since the start of the 21st century, various disasters and accidents have frequently occurred, and potential national biosafety risks have also increased continuously in China. Infectious diseases and other public health emergencies have occurred constantly in the world, requiring regular prevention, control, and treatment [4]. The occurrence of public health emergencies in an increasingly unprecedented, linked, and derivative manner has resulted in more difficulties for prevention and control, as well as in the rescue tasks [5]. Major acute infectious diseases are attached with the highest importance among public health emergencies as they are unpredictable and likely to cause large-scale health risks. For emergency response to such emergencies, the fundamental task is the proper handling of prevention, control, and rescue systems. The rescue system is the last line of defense and bottom line for response to public health emergencies. Therefore, the construction of an emergency rescue system has important political,

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social, and economic significance for quickly addressing the situation, effectively controlling development, and maintaining social stability [6].

From the sudden outbreak at the end of 2019, the COVID-19 pandemic has been characterized by its unknown causes and rapid spread, and continues to pose unprecedented challenges to the construction of emergency response capabilities. In the fight against the pandemic, China has taken many effective actions under the strong leadership and unified command of the CPC Central Committee. By fully utilizing the advantages of socialism, China has launched nationwide effort and employed its resources. It has achieved remarkable results and continues on a unique path with Chinese characteristics as it battles the epidemic. In the context of the significant gains in the nationwide fight against COVID-19 in China, the present study intended to summarize and reflect on the relevant experience and lessons from emergency rescue during the epidemic. The findings can provide important references for improving relevant policies and systems, building a defense net for the life and health of people, and maintaining a good environment for national safety and sustainable development.

2 Development history of emergency rescue system for health emergencies in China

The development of China's emergency rescue system for public health emergencies can be divided into three stages: government-guided management, legalization, and upgraded development.

2.1 Government-guided management stage

China's health administrative authorities put forward the systemic management requirements for emergency medical rescue during emergencies in *Regulation on Medical Rescue in Case of Disastrous Accidents* issued by the Ministry of Health in 1995. This legal document stipulated, for the first time, the standard management for medical rescue in case of disastrous accidents in organizations, as well as for disaster reporting, on-site medical rescue, victim transfer, departmental coordination, and personnel training [7]. One important aspect of emergency health response is controlling and eliminating severe health damages and social hazards caused by natural disasters, accidents, public health events, and social security events [8].

2.2 Legislation stage

The epidemic of severe acute respiratory syndrome (SARS) was a turning point in the construction and development of a public health emergency rescue system in China. Before the outbreak of SARS in 2003, the government-guided management mode was adopted in China; after the outbreak, China established a public health emergency rescue system under unified command. For the effective response to SARS, the State Council issued *Regulations on Preparedness for and Response to Emergent Public Health Hazards* in May 2003, providing the law for the emergency handling of the SARS epidemic. In 2004, the State Council established the Health Emergency Office, responsible for the unified command for public health emergencies, to form a clear framework of the emergency response system for public health emergencies. The principles were determined for handling public health emergencies: 1) Perform management according to laws and regulations to ensure rapid response; 2) adopt the unified command of the central government and the hierarchical responsibilities of local governments; 3) improve the monitoring system to enhance early warning capabilities; 4) improve the infrastructure to ensure continuous operation; and 5) establish an effective system for testing, information reporting, and multi-channel exchange and cooperation [9]. Subsequently, in 2006, the State Council issued *Overall National Emergency Plan for Public Health Emergencies*, *National Emergency Plan for Major Food Safety Accidents*, *National Emergency Plan for Major Ergent Animal Epidemics*, *National Emergency Plan for Health Rescue in Public Health Emergencies*, and *National Emergency Plan for Public Health Emergencies* [10]. Emergency medical rescue could therefore be conducted in a more standard manner. Corresponding to the four levels in the *National Emergency Plan for Public Health Emergencies*, the National Emergency Plan for Health Rescue in Health Emergencies also provides response at four levels: Level I for Extremely Major, Level II for Major, Level III for High, and Level IV for Common.

2.3 Upgraded development stage

To cope with the changes brought about by multiple and frequent outbreaks of public health emergencies in recent years, such as SARS, influenza A virus (H1N1), and COVID-19, Chinese agencies sped up the pace of upgrading relevant systems and mechanisms. The National Health Commission, Ministry of Civil Affairs, China Earthquake

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Administration, and the Health Department of the former General Logistics Department of People's Liberation Army, among other agencies, divided the country into seven emergency rescue areas, namely, Northeast, Northwest, North, East, Central, South, and Southwest, and accordingly established the national, provincial, and municipal health emergency response team systems. Military forces also established professional rescue teams. While enhancing the construction of emergency medical rescue systems for public health emergencies, China has also continuously enhanced the construction of emergency medical rescue capabilities for public health emergencies, including logistics, coordination mechanisms, and other supporting systems and mechanism arrangements [11]. In the fight against COVID-19, China has contributed the Chinese mode and experience to the world and stepped on a new level in its construction of its emergency medical rescue system and capability for public health emergencies.

3 Existing issues and insufficiencies of emergency rescue system for health emergencies

Overall, China has handled the COVID-19 pandemic with a quick response, strong prevention and control, effective rescue, and ready assurance. However, some insufficiencies and issues have been revealed in the construction of the emergency rescue system for health emergencies, chiefly including the following three aspects:

3.1 The emergency rescue mechanism does not operate smoothly.

At the beginning of the COVID-19 epidemic, the hospitals were crowded with patients, causing frequent hospital-acquired infection and aggravating squeezing of medical resources. The resources of small- and medium-sized medical institutions were set aside, and timely transfer was not possible owing to the absence of coordination between normal and emergency facility use. Additionally, there were apparent deficiencies in the professional rescue teams, reserves of emergency rescue supplies, and dispatching mechanisms. Information exchange between functional departments and regions was not smooth. Difficulties in coordination and delays in decision-making prominently reflected the unwieldy emergency rescue mechanism for public health emergencies, particularly the high difficulty in horizontal coordination and cooperation between departments, as shown in the ambiguous boundaries between risk management departments, unclear and asymmetric responsibilities and rights of departments, and poor coordination between them. Such problems make it impossible to realize the mechanisms of classified rescue, triage for testing, and hierarchical treatment. Therefore, the timeliness and cure rates of emergency rescue could not be ensured.

3.2 The emergency response capability is insufficient.

The prominent issue of insufficient reserves of medical resources for infectious diseases was exposed in this outbreak. (1) Currently, the construction of infection and infectious disease departments has not paid due attention to many grassroots medical institutions in China. Such institutions, with incomplete infrastructure, poor management, inadequate professional staff, and lacking specialized departments, had no capability to perform the emergency response function in case of any public health emergency. (2) Owing to the limited medical resources and poor understanding of the emerging infectious disease at the early stage, medical institutions only focused on the treatment of patients with critical and severe conditions. They neglected the management of patients with mild conditions, asymptomatic carriers, those in the latent period, or close contacts, which is one of the causes of the spread of the infectious disease.

For instance, in Wuhan, the registered population and permanent residents totaled over 14 million, but the city only had two infectious disease hospitals, Jinyintan Hospital and Pulmonary Hospital, with more than 900 beds. This capacity translated to an average of 0.64 beds /10 000 persons, far less than the standard of 1.2 to 1.5 beds /10 000 persons of the non-rural population for infectious disease hospitals in China [12]. The current medical rescue teams in China consist of staff with overall lower technical titles. They have few talents with high academic credentials, specialized staff for the treatment of emergent critical cases, general practitioners, and specialized infectious disease treatment staff. As such, these hospitals cannot easily provide support for medical rescue and treatment upon the occurrence of significant public health emergencies. China's disease prevention and control system (CDC) has about 2100 staff. In contrast, in the United States, with only one-fourth of the population in China, the CDC system has 24 000 staff members.

To contain the COVID-19 outbreak in Wuhan, the government dispatched 344 national medical teams from many areas in the country, with more than 40 000 medical staff, including over 10 000 doctors and 20 000 nurses. However, most medical staff were temporarily transferred from clinical departments, and most of them had not received training for emergency rescue, leading to a hasty and disorderly response at the beginning of the epidemic. The

construction of specialized emergency medical rescue teams is urgently required in China.

3.3 The emergency coordination level requires improvement.

In the early period of the COVID-19 outbreak, owing to the absence of relevant guidelines for treatment and uniform operation procedures, competent medical institutions were unable to obtain permits for testing. This resulted in the crowding of suspected patients in medical institutions and a high risk of hospital-acquired infection. Moreover, the testing reagents developed and manufactured by CDC institutions in a short period varied in quality, causing substantial impact on the early screening and diagnosis of patients. During treatment, the medical staff of infectious disease hospitals showed lower comprehensive rescue capabilities for critical cases, resulting in the deficient response to the epidemic. The poor collaboration between medical institutions at all levels also scattered the resources for intensive care and impeded the improvement of the rescue efficiency. Therefore, with the inability to form synergy or achieve complementation of resource advantages in the area, the authorities had difficulty in undertaking emergency medical rescue tasks for major disastrous accidents and major public emergencies.

4 Recommendations for the construction of technical management system

Based on the experience and lessons learned from the fight against COVID-19, the following technical management recommendations are provided for the construction of an emergency rescue system for major public health emergencies.

4.1 Establishing a “1 D and 3 Cs” rescue mode

“1 D” refers to determination—to evaluate the risk of the disaster and determine the nature and scope of infection, whether emergency response is required, whether on-health departments shall be mobilized for emergency response, and if so, what scale of rescue is appropriate. This is the precondition for all work, especially rescue. For the COVID-19 epidemic, the expert team of the National Health Commission visited Wuhan for field investigation twice, but they provided different conclusions. Eventually, they concluded that virus was capable of human-to-human transmission, based on which the lockdown, emergency treatment, and other strict control measures were taken. Therefore, evaluation and determination are important. To improve the synergistic mechanism for determination, evaluation, decision-making, and prevention and control of significant public health risks, experts and first-line medical staff should arrange for evaluation and determination based on facts upon discovery of any early signs of epidemic. In this manner, they can provide definite recommendations for prevention and control, and strong support for emergency response decisions.

The “3 Cs” refer to classified response, triage in testing, and hierarchical admission for treatment. For classified response, the response is classified into four levels, namely, Blue, Yellow, Orange, and Red, corresponding to the warning signal for emergencies. According to the severity of the incidence, the prefectural, provincial, regional, and national level rescue forces may be dispatched, respectively. The triage for testing shall be performed to distinguish healthy persons from infected patients and close contacts, and severe cases from mild cases. In emergency response to emergencies, the triage shall be conducted first. The victims must be divided into different levels, and the first aid and medical treatment shall then be conducted in an orderly manner and according to the severity of victims and the hierarchical sequence. This way, the efficiency of disaster relief can be improved. For hierarchical admission for treatment, patients of different severity levels shall be admitted according to the respective levels and types. According to international standards, for treatment of victims after examination and classification at the disaster site, the priority shall be placed first on severely wounded persons, followed by those moderately wounded, mildly wounded, and, finally, the corpses. Such principles shall be followed in handling public health emergencies. The classified response to sudden infectious disease outbreaks is a special arrangement, and the classified centralized quarantine is particularly important. Anyone, whether with a mild or severe condition, so long as they had close contact with any patient, shall be quarantined for observation, and any clinically diagnosed case, mild case, asymptomatic carrier, or close contact shall not be released from hospital without nucleic acid testing. Among the “3 Cs” measures, the most important is the advanced testing. Higher testing levels can ensure the effective conduct of quarantine and control of diseases, protect vulnerable groups, and also lay the foundation for rescue (Fig. 1).

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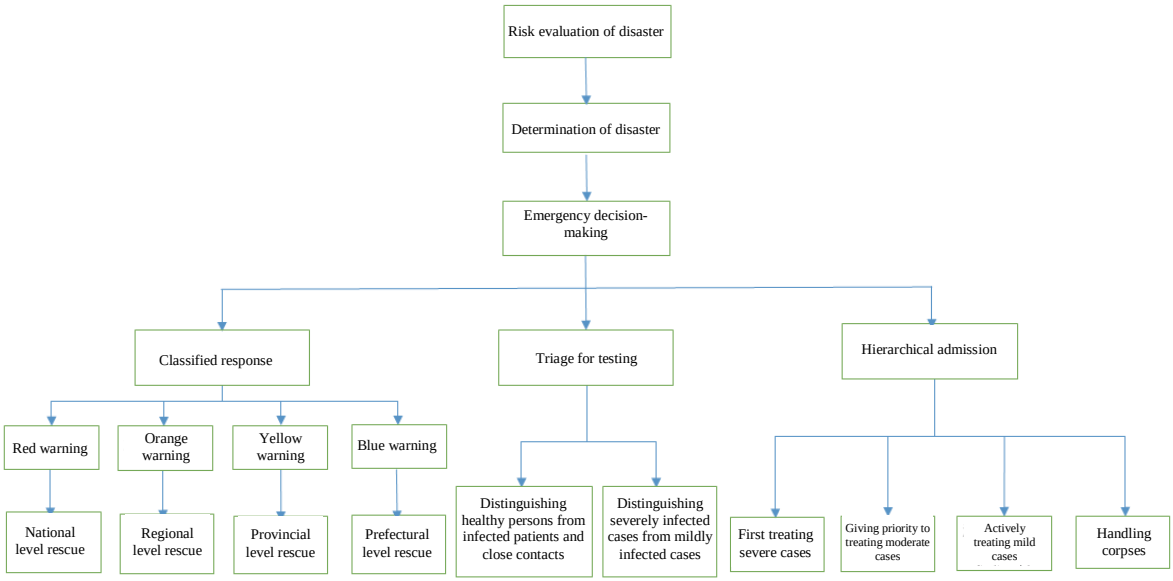

Fig. 1. Diagram of "1 D and 3 Cs" emergency rescue mode.

4.2 Making scientific layout of medical institutions and improving emergency response capability according to the requirements for "coordination during peacetime and wartime"

Currently, China's medical institutions are built for conventional medical services, and the functions for response to public health emergencies are not completely provided, with low emergency rescue capability. In this regard, a new strategic layout should be made for medical institutions oriented toward daily service and wartime emergencies. Existing medical institutions should be functionally classified, reconstructed, and restructured in detail.

Several emergency rescue and treatment medical centers should be built oriented toward wartime emergencies while also taking into account daily application. Such centers shall be chiefly for the treatment of critical patients in their respective areas in the case of significant public health emergencies. The national emergency medical rescue centers shall be built based on the excellent medical resources of tertiary comprehensive medical institutions in the area, and preparation shall be made for participating in medical rescue following emergencies in foreign countries. It is recommended to build one to three rescue and treatment bases (public health medical centers) for significant outbreaks in each province and provide the necessary facilities.

Comprehensive hospitals should enhance emergency transfer functions during both peacetime and wartime. For comprehensive medical institutions in cities above the sub-provincial level, the existing fever clinic, enteric diseases clinic, and necessary quarantine observation wards shall be sorted out and regularly arranged, focusing on construction of emergency, infectious disease, and disease control departments, as well as other basic network nodes, to form the relatively independent special diagnosis and treatment zones for infectious diseases. Permanent in-patient zones shall be built with the appropriate size and the necessary conditions for negative pressure isolation for some beds. In addition, several comprehensive hospitals should be designated for transfer, and necessary renovations should be made. Owing to a shortage of medical resources, comprehensive or specialized hospitals may be quickly transformed into competent designated hospitals for the admission of patients.

The optimized use of resources should be properly implemented, focusing on the functional construction of large stadiums and venues for temporary emergency medical renovation. Mobile cabin hospitals have played an important role in the fight against COVID-19. To respond to significant public health emergencies in the future, the authorities should explore approaches for emergency renovation or setting of emergency sites according to actual conditions. In the future, relevant designs should be made in advance for large stadiums, garages, schools, hotels, and other facilities, upon construction, so that they can be transformed to simple emergency hospitals with minor renovation upon the occurrence of any emergency.

Currently, the construction of infection and infectious disease departments has not paid due attention to many grassroots medical institutions. Such institutions, with incomplete infrastructure, poor department management, inadequate professional staff, and incomplete specialized departments, have no capability to perform the emergency response function in case of any public health emergency. Therefore, for the construction of the emergency response system for public health emergencies, it is recommended to focus on the construction of the emergency department,

infectious disease department, intensive care units (ICU), and other basic network nodes in medical institutions. The creation of a scientific layout for medical institutions and improvement of emergency response capability comprise a systematic project. Relevant personnel should be assigned to prepare the construction and renovation standards. National support should be provided for funds and other matters to achieve the overall improvement of medical services and emergency rescue.

4.3 Establishing emergency rescue teams with high maneuverability for emergency and conventional deployment

High importance should be attached to improving the structure of clinicians and public health staff, as public health teams are the basic force for emergency medical rescue. Among medical practitioners in China, there are only 114 000 public health physicians, accounting for only 3% of the total number. Special measures should be taken, including preferential policies, occupational benefits, and training in universities, to increase the number and quality of public health personnel. The chief public health expert system should also be established. The assignment and grouping of staff in medical institutions should be planned properly. Several national, provincial, and prefectural emergency health rescue teams should be established, with the members chiefly coming from the infectious disease, respiratory, ICU, prehospital care, and other departments of the respective comprehensive hospitals and CDCs. These teams should be provided with training and drills.

Therefore, emergency rescue reserve teams should be established. The mechanism for cross-training and promotion examinations should be operated between public health institutions and secondary and tertiary medical institutions. Specialized health technical staff at urban and rural emergency centers and CDCs should receive the necessary training in clinical rescue skills for not less than half a year at national and provincial emergency medical rescue centers, before promotion to the title of vice professor. Specialized internal medicine physicians at medical institutions should be dispatched to and receive the necessary training on emergency prevention and control skills for public health emergencies for not less than half a year at CDC or urban/rural emergency centers, before promotion to the title of vice professor. Through such cross-training and drills, more combined talents can be cultivated and dispatched in case of any emergency rescue task.

Training of public health talent is a long-term project and should be planned in advance and in a forward-looking manner. The academic education of emergency response staff should be enhanced. Full-cycle training and education should be added for specialized staff. Moreover, anti-epidemic knowledge shall be disseminated broadly to build and secure the bottom net of public health. An emergency technology university should be established jointly with universities with competent education resources, research institutes, large companies, medical universities, and provincial/ministerial-level comprehensive universities that are encouraged to establish or jointly establish schools of public health. The construction of public health, preventive medicine, and other disciplines in medical universities shall be improved, and the global training program for masters and doctors of public health shall be launched according to the actual conditions.

4.4 Establishing material supply system for emergency rescue that integrates storage, purchase, production, and transport

Medical material supply is an important basic support for the effective implementation of emergency rescue during public health emergencies. As shown in the response to the COVID-19 epidemic, it is necessary to sort out the demands, streamline the process, establish relevant mechanisms, optimize coordination between production capacities and regional layouts, and improve the emergency material supply chain system.

The reserve and supply of important emergency materials and regional layout shall be optimized. Military–civil integrated emergency material production and supply bases shall be built along “2 belts and 1 axis” and in other important and special areas. It is recommended to build emergency rescue material reserve bases for health emergencies in all provinces and cities, to cover the city–district–hospital three-level medical material reserve system for emergency rescue. It is also imperative to strengthen the material reserve for emergency medical equipment, drugs, vaccines, consumables, reagents, and medical protection articles, meeting the emergency rescue needs for one to three months.

The reserve should be planned according to reserve capacity. The production capacity for public health emergency supplies should be ensured. Three to four designated enterprises shall be chosen in each province or city to build or reserve the necessary production lines. Measures shall be taken to ensure the following: support the technical renovation of mobilized enterprises to ensure stable production, expansion, and transfer; plan and deploy new

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industrial types and new modes; establish the full chain industrial cluster for research and development (R&D), production, and logistics of public health emergency supplies; build the upstream and downstream with strong competitive advantages of the industrial chain; cultivate combined manufacturers for raw material supply and production of public health emergency products; and realize the independent supply and control of high-end medical equipment and other equipment.

A complete system shall be established for the purchase and distribution of emergency supplies. Standard management shall be implemented for the following: dispatch of authorized emergency supplies under urgent conditions, responsibility for reserve management, scope of materials of urgently mobilized enterprises, types of reserve supplies, funds for material reserves, and systems for risk provision funds. The international material supply and purchase network shall be established. Economic and trade cooperation shall be enhanced with Japan, South Korea, Southeast Asian countries, and other neighboring countries, as well as countries along the Belt and Road. Such cooperation will help establish fast tracks for material entry and quality standards certification as early as possible, and utilize international health care resources. Attention should also be paid to utilizing the auxiliary function of the civilian force for emergency purchases and building a modern comprehensive global purchase and logistic distribution system as supplements.

4.5 Improving the emergency response and treatment capability at the grassroots level

The comprehensive rescue mode is reflected by the configuration of rescue forces—the rescue task is undertaken by not only specialized teams but also by rescue forces in echelons, to form synergy. The requirements for medical rescue and treatment in case of significant public health emergencies can only be met after the formation of the emergency rescue system consisting of provincial, municipal, regional, district, and community medical institutions. Therefore, it is recommended to lower the prevention and control levels for significant public health emergencies, and establish the combined medical rescue response during peacetime and wartime that links with grassroots community institutions. These efforts can improve the anti-epidemic capability of the community level.

Meanwhile, the rescue function of community hospitals should be enhanced, focusing on discovery and on-site handling of epidemics. With reference to the prevention and control system of Singapore, the entity of each system level shall have the appropriate right for decision-making, particularly on-site handling during an emergency in the community according to the actual condition. The equipment configuration should meet the requirements for site inspection and testing, epidemiological surveys, and emergency handling. Fever clinics shall be established in county-level hospitals, competent town/township health centers, and community health service centers. In principle, these clinics shall be provided with independent quarters, separated from the common clinic, with double channels and double entrance/exit paths. These may be used as emergency quarantine venues.

Importance shall be put on utilizing the rescue function of individual volunteers. The complete emergency rescue system shall be established. Volunteers and volunteer rescue organizations must be included in the emergency plan, to make them play more important roles. These approaches can arouse the enthusiasm of social forces to participate in rescue and reduce the pressure and burden on the government to some extent. More efforts shall be taken toward mobilization and organization. Smooth channels for participation shall be established. Moreover, the authorities shall develop the complete organization, rules, training, and requirements, to reduce random actions. The complete laws and regulations shall be developed, to protect the rights and identify the obligations of volunteers.

4.6 Enhancing scientific, standards, and multidisciplinary fusion for emergency responses

Emergency rescue is ultimately determined by its effect. For COVID-19, characterized by such a wide scope of infection and high difficulty in treatment, controlling the infection rate and reducing the mortality rate are the most important targets. Thus, the treatment specification shall be followed in diagnosis and treatment. After the outbreak of COVID-19, the National Health Commission quickly issued and continuously revised the diagnosis standards, providing the effective guidance for diagnosis and treatment. Emergency rescue shall be conducted according to regulations, and the four centralized targets shall be achieved: centralized arrangement of patients, experts, resources, and treatment. Consequently, patients can be rescued and treated with optimal techniques and medical wisdom.

The combination of Western and traditional Chinese medicine (TCM) shall be actively implemented in emergency rescue. After the start of the COVID-19 epidemic, Western medicine and TCM practitioners joined hands in the fight against the epidemic and achieved good results in controlling the infection rate, reducing the mortality rate, and forming an effective treatment mode with Chinese characteristics. This shall therefore be the peg for a successful experience. Due effort shall be put forth to solve the problem of the imbalanced ratio between Western

medicine and TCM staff, and to speed up the pace for the arrangement of TCM emergency rescue facilities, equipment, talents, and technical reserves. Moreover, efforts must be applied toward increasing the ratio of TCM in the health care system and establishing several TCM and Western medicine integrated diagnosis and treatment centers for significantly difficult diseases with leading and demonstrative functions. The TCM and Western medicine cooperation mechanism shall be improved to establish an integrated service mode: TCM and Western medicine multi-disciplinary joint outpatient, TCM physician participating in Western medicine ward rounds, and establishment of joint wards. Upon the outbreak of any epidemic, an appropriate percentage of TCM experts shall be determined for full process participation in the study of the rescue and treatment program. TCM medical institutions shall be included in a timely manner according to the emergency plan.

Mental relief and intervention shall be included in clinical rescue and treatment. Sudden epidemic not only threatens the physical health of people but also affects their mental health. Therefore, in the diagnosis and treatment, psychological counseling and intervention shall also be provided, as the combination of the two aspects shall greatly promote the effective treatment and quick recovery of patients. Mental health services shall be provided to affected groups according to the different characteristics, including mental interventions for those requiring such services. Measures shall also be taken to prevent, slow down, and control the social and psychological impacts of the epidemic.

5 Recommendations for the construction of policy and system mechanism

5.1 Construction of synergistic mechanism of scientific research, disease control, and clinical treatment

Clinical treatment is not standalone, and can be effective only with the synergy of scientific research and disease control. This is also an important experience in the fight against COVID-19. To overcome diseases, humans will eventually rely on science and technology for answers and solutions. The prevention and control specification should be improved for any sudden epidemic. The joint breakthrough mechanism of universities, research institutes, military medical institutions, enterprises, and others should be optimized. Moreover, international cooperation shall be strengthened to improve the virus testing and treatment ability and vaccine and drug R&D ability. Such cooperation could also transform research results into clinical application and provide scientific support to rescue and treatment.

Intensified measures should be adopted for the application of big data and other new technologies, sharing of relevant data according to law, improvement of the national epidemic prevention and control information platform, and enhancement of the protection of intellectual property rights in medical technologies. Integration and sharing shall be promoted for electronic medical records, laboratory examination, drug prescription, and health archives, to provide data support for the monitoring of infectious disease epidemic, virus tracing, management of high risk patients, and management of close contact. Additionally, smart medicine shall be actively developed, for remote diagnosis and treatment based on big data and 5G technologies. This will improve the cure rate of clinical treatment.

The medical research laboratory is the nerve center for epidemic rescue and treatment. The interface among sub-centers of national laboratories shall be arranged, and laboratories with high safety levels shall be established in the following: high-level universities, research institutes and hospitals, national and provincial key laboratories, engineering technical centers, enterprise technical centers, and novel R&D institutions. It is recommended to establish at least one biosafety Level 3 protection laboratory in each province, and at least one biosafety Level 2 laboratory in each prefectural city, with the testing capability for pathogens of infectious diseases, health risk factors, and those required in national health standards. These will form the linking effect with clinical treatment and improve the medical treatment effect.

5.2 Establishing and improving special period (wartime) mobilization mechanism for emergency rescue

A significant public health emergency is a “war without smoke,” requiring special period (wartime) mobilization and assurance. According to the requirements of the four levels of response to public health emergency, improvements must be made in terms of the mobilization of medical institutions, regional synergy and interlinking, and personnel dispatching in the area under the emergency condition. Coordination and dispatching of excellent resources in the entire area must be implemented quickly and efficiently. The needed personnel and materials for rescue must be delivered to the front line quickly. Therefore, it is recommended to improve the following four mechanisms as soon as possible.

First, improving leadership and command mechanisms. Upon the outbreak of any public health emergency, the provincial CPC Committee shall establish a leading group and joint command responsible for the unified leadership and command of emergency response in the province. The public health joint meeting and joint prevention and

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control mechanism should be further improved to form synergy for prevention and control. All levels of government should establish an emergency medical rescue commission for emergencies. This commission shall coordinate the emergency medical rescue responsibilities scattered in the different departments and jointly discuss the emergency medical rescue for the emergency.

Second, improvement of mobilization and response mechanisms. Explorations shall be made to establish the mechanism for synchronizing the review result and reporting related to the epidemic as well as epidemic information release and emergency response requests. Except for comprehensive hospitals, the CDC may link to multiple school hospitals, community hospitals, designated drugstores, and other institutions, and establish an intelligent quick warning and multi-point trigger mechanism based on a database system and big data platform. According to different warning mechanisms, the quick emergency mobilization response should be improved for all levels of hospitals, communities, and departments for information release, material reserve, transportation, social security, and social rescue.

Third, improving dispatching and requisition mechanisms. According to the requirements of emergency rescue levels, an interlinking mechanism should be established for medical rescue organizations and teams in different areas (prefecture/county, provincial, military area, and national), available to mobilize forces in case of any public emergency. The objects to be mobilized are limited to housing, transport means, and relevant facilities and equipment, excluding consumable materials, which shall be handled in the national unified emergency material purchase and supply system. For stadiums and venues, hospitals, hotels, and medical materials and equipment, relevant departments shall prepare the list, develop standards, follow requisition procedures, and prepare for the requisitions.

Four, improving the medical and control linking mechanism. The rights to engage in discourse on the disease prevention and control system in the national health care system, and to decision-making for the prevention and control of infectious disease epidemic shall be further highlighted. Following the practice of the financial and audit systems, the CDC commissioner system may be established, on the basis of the existing CDC system and presently established National Administration for Disease Control and Prevention. A commissioner office may be established in all areas, and national quarantine officers appointed, to ensure the quick and accurate discovery of epidemics and the subsequent control of its spread.

A big data center for national emergency rescue should be established to analyze and monitor personnel involved in epidemics; realize dynamic, scientific, and accurate prevention and control; and provide support for the demands for information and decision-making for emergency rescue. Provinces and prefectures meeting the requirements shall also establish such big data centers.

5.3 Boosting the construction of international cooperation mechanisms for public health emergency rescue

Significant public heath emergencies can easily spread worldwide. In the 21st century, five events have occurred before COVID-19that merited the status of public health emergency of international concern (PHEIC): the H1N1 pandemic in 2009, poliomyelitis and Ebola in West Africa in 2014, Middle East respiratory syndrome in 2015, Zika virus in 2015–2016, and Ebola in Congo in 2018–2019. Thus, sudden highly infectious virus epidemics have been occurring. Epidemics will spread, as shown in the case of the COVID-19 pandemic. Several world-class virus laboratories (including nuclear biological laboratories) shall be planned, to track virus development and engage in R&D of antivirus drugs. The timely transfer of research results to clinical uses shall be promoted.

International cooperation shall be enhanced with respect to emergency rescue. China must perform its obligations as a responsible power player. China must also improve academic exchange and cooperation in treatment, particularly in the communication on experiences and technologies in the treatment of patients. After the outbreak of COVID-19, China, based on its consistent principles of opening up and transparency, communicated epidemic information to the World Health Organization, as well as other countries and regions. The country also shared the virus gene sequence, invited international experts to work together, and enhanced cooperation with countries in virus tracing, R&D of drugs and vaccines, and testing, sharing research data and information, and jointly studying and proposing response strategies. China also learned from the experience and lessons in the practice of other countries in the fight against the pandemic, and continuously improved its medical efficacy.

China shall improve interest sharing and the deployment of preemptive opportunities. After the outbreak, Chinese researchers accelerated the development of vaccines and screening of effective drugs. Some products have been finalized and put into use to meet domestic requirements, and also delivered as public products to people around the world. Thus, China has occupied a leading position in the R&D of vaccines and drugs. In the meantime, China shall, by utilizing its advantages as the leading manufacturing country, deploy its emergency medical industrial cluster and

establish an anti-epidemic material supply chain as soon as possible. These efforts will make China a global humanitarian emergency warehouse and hub.

5.4 Quickly preparing action guidelines for constructing a public health emergency rescue system

In terms of laws and regulations for emergency rescue, some laws and regulations have been issued for emergency rescue during public health emergencies. Examples are the emergency plan, system, mechanism, and regulation for emergency management, which have had significant results. However, some prominent issues remain. First, many versions of emergency rescue laws are outdated and unable to meet the requirements of the present period. Second, the laws and regulations for public health emergencies are fragmented and sectional; there is no epidemic prevention and control system law that stipulates a complete system, including scientific and standard contents, effective operation, and clear responsibilities. Third, *Law on Emergency Response* and *Law on Prevention and Control of Infectious Diseases* are inconsistent with each other in terms of early warning for emergencies, information reporting and release, emergency preparation, emergency response, rescue, and other aspects. Some issues in the fight against the epidemic are related to the deficiency of the legal system for epidemic prevention control and the incompleteness of the legal system. For such risks and challenges, it is necessary to improve the systemic, scientific, and detailed aspects of legislation in a macro manner. The *Law on Prevention and Control of Infectious Diseases* needs a comprehensive revision that will introduce more concrete requirements for emergency response. Currently, the law only provides three principles for medical treatment, all of which cannot meet the actual requirements. It is recommended that a complete public health emergency response regulation or action guidelines be developed with Chinese characteristics for application in emergency rescue. In 2006, the State Council issued the *National Emergency Response Plan for Public Incidents*. This version is now outdated and urgently requires supplements and improvement.

Many countries have developed special laws and regulations for emergency rescue. The United States issued the Disaster Relief Act, Emergency Aid Act, and emergency plans; Japan issued the *Basic Disaster Management Plan* and *National Action Plan for Pandemic Flu and Infectious Diseases*. Australia issued the *National Health Safety Law*; some of its states also issued relevant laws. For example, New South Wales issued *Law for Emergency and Rescue Management*. As a large developing country, China shall also provide clear legal requirements for emergency response to public health emergencies, which are requirements for the construction of an emergency management system. Legal protections are also internal requirements in emergency response practice.

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