Surveillance Networks– Improving the National Waterborne Disease Database

By Kelly A. Reynolds, MSPH, Ph.D.

The mantra of the Centers for Disease Control and Prevention (CDC) is, "Saving Lives. Protecting People. Saving Money. Through Prevention." One of the ways the federal agency contributes to this mission is through surveillance of environmental diseases. Identification of hazards is the first step in the risk assessment paradigm and necessary to develop effective policy in risk management. Tracking foodborne and waterborne outbreaks is accomplished through relatively new, focused surveillance systems. The following is a review of the various tools used to track environmental contaminants and how the data they produce can be used to prevent the incidence of waterborne disease.

Leading agents

The primary causes of drinking water outbreaks are: *Giardia*, *Shigella*, norovirus, hepatitis A and copper.[1] In contrast, the top five causes of recreational water outbreaks are *Pseudomonas*, *Cryptosporidium*, *Shigella*, *Legionella*, and calicivirus (which include norovirus and sapovirus). The main infection concerns in food are *Campylobacter*, *Cryptosporidium*, *Cyclospora*, *Listeria*, *Salmonella*, *Escherichia coli* O157 and non-O157, *Shigella*, *Vibrio* and *Yersenia*. Although *Pseudomonas* and *Legionella* bacteria are associated with skin and respiratory infections, respectively, other waterborne bacteria, protozoa and viruses cause very similar gastrointestinal illnesses, including diarrhea and stomach upset. Outbreak etiology can be difficult to determine based on symptomology alone. Thus an active and investigative surveillance system is necessary for accurate data collection, pathogen recognition and source identification. Surveillance systems have been developed to build databases on food and waterborne disease transmission. While there is certain overlap, separate food and water surveillance systems exist, each with variable detection and reporting methods. As a result, different outcomes are obtained. For example, food surveillance systems effectively identify endemic and sporadic disease incidence, whereas water surveillance systems are focused largely on outbreak detection.

Active surveillance systems

The majority of CDC's active surveillance program is geared toward foodborne agents. Initiated in 1995, FoodNet tracks infections related to microbial contaminants.[2] The program is not just an outbreak data depository but a collaboration between the CDC, state health departments, the US Department of Agriculture's Food Safety and Inspection Service and the Food and Drug Administration, aimed at improving diagnostics and reporting. Clinicians (physicians and laboratory personnel) and the general population in 10 states (Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, Tennessee, Colorado and New York) are part of the reporting. In this active surveillance program, patients in the representative population are encouraged to seek the care of a physician when ill. Physicians are encouraged to order diagnostic tests and laboratories are encouraged to conduct an array of tests to identify the causative agent. The program actively tracks approximately 46 million people, or 15 percent of the US population. FoodNet is designed to track trends in foodborne disease burdens over time and location, and evaluate the impact of food safety initiatives. Prior to 2004, the incidences of laboratory-confirmed infections were not documented in relationship to outbreaks. Now, individual infections are routinely evaluated for connections to other cases (i.e., an outbreak); however, most cases are not linked to an outbreak.

Beyond outbreaks

Nearly two decades before there was FoodNet, the CDC was monitoring the incidence of drinking water oubreaks via the Waterborne Disease and Outbreak Surveillance System (WBDOSS). The WBDOSS was initiated in 1971 in collaboration with US EPA and the Council for Site and Territorial Epidemiologists (CSTE). This system relied upon public health departments in individual states and territories in the US to provide information that was compiled into biennial surveillance summaries. Since 1985, these summaries have been published in the *Morbidity and Mortality Weekly Report (MMWR)* and used by US EPA to set regulatory standards for waterborne contaminants.[3]

More recently, the National Outbreak Reporting System (NORS) has been used to track certain nationally notifiable diseases. Building on the WBDOSS, NORS represents a new innovation in outbreak reporting. Launched in 2009, also in collaboration with US EPA and the CSTE, NORS promises to improve the quality, quantity and availability of data submitted to the WBDOSS. Such improvements were facilitated by the departure from paper-based outbreak reporting to the development of a rapid, online, electronic reporting system.

Whether we are talking about the WBDOSS or the new NORS, the operative word in each of these databases is 'outbreak'. Like foodborne diseases, infections related to drinking water are probably not associated with outbreaks the majority of the time. The endemic rate of waterborne disease is not known, but using varied approaches, researchers have estimated the non-outbreak level of disease in the US to be as high as 32 million infections per year.[4, 5] With a surveillance system based primarily of the recognition of outbreaks, one wonders just how often non-outbreak related drinking water infections are overlooked.

Incriminating fingerprints

FoodNet also has limitations. One is that routes of infection other than food cannot be definitively distinguished. In other words, in the FoodNet participant network, infections caused by water exposures would not necessarily be distinguished from the presumed food route. Norovirus, for example, is easily spread via food, drinking water and recreational water routes. Noroviruses are the number-one cause of food and waterborne outbreaks in the US. Their detection presents a particular challenge as they are not culturable in the laboratory but can be detected using molecular methods that target unique nucleic acid sequences in the virus—a technique generally referred to as microbial fingerprinting.

Utilizing RNA tracking technologies, the CDC launched CaliciNet in 2009. CaliciNet is an electronic system developed to rapidly fingerprint human caliciviruses, including noroviruses and sapoviruses. As health department laboratories identify calicivirus infections and characterize specific strains of the viruses, they can directly input their data into a national surveillance database. Fingerprints are matched to other data inputs around the country. If a match exists, a dispersed outbreak may be detected.

As of February 2011, 20 state and local health laboratories were certified to submit data to CaliciNet.[6] Of the 552 outbreaks submitted to the surveillance network in the first year, 298 (54 percent) were due to a newly emerged variant. A new variant means that large segments of the population are not immune to the changed strain, which has historically resulted in a pandemic spread of calicivirus infections. The CaliciNet database was developed to improve standardized fingerprinting of circulating norovirus strains and establish links between outbreak clusters and norovirus type.

Conclusions

Improved detection of microbial infections helps health agencies respond to prevent additional exposures in the population. Product recommendations or boil-water notices can be issued with greater certainty when supported by surveillance data. Surveillance data can be used to target high-risk sources and scenarios while identifying critical control points in food production or water collection, treatment and distribution where disease transmission can be mitigated.

To address the issue of outbreak versus non-outbreak incidence rates of microbial infections transmitted via food, surveillance systems are being designed to incorporate genetic information unique to offending pathogens. This same type of technology could also be applied to improve the active surveillance of waterborne disease, the result of which will further justify the need for POU treatment.

References

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