Editorial

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Strengthening medical facility responses to respiratory infectious diseases: Global trends, challenges, and innovations post-COVID-19

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SUMMARY Respiratory infectious diseases have long been a serious public health problem. This study explores the significance of respiratory infectious disease prevention and control systems worldwide, particularly during and after the COVID-19 pandemic. The epidemiology of many respiratory diseases such as influenza changed over the past two years, and the incidence of pathogens such as Mycoplasma pneumoniae and Bordetella pertussis has also increased. Based on influenza surveillance data in China, the influenza season in 2023 was notably delayed and extended, with A(H1N1) pdm09 being the predominant strain. This editorial also reviewed the gradual establishment of China's infectious disease prevention and control system following the 2003 SARS outbreak, highlighting the role of medical facilities in managing public health emergencies, conducting infectious disease pre-screening, and reporting cases to networks in real time. In the future, China will further develop an intelligent, multi-trigger infectious disease surveillance and early warning system to increase the early detection of unknown infectious diseases and optimize the allocation of medical resources. A robust infectious disease control system is crucial to addressing future pandemic threats.

Keywords respiratory infectious disease, influenza, coronavirus disease 2019 (COVID-19), respiratory infectious disease prevention and control system, infectious disease surveillance

Respiratory infectious diseases pose a major global public health challenge, contributing significantly to the overall disease burden. The prevention and control of common respiratory infectious diseases, such as influenza and tuberculosis, remains a critical issue. Compounding this, the emergence of new and unpredictable outbreaks – including severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), avian influenza in humans, and most recently, coronavirus disease 2019 (COVID-19) – further threatens public health and socio-economic stability worldwide.

Prevalence of respiratory infectious diseases

Following the relaxation of COVID-19 prevention and control measures worldwide, shifts in the epidemiological trends of respiratory infectious diseases have been observed (*1*). In addition to influenza viruses and respiratory syncytial viruses, novel coronaviruses have emerged as a significant pathogen responsible for epidemics of respiratory infectious diseases (*2*). Concurrently, the number of patients infected with other pathogens, such as Mycoplasma pneumoniae and Bordetella pertussis, have increased following the emergence of pandemic-causing novel coronaviruses (*3*).

The epidemiology of influenza, the most prevalent respiratory infectious disease in the past, underwent a notable transformation prior to the emergence of the COVID-19 pandemic (Figure 1). According to data from the World Health Organization (WHO), the number of influenza cases remained relatively stable before the start of the COVID-19 pandemic. In 2020-2021, however, the global spread of COVID-19 led to a significant reduction in the annual transmission of influenza viruses worldwide. In 2021, the global number of influenza cases reached a historic low of 662,862, marking a decline from the previous year. However, the number of influenza cases globally increased significantly in

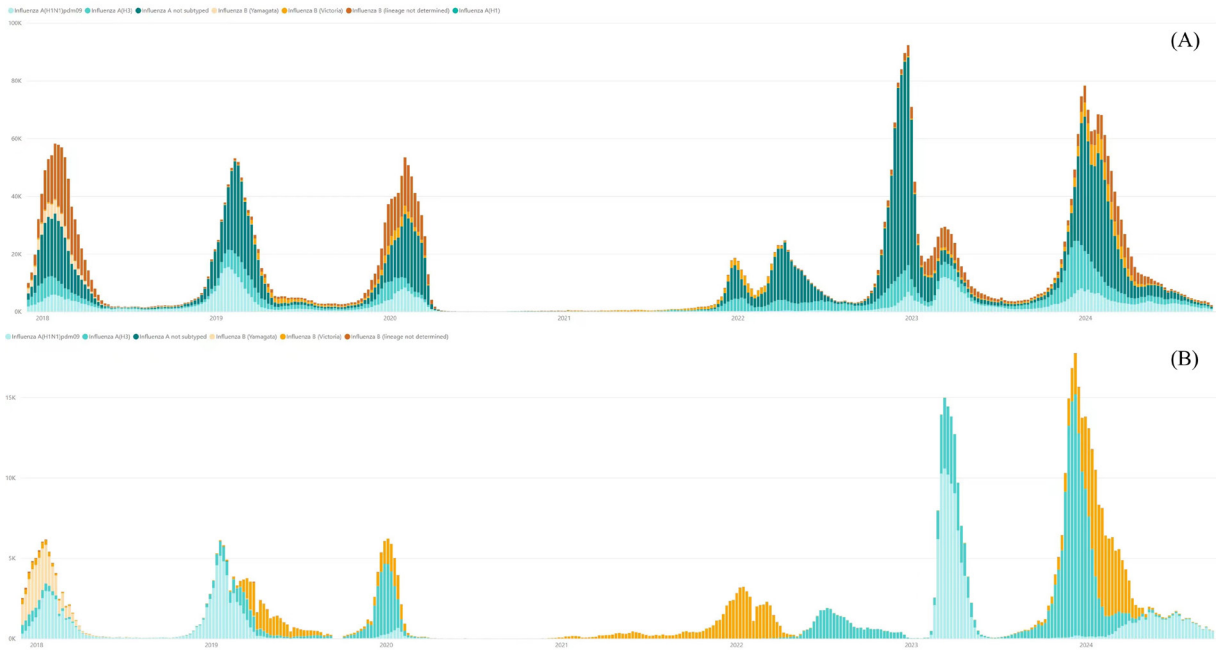

Figure 1. Instances of global influenza detection by subtype, 2018-2024, reported to FluNet, GISRS (2024-09-29) (A), Instances of influenza detection by subtype in China, 2018-2024, reported to FluNet, GISRS (2024-09-29) (B).

September 2023 and 2024, reaching levels well above those observed historically. In addition, the seasonality of influenza viruses shifted before and after the start of the COVID-19 pandemic. The timing of annual global influenza circulation in 2020 differed from that of any season observed previously. Influenza activity peaked in late January-early February 2020 and continued into early April 2020. For the remainder of 2020, influenza activity was either absent or minimal compared to that in previous years. However, the subsequent years, 2023 and 2024, witnessed a delayed and significantly prolonged influenza season. From mid-February to the end of April 2023, China experienced a wave of influenza epidemics predominantly involving the A(H1N1)pdm09 subtype. These seasonal epidemics occurred approximately two months later than the previous winter and spring influenza seasons (*4*). Moreover, the subspecies causing influenza epidemics differed. Of the 33,118,831 samples of respiratory viruses collected globally during inpatient and outpatient surveillance, 19% (614,907) were positive for influenza between early November 2019 and the end of December 2020. Of these positive samples, 63% were subtyped as influenza A and 37% (229,639) as influenza B. In contrast to the situation during the 2019–2020 COVID-19 pandemic, the 2023 and 2024 influenza seasons are predominantly characterized by untyped influenza A, and to a lesser extent, subtype A(H3N2). Data from the Global Influenza Surveillance and Response System (GISRS) indicate that the 2022-2023 influenza season in the EU/EEA countries was characterized by a co-pandemic of A(H1N1) pdm09, A(H3N2), and B/Victorian lineage viruses, with the A(H3N2) subtype predominating in 2024 (*5*). In 2022, an influenza outbreak primarily caused by the B(Victoria) lineage occurred in northern China. After May 2022, the influenza epidemic season in the southern provinces of China predominantly involved the A(H3N2) subtype. From mid-February to the end of April 2023, a wave of influenza predominantly caused by the A(H1N1) pdm09 subtype was observed in the country. In the 2024 influenza season in China, epidemics caused by both the A(H3N2) and B(Victoria) lineage viruses occurred simultaneously.

The infection trends for the novel coronavirus warrant attention. According to the Centers for Disease Control and Prevention (CDC), both the nucleic acid positivity rate and mortality rate in the United States exhibited a seasonal pattern as of August 2024, with peaks in July-August and December-January, followed by a gradual decline beginning in March. The initial pandemic peak occurred between March and June 2020, with cases steadily rising in the months that followed. In the first week of January 2021, weekly deaths reached a record high of 25,974. Another surge in cases occurred in July 2021, driven by the spread of the Delta variant. The emergence of the Omicron variant in late 2021 and early 2022 led to a resurgence in cases, with a positivity rate of 30.5% in the first week of January 2022. However, widespread vaccination helped mitigate severe outcomes, keeping the proportion of severe cases relatively low. Over the past two years, the rise in incidence and mortality rates has stabilized (Figure 2A) (*6*). As of August 31, 2024, the cumulative number of confirmed cases in the United States surpassed 100 million, with over 1.2 million deaths. In December 2022, China announced a relaxation of its strict containment

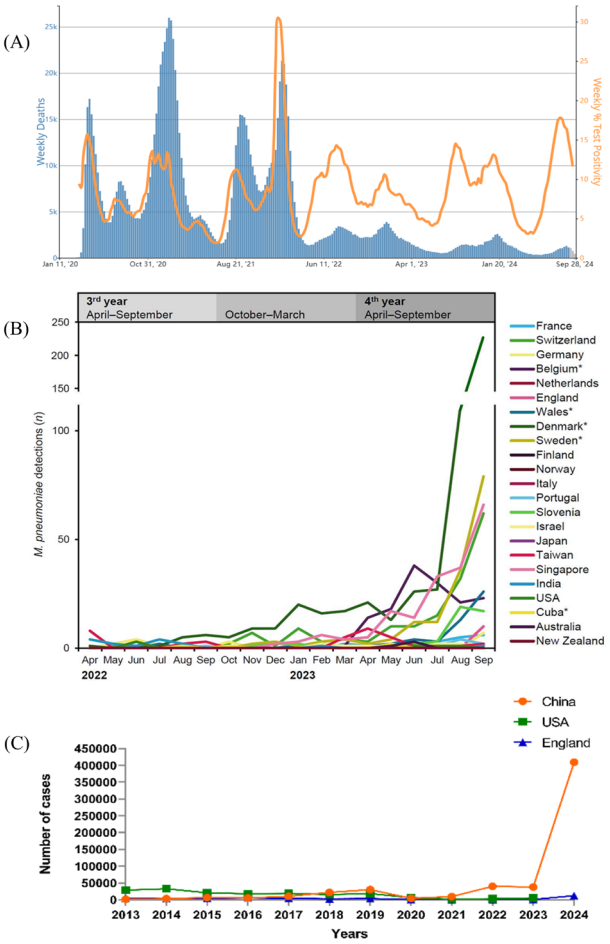

Figure 2: Provisional COVID-19 Deaths and COVID-19 Nucleic Acid Amplification Test (NAAT) Percent Positivity, by Week, in the United States, Reported to the CDC (through August 2024) (A); Mycoplasma pneumoniae detection by PCR worldwide since the start of the global prospective surveillance. Time in years and 6-month periods since the introduction of non-pharmaceutical interventions are indicated at the top of the graph. *National surveillance. Detection during the 3rd year was previously reported (B); The number of Pertussis cases in the United States, United Kingdom, and China, 2013-2024 (2024-07) (C).

policy, transitioning to a strategy of coexisting with the virus. From December 2022 to January 2023, China experienced a sharp surge in cases, with daily confirmed infections reaching several million. Despite this rebound, the proportion of severe cases declined, highlighting the effectiveness of China's vaccination efforts. By October 2023, China had reported approximately 120 million cumulative confirmed cases and around 60,000 deaths. The overall mortality rate has significantly decreased since the early stages of the pandemic. As of April 2024, the national COVID-19 positivity rate remains low (*2*).

Global surveillance data for M. pneumoniae indicate that the global incidence of M. pneumoniae before the COVID-19 epidemic was 8.61%, and in the early 2020s the number of M. pneumoniae cases decreased yearly due to the strict NPIs (non-pharmaceutical interventions) implemented during the epidemic, to 1.69% in 2020 to 2021 and 0.70% in 2021 to 2022 (*7*). More than three years after the implementation of restrictive measures during the COVID-19 pandemic, M. pneumoniae has re-emerged in both Europe and Asia (Figure 2B)(*8*). Since August 2023, there has been a notable surge in the incidence of M. pneumoniae cases in Denmark, Sweden, Singapore, and Switzerland (*7*). Similar changes in epidemiological trends have also been noted in China (*8*). M. pneumoniae triggered multiple outbreaks in Shanghai (*9*), Guangzhou (*10*), and Chongqing (*11*) after the COVID-19 pandemic, and especially among children (*12*).

Pertussis is an ancient infectious disease caused by B. pertussis that has historically had a low prevalence in countries around the world. Since 2023, the United States, the United Kingdom, and China have seen a significant rise in pertussis cases, with incidence far exceeding historical levels (Figure 2C) (*13*). This phenomenon has been particularly pronounced in China. Over the past year, reported pertussis cases in China have surged dramatically. In June 2023, there were 1,512 cases, though that number rose sharply to 15,275 by January 2024. This upward trend accelerated in the subsequent months, with the number of cases soaring to 91,272 in April and 97,669 in May—levels that are considerably higher than those observed historically.

Given the impact of the COVID-19 pandemic and the associated prevention and control measures, as well as the emergence of pathogen mutations and other factors, there have been changes in the pathogen spectrum and the epidemiological pattern of respiratory infectious diseases. This has resulted in the emergence of a number of new infectious diseases that have yet to exhibit clear epidemiological trends. Consequently, the threat to human health from Disease X will persist in the future. Therefore, development of a robust and comprehensive infectious disease prevention and control system is crucial.

How medical facilities respond to respiratory infections

In China, medical facilities act as the primary line of defense against respiratory infectious diseases. Effective prevention and control hinge on several key factors: monitoring and early warning systems for common respiratory infections, prompt identification of novel infectious diseases, and strategic allocation of medical resources. In response to the SARS outbreak in 2003, China progressively developed a comprehensive system for preventing and controlling respiratory infectious diseases centered around medical facilities. This system has been instrumental in enhancing the country's response to such health threats.

1. *Establish a Management System for Public Health Emergencies*: The State Council introduced the Emergency Regulations for Public Health Emergencies in May 2003 and the National Emergency Plan for Public Health Emergencies in January 2006. These frameworks

classify public health emergencies into four levels based on their nature, severity, and scope: especially major (Level I), major (Level II), moderate (Level III), and general (Level IV). This classification system has established a national emergency response system and clarified the responsibilities of the various agencies involved.

2. *Pre-screen and Triage Infectious Diseases in Medical Facilities*: On September 13, 2004, and February 18, 2005, the former Ministry of Health issued the Notice on the Establishment of Infectious Disease Departments in General Hospitals above Level II and the Management Measures for Pre-screening and Triage of Infectious Diseases in Medical Facilities. These regulations mandate that general hospitals at Level II and above establish dedicated infectious disease departments to handle pre-screening and triage. This initiative aims to enable early identification of infectious diseases, designate specific departments for treatment, and minimize further transmission within healthcare settings.

3. *Enable Direct Reporting of Infectious Disease Information in Medical Facilities*: Post-SARS, China developed a network-based infectious disease reporting system for real-time reporting from primary medical facilities or county/district disease control centers to the Chinese Center for Disease Control and Prevention *via* the Internet. Infectious Disease Information Management Standards were established to enhance the reporting process and improve data quality. This system facilitates real-time monitoring of respiratory infectious diseases, such as influenza, COVID-19, pulmonary tuberculosis, and pneumonic plague, providing timely and accurate diagnostic and clinical information to aid in outbreak prevention and control.

4. *Conduct Surveillance of Unexplained Pneumonia*: In July 2004 and August 2007, the former Ministry of Health introduced the Implementation Plan for (Trial) National Surveillance of Unexplained Pneumonia Cases and the National Surveillance, Investigation, and Management Plan for Unexplained Pneumonia Cases. These plans initiated nationwide monitoring of unexplained pneumonia cases and clusters, enabling rapid identification of new pathogens. Notably, human infections with H7N9 avian influenza and the novel coronavirus were swiftly detected. For example, following the first reported H7N9 case in Shanghai in March 2013, specimens were analyzed, leading to the isolation of three strains of the virus within two weeks. Similarly, in December 2019, the Wuhan outbreak of unexplained pneumonia prompted immediate government action, including pathogen identification and international dissemination of the novel coronavirus's genetic sequence by January 10, 2020, showcasing a rapid response from initial detection to global alert.

5. *Enhance Intelligent Multi-point Trigger Monitoring and Early Warning Systems*: On August 30, 2024, the National Center for Disease Control and Prevention issued the Guiding Opinions on Establishing and Improving the Intelligent Multi-point Trigger Infectious Disease Monitoring and Early Warning System. This initiative aims to unify the monitoring of clinical syndromes, laboratory surveillance of pathogens, and risk factors associated with vectors, host animals, and the environment, alongside effective monitoring of societal attitudes. By 2030, the goal is to develop a rapid, scientifically efficient monitoring and early warning system that significantly improves sensitivity and accuracy in detecting newly emerging infectious diseases, unexplained illness clusters, and key infectious diseases, achieving internationally advanced levels of epidemic detection, assessment, and warning capabilities.

Currently, China has established an effective system for preventing and controlling respiratory infectious diseases, centered on monitoring, diagnosis, and clinical outcomes at medical facilities. Future efforts will aim to further enhance the monitoring of infectious disease, clinical syndromes, and laboratory surveillance of pathogens. These improvements depend on the reliability of diagnostic practices across all levels of medical facilities.

In 2023, the National Health Commission introduced quality control indicators for influenza, which include metrics such as the positivity rate of laboratory diagnosis before antiviral therapy and the mortality rate among patients hospitalized with severe influenza. These indicators are designed to guide medical facilities in managing quality control related to etiological diagnosis, appropriate use of medication, and treatment of severe cases. Future indicators will also address diseases such as tuberculosis and COVID-19 with the aim of improving the diagnostic accuracy of respiratory infections.

These measures are expected to enhance China's capabilities in monitoring, warning of, and detecting unknown infectious diseases while ensuring the rational and effective allocation of medical resources.

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