



National molecular tracing network for foodborne disease surveillance in China

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ABSTRACT

To improve the early detection of geographically dispersed common-source foodborne outbreaks, a national foodborne disease molecular tracing network (TraNet) was launched in 2013 based on the existing laboratory-based foodborne disease surveillance system in China. TraNet consists of 32 provincial and many municipal Centers for Disease Control and Prevention that conduct molecular sub-typing using pulsed-field gel electrophoresis (PFGE) on foodborne pathogens submitted by sentinel hospitals within their jurisdictions, and submit these PFGE profiles to a national database for further analysis. Currently, TraNet plays a significant role in the identification of etiologic causes and tracks contaminated food during foodborne outbreaks.

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1. Introduction

Foodborne diseases are an important cause of morbidity and mortality worldwide. World Health Organization launched an initiative to estimate the global burden of foodborne diseases that has resulted in assessments of 31 biological and chemical foodborne agents, and it is estimated that 600 million foodborne illnesses and 420,000 deaths were caused in 2010. (Havelaar et al., 2015; Tauxe, Doyle, Kuchenmuller, Schlundt, & Stein, 2010). In 2011, the United States Centers for Disease Control and Prevention estimated that foodborne diseases result in approximately 48 million illnesses, 128,000 hospitalizations and 3000 deaths annually in US (Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011; Scallan et al., 2011). In China, an estimated 748 million cases of acute gastrointestinal illness and 420 million medical consultations occur each year (Chen et al., 2013). Early detection and response to foodborne outbreaks and effective control measures are critical to prevent foodborne infections. Many countries have launched foodborne disease surveillance programs to improve safety of food

supply and prevent foodborne infections (Bahk, Kim, & Park, 2015; Gkogka, Reij, Havelaar, Zwietering, & Gorris, 2011; Hall et al., 2005; Kumagai et al., 2015; Masoumi Asl, Gouya, Soltan-Dallal, & Aghili, 2015; Scallan & Mahon, 2012; Thomas et al., 2013; Pelt, Wit, Wannet, Ligtvoet, & Widdowson, 2003). China has made huge efforts to improve its foodborne disease surveillance system after the melamine incident in 2008 (“Food safety in China: a long way to go,” 2012). In 2013, China established a national foodborne disease molecular tracing network (TraNet) that collects molecular sub-typing information of foodborne bacteria to facilitate early detection of geographically dispersed common source foodborne outbreaks. The ultimate goal of TraNet is similar to that of PulseNet USA, the national laboratory network for foodborne outbreak detection (Boxrud, Monson, Stiles, & Besser, 2010; Swaminathan, Barrett, Hunter, & Tauxe, 2001). Due to the rapid increase in food marketing and broad distribution areas, an increasing number of outbreaks are multiregional and even multinational, such as the *Escherichia coli* O104 outbreak in Germany and France (Frank et al., 2011). In China, *Salmonella* species, *Vibrio parahaemolyticus*, *Staphylococcus aureus*, and diarrheagenic *Escherichia coli* are the most common foodborne pathogens leading to outbreaks (X. Liu, Chen, Wang, & Ji, 2004). In addition, *Salmonella* species is the main target pathogen detected through microbiological food safety surveillance in China (Pei et al., 2015). This paper describes China’s national foodborne disease molecular tracing network (TraNet).

Abbreviations: PFGE, pulsed-field gel electrophoresis; TraNet, national foodborne disease molecular tracing network; CDC, Centers for Disease Control and Prevention; CFSA, China National Center for Food Safety Risk Assessment; WGS, whole genome sequencing.

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2. Policy support

After the melamine incident in 2008, the Chinese government designated food safety as a national priority (“Food safety in China: a long way to go,” 2012) and in 2009, the Food Safety Law was implemented. To implement the foodborne disease surveillance requirements of the law, the Department of Health initiated a primary foodborne disease surveillance plan. The Institute of Nutrition and Food Safety of the China Center for Disease Control and Prevention (CDC), which provides technical support for ensuring food safety nationally, established the National Foodborne Disease Surveillance Network with national financial support in 2009. Initially, the foodborne disease surveillance network only focused on ‘abnormal cases’ reporting and foodborne outbreak reporting. Abnormal case reporting system collected any suspected unusual cases related to possible food consumption, such as infant kidney stones. This system was established in order to monitor health incidents related to food which cannot be explained by existing clinical knowledge and experiences. The foodborne outbreak reporting system mainly collected reports of point-source outbreaks — those that occurred at restaurants or large gatherings, or involve many ill persons who sought medical care at a common facility. In 2011, a new national agency, the China National Center for Food Safety Risk Assessment (CFSA) was established. CFSA is responsible for food safety risk assessments at the national level, and provides technical support, including food safety risk surveillance and assessments, national food safety standard developments and revisions, and provides other services (Jen & Chen, 2017). According to the 2015 updates of the Food Safety Law (“Food Safety Law of the People’s Republic of China”, 2015), six national agencies in China, including National Health and Family Planning Commission (NHFPC, formerly the Ministry of Health), Ministry of Industry and Information Technology (MIIT), Ministry of Commerce, General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), China Food and Drug Administration (CFDA), and State Administration of Grain, jointly developed and implemented a national food safety risk surveillance plan. This plan describes a comprehensive program for food safety, which includes sporadic case surveillance, outbreak reporting, population-based surveys, molecular sub-typing, antimicrobial resistance, and special studies. Based on the national surveillance plan, Provincial Health and Family Planning Administrative Departments convene provincial and local CDCs and sentinel hospitals to carry out the foodborne disease surveillance plan annually. The national surveillance plan requires that all pathogens from outbreak investigations, including suspected food and environment samples, all *Salmonella* isolates isolated from stool specimens of sporadic cases and microbiological food safety surveillance, and *Listeria monocytogenes* isolates from foodborne disease special surveillance, should be forwarded to provincial CDCs or municipal CDCs. Laboratories at these CDCs then conduct pulsed-field gel electrophoresis (PFGE) on isolates they receive and submit PFGE patterns to TraNet in a timely manner through BioNumerics software. Additionally, data on serotyping and antimicrobial resistance are also required to be submitted to TraNet for analysis.

3. Organization and structure

TraNet is a network of municipal, provincial, and national public health laboratories that use PFGE to analyze DNA patterns of foodborne bacteria. TraNet aims to establish databases that can be monitored in real-time for the surveillance of foodborne bacteria from human, food and environment. These pathogen-specific databases can be used for early detection and rapid investigation of dispersed foodborne outbreaks and to identify suspected food

vehicles. TraNet includes 32 provincial and 107 municipal CDC laboratories (Fig. 1). The databases are built in the BioNumerics server/client format, and the online database server is located at the CFSA in Beijing. National central databases have been established for eight pathogens, including *Salmonella*, *Shigella*, *Vibrio parahaemolyticus*, diarrheagenic *Escherichia coli*, *Listeria monocytogenes*, *Cronobacter sakazakii*, *Staphylococcus aureus* and *Campylobacter*.

CFSA is the national administrator and curator of TraNet, with online access to the central databases and is responsible for managing, analyzing and maintaining the databases. In addition, CFSA is responsible for providing technological guidance to provincial and municipal partners, personnel training and quality control. The administrator’s role includes setting up the BioNumerics server database and managing partner’s database structure, including field properties, forms, versions, users, etc. The database structure settings consist of managing fields, experiments, gel files, entries, and other parameters. All data and settings are copied automatically to the CDC client databases upon installing the client plugin. The curator’s role includes assuring the quality of data, and validating and naming PFGE profiles submitted by partners. The curators are also responsible for performing central cluster searches and alerting participants and epidemiologists when a cluster of indistinguishable PFGE profiles is detected.

The provincial Health and Family Planning Administrative Departments establish regional foodborne surveillance programs according to the national plan’s requirements. The provincial and municipal CDCs, as main technological institutions implement the surveillance plan, and are responsible for the confirmation of isolates from patients’ stools, food, and environment samples and for performing experiments, such as serotyping, PFGE, and antibiotic susceptibility tests. All participating CDCs can download the corrected experimental data and nomenclature by administrator and can search for similar isolates based on epidemiological information and experiment matching. Additionally, provincial and municipal CDCs are required to manage and analyze the regional surveillance data, and if multi-province/city clusters are detected,

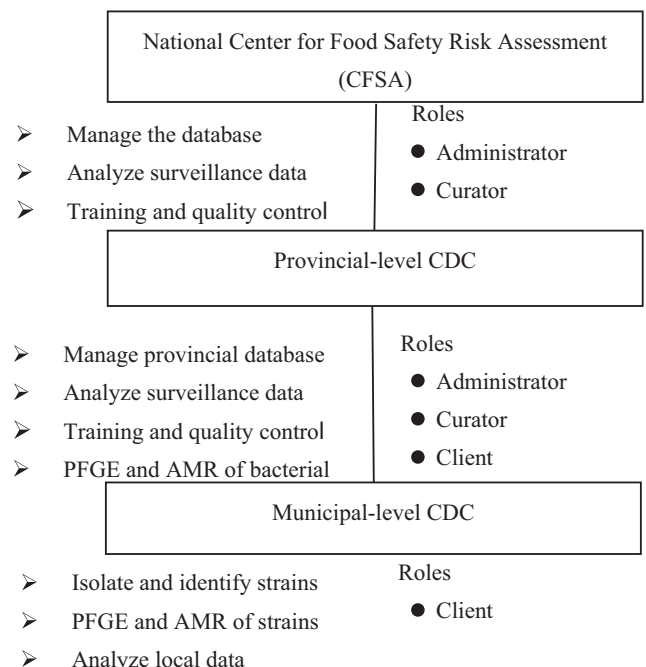


Fig. 1. TraNet organization structure.

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