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Consideration on the Coordinated and Synergistic Role of Science and Technology in Responding to Major Public Health Emergencies

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Thoughts on the Coordinating and Synergistic Role of Science and Technology in Responding to Major Public Health Emergencies

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General Secretary Xi Jinping attaches great importance to science and technology to support the prevention and control of the novel coronavirus pneumonia. On March 2, 2020, during inspecting the scientific research on prevention and control of the novel coronavirus pneumonia in Beijing, General Secretary Xi Jinping emphasized that science and technology are the most powerful weapons for human beings to fight against diseases, and the scientific development and the technological innovation are indispensable for human beings to overcome catastrophic epidemics. Besides, he also proposed that it is an important and urgent task to conduct the scientific research on prevention and control of the novel coronavirus pneumonia. It is necessary to integrate multi-disciplinary forces, make the leadership unified, and coordinate to promote the research, so as to accelerate the progress of research and development on the basis of adhering to scientificity and ensuring safety, overcome the key and difficult problems of the epidemic prevention and control as soon as possible, and provide the strong scientific and technological support for conquer this epidemic [1]. General Secretary Xi Jinping provided fundamental guideline for tackling scientific problems at the overall and strategic level.

In accordance with the deployment of the leading group under Central Committee of the Communist Party of China for the prevention and control of the epidemic situation, the scientific research team under the joint prevention and control mechanism of the State Council was established. The Ministry of Science and Technology of China, together with 12 departments including the National Health Commission, the National Medical Products Administration, and the Chinese Academy of Sciences, focused on the five major directions (i.e., clinical treatment and drug development, vaccine research and development, detection technology and products, viral etiology and epidemiology, and animal model establishment), founded special groups for key work related to drugs, vaccines, traditional Chinese medicine, big data, etc., concentrated the national preponderant scientific research forces, closely followed the urgent need of the first-line epidemic treatment, deployed emergency research projects, and fully devoted themselves to promote the scientific research on epidemic prevention and control ①. Under the unified leadership and coordination of the joint prevention and control mechanism of the State Council, the government, scientific research institutions, universities, and enterprises cooperated in joint research and examination. The scientific research has achieved a series of important application results in a short period of time, quickly screened out a batch of drugs and prescriptions with obvious efficacy such as the "three drugs and three prescriptions" [Jinhua Qinggan Granules, Lianhua Qingwen Capsules (Granules), Xuebijing Injection, Qingfei Paidu Decoction, Huashi Baidu Prescription, and Xuanfei Baidu Prescription] in traditional Chinese medicine and tocilizumab, rapidly produced a variety of detection reagent products, and launched multiple technical routes in parallel to promote vaccine research and development. Besides, great breakthroughs have been made in plasma therapy, stem cell therapy, and other technologies. The diagnosis and treatment protocol was continuously improved, on the basis of which the cure rate of patients reached higher than 94% [2].

1 Problems and challenges

Through the practice of the prevention and control of novel coronavirus pneumonia, we deeply realized that science and technology played a key supporting role in preventing and resolving major public health emergencies. In order to deal with the outbreak of new infectious diseases, efforts should be made simultaneously in the following

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① Press conference of the joint prevention and control mechanism of the State Council on March 6, 2020 (http://www.gov.cn/xinwen/gwylflkjz46/index.htm)

important aspects: tracing the source of the virus, transmission mechanism research, virus detection, and research and development of vaccines and drugs. At the same time, the interdisciplinary research, industry-university-institute cooperation, strengthening unified leadership, and collaborative promotion are the inherent requirements of tackling scientific problems. There are still many problems to be explored and considered, such as how to improve the collaborative mechanism for tackling key scientific problems, efficiently coordinate all kinds of main innovative forces, give full play to their respective innovative advantages, improve the ability and level of systematic prevention and control, and fully take advantages the new whole nation system.

1.1 Synergy of scientific research and clinical treatment

The starting point and ultimate purpose of epidemic prevention and control are to ensure the life safety and health of the people. "Improving the cure rate and reducing the mortality rate" is the top priority of emergency scientific research. The development of new drugs is a difficult long-term process, while the screening of safe "old drugs" with efficacy is fast and effective. Potentially effective drugs found in scientific research need to undergo clinical trials quickly, so as to realize the "relay" from the laboratory to the clinical department. Besides, scientific researchers should be promptly informed of the changes of the demand in clinical treatment in order to discard the false results and retain the true results through further experimental verification. This requires the scientific research team and the clinical treatment departments to establish a suitable and efficient cooperation mechanism around the major research tasks. If they do not have a certain basis for the cooperation, it is difficult to form an organic connection and efficient coordination in a short time.

According to the data statistics of the Chinese Clinical Trial Registry, as of July 19, 2020, 721 clinical research projects on the novel coronavirus pneumonia have been registered in this institution ①. In the front of numerous clinical research projects, it is necessary to deploy all the research activities of the nation as a whole, make a good top-level layout, effectively coordinate domestic clinical case resources, and organize experts to evaluate all kinds of clinical trials and treatment protocols comprehensively and objectively in a timely manner. In addition, various departments should be coordinated at the national level to provide priority support for drugs and protocols screened from scientific research with sufficient scientific data and high expert consensus. The number and standardization of clinical trial cases need to be ensured and the evaluation of clinical effectiveness should be completed as soon as possible.

The successful case in this aspect should be the scientific research and clinical team of the University of Science and Technology of China (USTC). Benefiting from the long-term cooperation foundation and self-synergistic advantages of the life science basic research and the clinical research of USTC, the immunology team of the USTC and the clinical team of the First Affiliated Hospital of USTC (Anhui Provincial Hospital) found the possible key mechanism of the severe pneumonia inflammation storm caused by the 2019-nCoV infection through the comprehensive analysis of 30 immunological indicators in the blood of 31 patients with the novel coronavirus pneumonia. Through the coordination of Chinese Academy of Sciences, Anhui Province, and many other parties, multicenter clinical trials are rapidly carried out in China. The hospital's tocilizumab treatment protocol has also been included in the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Version 7), which provides a new treatment strategy for severe patients with the novel coronavirus pneumonia [3]. At present, the protocol has been applied in more than 20 countries, contributing "Chinese wisdom" to the global fight against the novel coronavirus pneumonia epidemic ②.

1.2 Synergy of psychological rescue and disease treatment

The report of the 19th National Congress of the Communist Party of China proposed to strengthen the construction of the psychosocial service system, and the 4th Plenary Session of the 19th Central Committee of the Communist Party of China again emphasized the need to improve the psychosocial service system and the crisis intervention mechanism. The psychosocial service system is a necessary component of the national governance system and is closely related to each of us. Once epidemic occurs, the key groups such as the confirmed patients, the isolated population, and the medical staff in the frontline of epidemic prevention and control need psychological counselling urgently, so the psychological rescue needs to be carried out simultaneously with the medical relief. A study found that after the SARS epidemic in 2003, the detection rates of post-traumatic stress disorder (PTSD) symptoms were 55.1%, 25.8%, and 31.2% for the confirmed patients, the first-line medical staff, and the public in the epidemic area, respectively [4]. For these three groups of people, timely close attention, continuous follow-up evaluation, and early intervention should be provided. However, at present, the number of mental health practitioners in China is seriously insufficient. Even if there will be 40 000 psychiatrists at the end of 2020 as estimated in the National Mental Health Work Plan (2015–2020) [5], the number of mental health practitioners per capita in China is still less than half of the international standard. Thus, the

① Clinical research index of novel coronavirus pneumonia from Chinese Clinical Trial Registry (Updated to 2:30 a.m., Beijing time, July 19, 2020), http://www.chictr org.cn/uploads/documents/2020/07/19/da94349da3be40bda95c59a4ed50d0db.xlsx

② Press conference of the joint prevention and control mechanism of the State Council on March 6, 2020 (http://www.gov.cn/xinwen/gwylflkjz46/index.htm)

capacity and availability of the mental health service are seriously insufficient. Psychological problems caused by the epidemic are intertwined with social contradictions, which will be a hidden danger of social stability for a long time. Therefore, the psychological rescue should be integrated with the clinical treatment to the greatest extent. Close attention should be paid to the key population affected by the epidemic. Follow-up is needed to evaluate their psychological status, and timely intervention is conducted when necessary to reduce the occurrence of PTSD.

Different from natural disasters, accidents, and social security incidents, the psychological problems caused by the novel coronavirus pneumonia epidemic are unprecedented in space and time, which are even too serious to be solved through face-to-face communication. Therefore, it is necessary to issue "psychological crisis intervention guidelines" at the national level for major epidemic events of the new outbreak of infectious diseases, systematically plan the organizational structure, the personnel team, the system construction, etc., establish a clear, systematic, orderly, and normative psychological intervention mode for different groups, and accurately solve the mental health problems related to the epidemic situation [6]. Measures should be taken to strengthen the construction of the mental and psychological practitioner team, and improve the incentive mechanism of training, work, and evaluation of practitioners to reduce the loss of talents. At the same time, with the help of remote diagnosis and treatment, more public can be provided with mental health services.

1.3 Synergy of scientific research and public opinion guidance

The outbreak of the novel coronavirus pneumonia has a complicated mechanism, strong transmissibility, rapid development, and spread in a wide range. The public's scientific literacy, media literacy, and the overloaded information do not match and adapt. Besides, in "we media" such as microblog and Wechat, some scientific research progresses and expert remarks have been over-interpreted, and even bad cyber personal attacks have appeared. Some imprecise and even misleading research conclusions published in preprints have been extensively interpreted and widely disseminated, causing great harm to the researchers who stick to the front line of scientific research and seriously interfering with the progress of scientific research tasks. These public opinions have a great impact on undermining the public's trust in Chinese scientists and the confidence in the scientific and technological tackling of the epidemic in China. Therefore, the guidance to public opinion on the epidemic situation must be strengthened in time to protect relevant scientific researchers.

The epidemic prevention and control based on scientific and technological means is a war, and the public opinion is more like a war without smoke. The controversy of academic views should be limited within the academic circle and should not be extended to the public level. Scientific researchers' voice to the public should be on the basis of scientific facts. They should explain the problems thoroughly and rationally and not exaggerate scientific research achievements. Because of its rapid publication of academic results, the preprint platform has grown into an important mode of the academic exchange under public health emergencies in this novel coronavirus pneumonia epidemic. It should be noted that the research results on the preprint platform have not undergone rigorous peer review and the quality of the research is uneven. However, many media report these research results as established facts, which is easy to become the fuse of the public opinion and trigger an "information epidemic." Therefore, the scientific community should also pay the attention to organizing experts to research and judge articles on the preprint platform and make authoritative voices in a timely manner. In the era of "we media," facing the massive information, we should timely sort out hot issues, timely respond to public concerns, speak with the scientific logic, and guide the rational and scientific opinions with the help of a variety of new media platforms (such as video websites with bullet screen, short video sharing platforms, etc.).

1.4 Synergy of fundamental research and clinical application

In recent years, with the increasing investment in science and technology from all walks of life, China's scientific research platform conditions are changing with each passing day, and the conditions of the scientific research in some fields have also entered the international first-class ranks. For example, the SARS epidemic in 2003 lasted for three months before it was identified as a new disease, and the pathogen identification and the genome sequencing mainly relied on researchers in other countries. After the outbreak of the novel coronavirus pneumonia epidemic, Chinese scientific researchers responded quickly, completed the pathogen isolation and the genome sequencing in only a few days, and identified the pathogen as a new type of coronavirus. China shared the whole genome sequence of the virus with the World Health Organization immediately, which provided an important basis for global scientists to carry out drug, vaccine and diagnostic researches and gained valuable time for epidemic prevention and control.

On the basis of the long-term accumulation of fundamental research and applied fundamental research, some new technologies and products have been rapidly developed and applied to the clinical treatment of patients with the novel coronavirus pneumonia in time. With the long-term exploration and accumulation in the development of the new nuclear magnetic equipment for the pulmonary function assessment, the scientific research team of Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences, has developed the first set of hyperpolarized gas magnetic resonance imaging instrument

(^{129}Xe MRI) with independent intellectual property rights in China and rapidly applied it to the clinical diagnosis of the pulmonary fibrosis in patients with the novel coronavirus pneumonia. The quantitative information of the pulmonary function that cannot be obtained by conventional medical imaging methods can be achieved by ^{129}Xe MRI, which provides important functional parameters for the treatment of pulmonary fibrosis.

However, in general, China's accumulation in fundamental research fields and source technologies is insufficient. Some key technologies and products affecting biosafety are controlled by others, and the domestic level of the medical equipment is low. Therefore, it is necessary to increase the support for relevant fundamental research and applied fundamental research in the field of biosafety, change the traditional project approval mode, and carry out the applied fundamental research closely associated with the clinical application demand. Although there are many scientific researchers in China, there is a serious shortage of researchers who devote themselves to the original and fundamental research of virology, among which even fewer research groups focus on less popular viruses such as coronaviruses. Therefore, the sustained national investment in virology is needed to encourage scientists to conduct long-term and systematic research and avoid pursuing short-term returns.

2 Countermeasure analysis

Since 2003, outbreaks of SARS, Ebola hemorrhagic fever, Middle East respiratory syndrome (MERS), novel coronavirus pneumonia have occurred successively, and the struggle between human beings and infectious diseases has become increasingly fierce. From the point of view that science and technology play a coordinating and synergistic role in responding to major public health emergencies, it is suggested to focus on the following three aspects to rapidly conquer the epidemic.

(1) To coordinate peacetime prevention and wartime emergency management, and establish and improve a public health emergency management system combining peacetime and wartime. The environment of science and technology development in China is relatively stable and relaxed, and there is a lack of experience in dealing with major emergencies. In recent years, major public health and safety incidents have occurred frequently. It is suggested that a sound working mechanism for coordinating decision-making in response to public health emergencies should be established at the national level, with administrative leading group and the expert committee set up respectively. ① It is necessary to strengthen the top-level planning, adhere to the bottom-line thinking, and make a good system layout in "peacetime." The layout of biosafety laboratories of China needs improving, and the integration, optimization, and dislocation development of relevant scientific research forces of China should be strengthened. The capability of the innovation chain of production-education-research should be strengthened, during which not only the weak links need to be improved but also the repeated layout should be avoided. A transfer and transformation system of scientific research achievements on the premise of ensuring national security should be established, as well as a flexible, efficient, and synergic cooperation system between scientific research units and clinical treatment departments which is suitable for major research tasks. ② Decision-making mechanisms require to be coordinated in "wartime" to guarantee scientific and efficient operation. It is necessary to ensure firm decision-making, make a quick response by each innovation unit, take on own duties of each unit, and organically link up to tackle key problems synergically.

(2) To coordinate the current needs and long-term preparations, and strengthen the interdisciplinary construction and talent cultivation. The problem orientation should be adhered to, and shortcomings should be overcome. Relying on the advantageous units of China, a long-term mechanism for the enhancement of the basic research capacity in the field of infectious diseases needs to be established. Relying on universities, scientific research institutions, and clinical research hospitals, the construction of clinical pathogenic microorganisms and the public health discipline system should be strengthened to promote the deep integration of "medicine, education, and research" and cultivate interdisciplinary talents, so as to comprehensively support the tracing of the pathogen source, transmission route exploration, research on infection and pathogenic mechanism, infection prevention and control. The strategic planning and forward-looking layout should be strengthened to give full play to the integration of high-tech disciplines and biology, improve the research and development of key technologies for biosafety, make good preparations of relevant products and technologies, and overcome shortcomings in the high-end medical equipment manufacture in China.

(3) To coordinate both domestic and international situations and strengthen public opinion guidance and popular science propaganda. Scientists are key forces in the fight against epidemics, and high-level biosafety laboratories are the frontier positions in the battle against epidemics. The whole society should vigorously create an atmosphere of trusting scientists and caring for front-line scientific researchers so that they can concentrate on tackling key scientific problems. The popular science propaganda should be strengthened for scientific research activities to improve the public scientific literacy and the information discrimination ability. Good scientific literacy can make people treat all kinds of news rationally and become the best "vaccine" against the "rumor virus." There is a need to continue to carry forward the spirit of scientists, publicize the patriotic feelings of scientific researchers being not afraid of loneliness and overcoming difficulties via selfless dedication, and actively create a healthy and upward atmosphere of the public

opinion. Viruses have no borders. International scientific and technological cooperation activities should be actively carried out considering building a community of shared future for mankind. Actively learning from and sharing anti-epidemic experiences, enhancing the understanding, and building consensus are needed for the world to jointly address the challenges of biosafety risks. On the basis of scientific facts, correct report of both domestic and international news and the guidance of public opinion are needed to create a good environment for international cooperation.

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