Healthy China

Chinese Pathogen Identification Net: A Laboratory Network for Surveillance and Response of Bacterial Infectious Diseases

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Infectious diseases are a sustained threat to social development and public health. Bacterial infectious diseases, including plague, cholera, anthrax, brucellosis, typhoid fever, meningitis, and even those caused by antimicrobial-resistant bacteria, have been prevalent around the world for a long time, and still trigger outbreaks and long-term epidemics in different countries or regions nowadays (*1*), and trans-regional spread of diseases has frequently exhibited epidemic patterns. Facing the current threats of infectious diseases, it is important to identify and discover the outbreak at the earliest possible time, identify the pathogen, and ensure timely disposal to avoid escalation of the situation and for the prevention and control of infectious diseases.

For the purpose of infectious disease surveillance, the data of the disease need to be collected constantly, and the dynamics of prevalence need to be analyzed continuously in spatial and temporal scales in population. During the course, the real-time situation and trends of the epidemic can be obtained, and the epidemiological data can be applied in the activities of disease prevention and intervention. Laboratory surveillance is an essential component in the framework of infectious disease prevention and control (*2*). Laboratory monitoring is conducted by analyzing collected samples and pathogens, mainly including detection of pathogens in samples and analysis of biological characteristics of pathogens (*3*). These data are used for pathogen diagnosis, infection confirmation, and outbreak detection. The bioanalysis data of the pathogens from different patients and sources can be used to reveal the pathogen spectrum and its changes and to trace the transmission chain, spread, and source. Data from laboratory surveillance can provide support for diagnosis, treatment, epidemic discovery, and intervention decisions for responding to infectious diseases.

China has developed a nationwide reporting system of infectious diseases to collect diagnostic information of patients from the hospitals. In the early stages, paper report cards were used, doctors filled out the cards, and the cards were collected and gathered in the local public health institutions for analysis. In 2004, the reporting system was updated, a computerized recording and reporting system was established and used to collect the diagnostic data of infectious diseases through the nationwide information network (*4*). The data in the reporting system mainly included clinical diagnosis and epidemiological records, but the biological data of pathogens were not collected. In 2017, China established a national laboratory surveillance network for bacterial infectious diseases, the Chinese Pathogen Identification Net (China PIN) to collect the bioanalysis data of bacterial pathogens from the network laboratories to provide information on the pathogens and to support the early detection and tracing of infectious diseases. In the network, laboratory analysis includes pathogen identification, biotyping, antimicrobial resistance detection, molecular typing, and whole genome sequencing. The data were uploaded through the web-based information system to the central database from the provincial, municipal, and prefecture-level laboratories and were used to establish a database for comparative analysis and traceability of pathogenicity at all levels of laboratories. Each level of laboratory could also submit its own data query and obtain the typing results through the information system. Combining the epidemiological data and laboratory data, the network laboratory could detect the typing cluster of pathogens and suggest the possible cases cluster to initiate the epidemiological investigation for detection of potential outbreaks or spread and source tracing.

China PIN is under the management of the National Health Commission. The CDCs at the national, provincial, and prefectural levels execute the laboratory analysis. China PIN focuses on improving the technical capabilities of laboratory diagnosis; outbreak identification and source tracing of bacterial infectious diseases; and the monitoring, warning, and investigation capabilities of the laboratories of CDCs at

the provincial and prefecture levels, laying a solid technical foundation for the monitoring, prevention, and control of bacterial infectious diseases. China PIN provides an objective basis for rapidly identifying pathogens, detecting trans-regional transmission and scattered outbreaks, issuing early warnings, conducting source tracing, and responding to emerging infectious diseases. China PIN has established four levels of network laboratories in the current system of disease prevention and control institutions, namely, national, provincial, prefecture, and county. The network adopts standardized pathogen identification, antimicrobial resistance detection, molecular subtyping, and whole genome sequencing technologies to complete pathogen detection and laboratory analysis. Moreover, with the support of network information technology, an information system for workflow management of the network infrastructure to store and analyze pathogenic data and a resource database of infectious disease etiology has been developed, and the model of laboratory-based "experiment-data-internet" was established, which integrates microbial, molecular, and genome data of pathogens/samples and basic epidemiological data. The internet-based information system plays as the fundamental support and the working platform in the network. Each network laboratory can upload the data of pathogens/samples to the central database of the network and obtain feedback of analysis online.

This monitoring model can find the potential association between cases from the laboratories, propose an outbreak hypothesis, discover the risk factors and sources of infectious diseases, and initiate and support the epidemiological investigation. After a small number of cases were found and the pathogen was identified, analysis of pathogenic characteristics in laboratory, such as genome sequencing and cluster detection, can help to provide early warnings of outbreak, enhance the sensitivity and traceability accuracy of epidemiological analysis, and take timely prevention and control measures to protect population health (Figure 1).

At present, China PIN has established a four-level surveillance network comprising the national, provincial, prefecture, and county levels, with one national central laboratory, 32 provincial central laboratories, and 266 prefecture-level network laboratories. Laboratories at all levels carry out bacterial pathogen surveillance of infectious diseases, involving those related to intestinal, respiratory diseases, and zoonosis.

To date, China PIN has been continuously collecting laboratory data of the pathogenic bacteria. From 2017 to 2021, the laboratories in China PIN have been involved in responding to more than 150 public health events by providing molecular subtyping and other pathogen data of infectious diseases, showing important roles in outbreak detection and confirmation, transmission analysis, source tracing, and risk assessments of bacterial infectious diseases. In the face of sustained emergence of infectious diseases, sensitive detection and rapid response to new

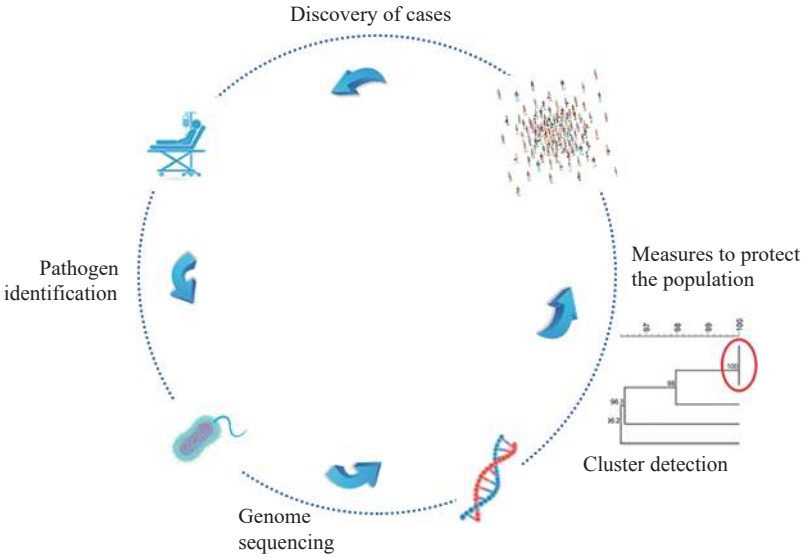

FIGURE 1. Overview diagram of procedure and public health outcome of China PIN surveillance.
Abbreviation: China PIN=Chinese Pathogen Identification Net.

infections and outbreaks are still challenges in China PIN. Laboratory capacities need to be improved constantly, and the network laboratories should be expanded. Now China PIN is promoting laboratory network practices in the infectious disease surveillance, and improving the integration of the epidemiological and laboratory-based monitoring, especially in response to outbreaks and epidemics.

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