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Review Article

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Ending future pandemics: An expert panel discussion

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ABSTRACT

Since the 20th century, global health security related biosafety risks have progressively intensified. Major public health crises, primarily caused by infectious diseases, have become more frequent. Additional concerns, such as population aging, the prevalence of chronic non-communicable diseases like hypertension and diabetes, the growing problem of antimicrobial resistance, and the ongoing effects of global environmental changes and worsening air pollution, have increased health risks for humanity. One Health, a multidisciplinary and cross-regional collaboration strategy that encompasses human, animal, and environmental health care, has become a key internationally recognized strategy for addressing significant and complex human health issues. On April 2, 2024, the One Health Innovation and Development Forum was held at Wenzhou Medical University. At this forum, experts from around the world gathered to discuss topics such as infectious disease prevention and control, vaccine development, antibiotic resistance, food safety, and environmental health. They reached a consensus and took action to jointly promote the realization of a global community of health for all.

KEYWORDS: One Health; Infectious disease; Antimicrobial resistance; Food safety

1. Tackling the challenges of unknown infectious diseases

Emerging infectious diseases (EIDs) can be caused by various pathogens, including bacteria, parasites, fungi, and viruses. Professor Jiahai Lu noted that over 70% of infectious diseases that affect human progress originate from animals or vector organisms. The increasing interaction between humans and animals in natural environments and biodiversity, inevitably leads to cross-species disease transmission. Ending pandemics requires focusing on the entire process from animal-to-human to human-to-human transmission, necessitating multidisciplinary collaboration among zoology, public health, clinical medicine, and preventive medicine, which is a core aspect of the One Health concept. At this forum, experts from around the world gathered to discuss topics such as infectious disease prevention and control, vaccine development, antibiotic resistance, food safety, and environmental health (See Appendix).

China's schistosomiasis control is a successful example of implementing the One Health approach. As Professor Xinbing Yu introduced, China's schistosomiasis control strategy encompassed tasks like eliminating snails in the early 1950s, the human-animal chemotherapy strategy in the mid-1980s, and comprehensive prevention and control strategies focusing on controlling infection sources since 2004. Professor Yu believes that the success in schistosomiasis control in China highlights the importance and effectiveness of the One Health strategy in combating infectious diseases through coordinated efforts across multiple sectors such

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as technology, health, agriculture, forestry, water conservancy, and education. He conservatively estimates that China can achieve the goal of eliminating schistosomiasis by 2030, laying a solid practical foundation for future One Health implementations.

Disease X, which refers to unknown infectious diseases caused by newly discovered pathogens or known pathogen with newly acquired pandemic potential, poses a significant challenge to public health worldwide. The One Health strategy addresses these challenges by enhancing monitoring of animals, occupationally exposed populations, and the environment to proactively control emerging infectious diseases. To tackle Disease X, Professor Ruifu Yang emphasizes the importance of understanding origins and the environmental and human factors influencing it. An effective monitoring system is needed, such as aggregating sequencing analyses of Disease X nationwide and monitoring genetic or protein synthesis technologies closely related to biosafety. Additionally, developing rapid detection technologies for Disease X, quick coordination among departments, and promoting the One Health concept in future generations are necessary steps to end Disease X.

2. Effective protection and monitoring methods as key elements of the battle

Zoonoses are diseases that naturally infect and spread between humans and vertebrates. In China, these diseases were legally classified mainly into three types: bacterial, viral, and parasitic. However, our understanding of new infectious diseases, especially viral one, remains incomplete. According to historical and pattern analysis, more than 500 000 unknown zoonotic viruses have yet to be discovered[1]. Over the past decades, multiple viral diseases suspected or confirmed to originate from wild animals have emerged globally, including zoonotic diseases like HIV, Ebola, SARS, and related viruses, and zoonotic diseases involving both farmed and wild animals like H5N1 avian influenza.

Academician Ningshao Xia noted that the outbreak of COVID-19 has brought new insights into vaccines. First, COVID-19 is a non-systematic respiratory virus, and a single vaccine shot provides limited protection duration. Second, the rapid mutation of the virus gradually reduces the protective efficacy of antibodies. Hence, COVID-19 vaccine research has evolved from traditional inactivated vaccines and attenuated vaccines to mRNA vaccines and viral vector vaccines, along with improvements in vaccine safety. In the future, developing diagnostic reagents for potential new diseases, especially respiratory infectious diseases, remains crucial. This includes determining how quickly diagnostic reagents can be produced after the first case, how soon diagnostic results can be obtained, and how quickly these reagents can be made widely available. Only in this way can we truly end pandemics.

Currently, China's development of drug and vaccine systems for zoonotic infectious diseases lags in effective investment and talent reserves, often relying on existing drugs for experimental treatment during outbreaks. Professor Zeliang Chen, based on his research on brucellosis, suggested that to effectively control zoonoses, in addition to using new technologies (such as developing marker vaccines that distinguish between immune infection and natural infection to reduce the high cost of culling positive animals), using protein nanoparticle delivery technology and antimicrobial quantum dot technology to improve targeted drug efficacy is another very effective measure. These two technologies' potential applications can optimize cost-efficiency and production processes, providing a technical platform reserve for addressing unmanifested emerging infectious diseases.

Additionally, Academician Zixin Deng summarized that the historical development of zoonoses demonstrates the importance of consensus and action in achieving One Health. Practicing the One Health concept involves analyzing and integrating scientific issues through the apparent processes of disease prevention, treatment, and rehabilitation to form a One Health big data network, providing timely and effective data and emergency measures to the government. Despite the rapid development of clinical vaccines, antibiotics, and small-molecule drug research, the speed of pathogen mutation and resistance development often outpaces our research speed, leaving us in a passive position. Thus, One Health research is not only a natural science study but also a social science study, emphasizing mutual support and coordination between scientific research and government management. Therefore, forming a consensus on One Health, mobilizing interdisciplinary resources, and utilizing various strengths is the direction that the One Health Research Institute can strive for next.

3. Curbing antimicrobial resistance is imperative

Antimicrobial resistance (AMR) is currently one of the most complex threats facing global public health. It is reported that in 2019, approximately 4.95 million deaths worldwide were associated with bacterial AMR, with 1.27 million directly attributable to bacterial AMR. Professor Yanjun Zhang pointed out that one factor contributing to antibiotic resistance is the misconception about antibiotic use, where people's first choice for illness and fever is often antibiotics. Another equally important factor is the overuse of antibiotics in food-producing animal farming, where the speed of antibiotic metabolism in poultry cannot keep up with the speed from production to sale for consumption.

Professor Zhenbin Mao mentioned that during drug regulation, it was found that antibiotic residues exceeded the standard in children who had never used antibiotics, possibly related to antibiotic and drug residues in animal-derived foods. Although China's Veterinary Drug Administration Ordinance explicitly prohibits the use of human medicines in animals, current regulatory efforts are insufficient. This requires a coordinated scientific regulatory approach for human and animal medications. When approving animal medications, besides considering the safety and efficacy for animals, the impact of drug residues in animal-derived foods on humans must also be considered. Therefore, One Health research needs to be elevated to the national level, promoting both nationwide system implementation and enhanced supervision efforts. Despite many studies highlighting the urgency of antibiotic resistance, few focus on finding solutions. Microecology expert Professor Chunling Xiao believes that developing and using probiotics and other live bacterial preparations may provide some effective means to address the post-antibiotic era and antibiotic resistance.

4. Food safety and environmental monitoring closely related to human health

Globally, foodborne diseases remain a persistent public health issue. Preventing foodborne diseases and effectively promoting food safety and security require guidance from the One Health concept. The “One Health Joint Action Plan Guide” released in December 2023[2] by four parties emphasizes strengthening food safety risk assessment, management, and communication to address human-animal-plant-environment health challenges. From addressing hunger, to food safety, to the Healthy China hypothesis, as proposed by Chinese president Xi Jinping, “establishing a broad food perspective and building a diversified food supply system” requires efforts to ensure food safety. Professor Yongning Wu believes that this process involves, first, preventing foodborne diseases, second, adding food pollution and foodborne disease detection departments, and third, establishing a multi-department coordination mechanism aligned with the One Health concept, which is also a global goal.

Furthermore, with global warming, atmospheric and ocean temperatures are rising, ice and snow are decreasing, and sea levels are rising. Multiple studies indicate that climate change affects pathogen release and dilution processes, with a positive correlation between rainfall and waterborne disease outbreaks. The World Health Organization Air Quality Guidelines (2020) first proposed the close relationship between air quality and human health[3]. The United Nations Framework Convention on Climate Change (2023) further integrated One Health into climate and environmental governance as a crucial dimension of global health[4]. In December of the same year, the “One Health Joint Action Plan Guide” released by four parties also advocated for countries to strengthen One Health actions, recognizing that climate change poses significant risks to the health of all life on Earth. Professor Xu Tang also proposed that using the One Health concept to guide global climate and environmental governance represents a deepening and elevation of our cognitive system and behavioral standards.

5. Expert consensus and action recommendations

Through comprehensive discussion, participating experts unanimously agreed to adopt the One Health concept as an important theoretical guide for building a global health community for all. They proposed the following recommendations to promote the implementation of One Health in China:

5.1. Adhere to the One Health concept and strategy to guide practice

One Health strategy is internationally recognized as an effective approach to addressing many current public health safety challenges. Academician Guoping Zhao emphasized that all relevant departments and disciplines should collaborate under the guidance of the One Health concept to address significant and frequent emerging infectious diseases, such as zoonoses and vector-borne diseases, antimicrobial resistance, food safety, experimental diseases, and public health challenges in environmental health like water pollution, air pollution, and climate change.

5.2. Enhance information sharing and joint prevention and control

As Academician Weimo Zhu proposed, the disease monitoring system should be diversified and comprehensive, incorporating multi-layered defense and monitoring systems for pathogens, population immunity, and social environment. The fight against COVID-19 demonstrated the significant role of data sharing in improving the monitoring and early warning capabilities for public health events. In the future, we should build a unified national One Health big data management platform, integrating monitoring data of infectious and non-infectious diseases (including chronic diseases), residents’ health records, environmental pollution, climate change, food, and livestock.

5.3. Develop treatment methods and strategies for emerging infectious diseases

During the COVID-19 pandemic, Academician Fusheng Wang treated 226 severe COVID-19 patients in Wuhan using mesenchymal stem cells, finding no adverse events or reactions and effectively alleviating lung inflammation and fibrosis caused by the virus. This clinical emergency research indicates that the application of stem cells extends far beyond anti-aging and health maintenance. Moreover, the identification of pathogenic targets in drug research for emerging infectious diseases is still in its early stage. Professors Xinghua Pan and Wenqi Dong agreed that the establishment of the One Health Research Institute could promote the development of stem cell therapy and new drug research technologies, thus truly implementing the One Health concept and strategy in multiple fields.

5.4. Establish new disciplines and research institutions for the One Health concept

Universities should establish new disciplines focus on One Health to cultivate interdisciplinary talents that meet future global trends. The establishment of the One Health Research Institute will integrate One Health into the public health system, promoting the construction of a One Health epidemic prevention and control system. Academician Xiaokun Li emphasized that universities are the cradle of knowledge and the birthplace of talent and ideas. Forming a consensus on One Health requires educators to optimize the education strategies of medical schools through the education system, curriculum system, science popularization system, research and development system, and industrial system. Only in this way can the next generation, guided by the One Health concept, achieve a multidimensional combination of education, science, and medicine, effectively responding to unknown infectious diseases, and ultimately realizing the end of pandemics.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding author upon request.

Authors' contributions

Wen CW, Xie DL, and Li X wrote the original manuscript. Zheng XQ, Lou YL and Lu JH reviewed the manuscript and supervised the One Health Innovation and Development Forum. Lu JH contributed to project administration and conceptualization.

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Appendix: List of participating experts (alphabetical order by surname)

Zeliang Chen: Distinguished Professor of Shenyang Agricultural University; Deputy Director of National Medical Products Administration Key Laboratory for Quality Monitoring and Evaluation of Vaccines and Biological Products

Zixin Deng: Academician of Chinese Academy of Sciences; Academician of The World Academy of Sciences; Foreign Full Member (Academician) of Russian Academy of Engineering; Academician of American Academy of Microbiology

Wenqi Dong: Professor of Southern Medical University

Xiaokun Li: Academician of the Chinese Academy of Engineering; Deputy Secretary and President of the Party Committee of Wenzhou Medical University

Jiahai Lu: Director of Institute of One Health, Wenzhou Medical University

Zhenbin Mao: Academician of International Academy of Ecology and Life Protection Sciences; President of China Food and Drug Corporation Quality and Safety Promotion Association

Xinghua Pan: Director of Stem Cell Center at Kunming General Hospital; Director of Clinical Laboratory Department; Deputy Director of Postdoctoral Workstation at Kunming General Hospital

Xu Tang: Senior Scientific Advisor of the Office of the International Research for Disaster Risk program, Director of the United Nations Office for Disaster Risk Reduction; Director of the Science and Technology Department of the China Meteorological Administration

Yongning Wu: Director of WHO Collaborating Centre for Food Contamination Monitoring; Director of China National Center for Food Safety Risk Assessment Committee and Chemical Hazards Sub-committee; Director of Key Laboratory of Food Safety Risk Assessment of National Health Commission

Ningshao Xia: Academician of Chinese Academy of Engineering; Member of Chinese Academy of Medical Sciences

Chunling Xiao: Member of Microecology and Health Professional Committee of China Medical Education Association

Ruifu Yang: Director of State Key Laboratory of Pathogen and Biosecurity at Beijing Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences; Director of Laboratory of Analytical Microbiology at the National Center for Biomedicine Analysis

Xinbing Yu: Guangdong Health Science Popularization Promotion Association; Chairperson of the Guangdong Health Science Popularization Alliance

Yanjun Zhang: Deputy Director of the Party Committee of Zhejiang Provincial Center for Disease Control and Prevention

Guoping Zhao: Academician of Chinese Academy of Sciences; Academician of the World Academy of Sciences; Academician of American Academy of Microbiology

Weimo Zhu: Academician of US National Academy of Kinesiology; professor of University of Illinois at Urbana-Champaign; Scientific Advisor of the Scientific Board of the President's Council on Physical Fitness and Sports