EVIDENCE BASED PUBLIC HEALTH POLICY AND PRACTICE

Beyond compliance: environmental health problem solving, interagency collaboration, and risk assessment to prevent waterborne disease outbreaks

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J Epidemiol Community Health 2006;60:672–674. doi: 10.1136/jech.2005.040394

A systems approach to environmental health problem solving was used to investigate two waterborne norovirus outbreaks in Wyoming and can serve in the development of improved prevention strategies. An interagency collaboration to prevent waterborne disease involving local, state, and federal partners was designed to coordinate response to outbreak investigations. Improved risk assessment and reporting procedures were also integrated to ensure better availability of necessary data. Public health entities should implement sustainable intersectoral interventions to prevent waterborne disease that not only improve regulatory compliance but also have a positive impact on community health outcomes. Collaborative preventive health and water system protection activities should receive priority attention for implementation in state and local jurisdictions.

environmental health scientists is essential to any environmental systems evaluation. Applying this approach allows the collaborative team to better understand the direct cause of illness as well as the environmental antecedents of disease outbreaks (see box 1).

Environmental antecedents have been defined as factors or circumstances in the environment supporting or contributing to the contamination by and persistence or increase of agents that set the stage for disease or illness to occur.⁴ In non-outbreak settings, this approach can improve preventive practices and reduce the risk for environmentally related adverse health outcomes.⁵

During February to October 2001, the WDH investigated two norovirus (formerly known as Norwalk-like virus or NLV) outbreaks linked to contaminated water systems in remote tourist establishments. One represented the largest reported waterborne outbreak in Wyoming's history. In both cases, investigations were conducted that incorporated a systems based environmental assessment with traditional epidemiological and laboratory practices.

CASE REPORT 1

In February 2001, state and federal agencies investigated a multistate outbreak of gastroenteritis associated with a snowmobile lodge in northern Wyoming.⁶ A retrospective cohort study was conducted, and consumption of tap water was significantly associated with illness (relative risk (RR) = 3.3, 95% confidence interval (CI) = 1.4 to 7.7). No food items were associated with illness. Seven (88%) of eight well-water samples tested positive for faecal coliforms. Water from one well and eight (62%) of 13 patient stool samples tested positive for norovirus by reverse transcription polymerase chain reaction (RT-PCR). NLV genogroup II was detected in all eight stool specimens.

A systems based environmental investigation, including an assessment of the water supply system and sewage disposal system, was conducted. An overloaded sewage disposal system, coupled with inadequately designed and maintained holding tanks, diminished the capacity of the septic system to treat effluent. Improper construction of the well and water supply lines also compromised the drinking water supply system. Throughout this investigation, several coordination concerns were identified between state and federal agencies regarding the

Outbreaks associated with drinking water can be protracted and lead to widespread illness. In the USA, from 2001 through 2002, 31 drinking water associated outbreaks affecting an estimated 1020 persons were reported.¹ Environmental health strategies to prevent waterborne disease outbreaks typically focus on a model of compliance with federal and state regulations and routine monitoring for turbidity, total coliforms, and disinfection byproducts. Despite the nationwide use of regulatory compliance models, disease outbreaks linked to contaminated drinking water have continued to increase. This report summarises the strategies of the Wyoming Department of Health (WDH) and multiple collaborating public health agencies to improve the capacity to prevent waterborne outbreaks in public water systems.

As part of a broader initiative to improve environmental public health practice, the Centers for Disease Control and Prevention (CDC) is developing integrated systems approaches to improve responses to and prevention of emerging environmental health problems. Rather than concentrating on enforcement of regulations, a systems approach attempts to understand the interactions of different parts of an operation and identify underlying vulnerabilities in the system.^{2–3} At the local level, collaboration between epidemiologists, laboratorians, and

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Accepted for publication
28 February 2006

Box 1 Steps in an integrated systems investigation

A full, systems investigation can strengthen disease prevention efforts if the following steps are taken:

Set up interdisciplinary investigation team

In a waterborne outbreak, this will mean bringing environmental health specialists, laboratorians, and epidemiologists to the table.

Assess situation

Perform a full investigation to understand the interaction of different elements of a system.

Identify vulnerable points

Evaluate potential weaknesses that may compromise a system (that is, chlorination issues, sewage disposal systems, septic system).

Find prevention oriented solutions

After determining the cause of an outbreak, identify measures that would have prevented disease or facilitated response.

Enact system modifications

Turn prevention into practice and enact changes by institutionalising prevention methods.

Monitor outcomes

To the extent possible, evaluate effectiveness of system modifications.

jurisdiction, monitoring, and enforcement of water quality in public water systems.

INTERAGENCY COLLABORATION AND DEVELOPMENT OF BEST PRACTICES

A Governor's Water/Wastewater Task Force was established in September 2001 to develop an integrated, systems approach to the response and prevention of waterborne outbreaks. All state and federal agencies that deal with water and waste water systems in Wyoming participated, including the WDH, Wyoming Department of Agriculture (WDA), Wyoming Department of Environmental Quality (DEQ), Environmental Protection Agency (EPA), National Park Service, State Engineer's Office, and local public health officials.

The initial meeting allowed the agencies' representatives, many meeting for the first time, to assess the strengths and weaknesses of the existing response mechanisms. Subcommittees were established, and measures were started to address outbreak intervention and prevention:

- Establish an interagency memorandum of understanding between WDH, EPA, DEQ, and WDA to identify routine and emergency coordination activities in public water systems,
- Involve environmental health specialists concurrently with the epidemiology and laboratory portions of outbreak investigations in which waterborne transmission is suspected,
- Identify the broad public health protection authority of the state health officer as a mechanism for enforcement of repairs to water system infrastructure,
- Encourage interagency cross-training to promote cooperation during routine activities as well as for outbreak response (for example, allow regional consumer health specialists to accompany DEQ and EPA contractors on water/wastewater investigations and allow WDH and WDA to participate in water operator training sessions),

- Train environmental health specialists to conduct a general evaluation of the sanitary conditions of a water system while conducting restaurant inspections. Notify DEQ and EPA of any potential problems.

CASE REPORT 2

In October 2001, state and federal agencies investigated an outbreak of acute gastroenteritis associated with a saloon in central Wyoming.⁷ A retrospective cohort study was conducted, and consumption of drinking water and/or ice was significantly associated with illness (RR = 4.5, 95% CI = 1.3 to 15.9). No food items were associated with illness. Five (83%) of six well-water samples tested positive for faecal coliforms. NLV genogroup I was detected in two of three stool samples and one well-water sample by RT-PCR. In addition, a genogroup II strain was detected in one stool sample.

An environmental assessment of the saloon's water supply and sewage system showed improper well construction and maintenance. In addition, the well's chlorinator was malfunctioning because of blockage of the chlorine pellet dispenser. These deficiencies, coupled with the well's installation in fractured volcanic rock, probably caused sewage contamination of the well water.

An investigation of the monitoring logs showed that a quarterly water sample, tested by a local private laboratory, was positive for faecal coliforms in September 2001. The owners, who were both ill with gastroenteritis, responded to this report by manually adding chlorinator pellets to the disinfection system. No regulatory agency was notified and, within two months, at least 84 persons were ill with gastroenteritis.

RISK ASSESSMENT AND REPORTING

To prevent unintentional or intentional waterborne outbreaks in public water systems, additional measures were started by WDH in 2002 and are continuing:

- Mandate that all public and private laboratories that perform bacteriological analyses report positive faecal and/or total coliform results to WDH within 24 hours,

Box 2 What this paper adds

- Environmental health strategies to prevent waterborne disease outbreaks typically focus on a model of compliance with federal and state regulations and routine monitoring for turbidity, total coliforms, and disinfection byproducts. Despite the nationwide use of regulatory compliance models, disease outbreaks linked to contaminated drinking water have continued to increase. This report summarises the strategies of the Wyoming Department of Health and multiple collaborating public health agencies to improve the capacity to prevent waterborne outbreaks in public water systems.
- This paper represents a broad initiative to improve environmental public health practice through the presentation of an integrated systems approach. Rather than concentrating on enforcement of regulations, a systems approach attempts to understand the interactions of different parts of an operation and identify underlying vulnerabilities in the system. Applying this approach allows the collaborative team to better understand the direct cause of illness as well as the environmental antecedents of disease outbreaks.

- Conduct onsite bioterrorism risk assessments in community water systems throughout Wyoming. Assess physical infrastructure, security, and operation of community water systems through the administration of a questionnaire to licensed water operators. Develop a database with assessments that are hyperlinked to an existing EPA database.
- Encourage the sharing of water quality data among the state health department and regulatory agencies.

CONCLUSIONS

A systems approach to environmental health problem solving attempts to understand the interactions of environmental factors that can allow biological, chemical, or physical agents to adversely affect human health. The traditional approach to waterborne outbreak investigations entails (1) the use of epidemiology to identify significant risk factors for disease occurrence, (2) laboratory support of this epidemiological link, and (3) a set of interventions to mitigate the proximal cause of the association.⁸ A systems approach extends beyond traditional "compliance based" regulatory management toward identifying vulnerabilities in the entire system. Measuring either the symptoms of a problem or discovering if a system is non-compliant with agency regulations does not always show the underlying causes of an outbreak. A combination of vulnerabilities usually drives each outbreak event, including factors related to geology, climate, human behaviours, and administrative controls.

Protecting water quality and preventing outbreaks depends on identifying how and why water systems become contaminated. In Wyoming, evaluating the implicated systems (in these cases, water and waste management systems) concurrently with an epidemiological investigation was crucial for the development of effective intervention strategies. Linking environmental health with epidemiology also served to integrate environmental health specialists, epidemiologists, sanitarians, water operators, and business owners in the practice of disease control and prevention. Expanding beyond basic food and water sanitation measures was vital to the development of long term prevention strategies.⁹

Uncovering water system deficiencies depends on an understanding of how facilities operate in order to protect the water supply. Water systems can be compromised by several factors, including errors in design or construction, chlorination system problems, overloaded sewage disposal systems, inadequate septic systems, environmental and climatic conditions such as drought, and the geological conditions affecting installed systems. A rapid evaluation of these interrelated factors can help determine how an aetiological agent enters the water distribution system and is able to remain viable. It also can inform decisions about whether to close a facility, when to issue a boil water order or

bring in additional water supplies, what conditions should be met for reopening, and whether the replacement of existing purifying systems is necessary or if installation of a better system is warranted.

Preventing illness associated with contaminated drinking water is an essential function of state and federal agencies. A systems approach to waterborne disease prevention requires that effective interagency collaboration be combined with a well maintained water supply and sewage system. Developing strategies to corroborate compliance with prevention measures can contribute to improved health outcomes.

Since the two large waterborne outbreak investigations in Wyoming in 2001, interagency collaboration to prevent future incidents has continued. Furthermore, the trends in increased reporting of water quality concerns have also been sustained. To date, no additional drinking water related outbreaks have been reported or detected in the state, perhaps because of the improved intervention measures being carried out.

ACKNOWLEDGEMENTS

The authors thank Annette Heryford and Matt Laidler from the Wyoming Department of Health; Laurie Leis from the Wyoming Department of Agriculture; Dennis Lamb from the Wyoming Department of Environmental Quality; Alicia Anderson from the Centers for Disease Control and Prevention; and G Shay Fout, Sandhya Parshionikar, David Robbins, and Sandra Willian-True from the Environmental Protection Agency for their contributions to the outbreak investigation and manuscript preparation. These investigations were supported in part by the epidemiology and laboratory capacity for infectious diseases cooperative agreement with the Centers for Disease Control and Prevention.

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Competing interests/support: the findings and conclusions in this report are those of the authors and do not necessarily represent the official policy or views of the US Department of the Interior (National Park Service) or the US Department of Health and Human Services (Centers for Disease Control and Prevention).

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Policy implications

The paper clearly illustrates the need for interagency collaboration and coordinated response for prevention activities using waterborne disease examples from the US state of Wyoming. Collaborative preventive health and water system protection activities should receive priority attention for implementation in state and local jurisdictions. We review the two outbreaks but in addition, present policy and practice recommendations that may assist other public health entities.