Walkerton — 5 years later
Tragedy Could Have Been Prevented

by Steve E. Hrudey and Richard Walker

In May 2000, several serious flaws in the Walkerton, Ont., municipal drinking water system aligned to permit a breakthrough of *E. coli* O157:H7 and *Campylobacter* bacteria, causing seven deaths and more than 2,300 cases of waterborne disease. These included 27 cases of hemolytic uremic syndrome, a serious kidney ailment with potential lifelong implications. Most of the cases of kidney disease were among children aged one to four. Other Walkerton residents have also reported enduring illness.

Walkerton, a town of about 5,000 people in southwestern Ontario, Canada's richest province, is a pleasant and comfortable community like many other towns in this rural region. However, the tragic events of five years ago have left lasting scars on the community and severely undermined the trust many Canadians had in their municipal water supplies. Those events also cost Ontario taxpayers hundreds of millions of dollars.

The trial and recent sentencing of the Walkerton water system operators suggested that nothing they could have done would have prevented the fatal outbreak. The operators were charged with breach of trust, uttering forged documents (falsifying records), and common nuisance for their roles in the Walkerton outbreak. The prosecution agreed to a plea bargain, dropping the more serious charges in return for guilty pleas to common nuisance. The general manager was sentenced to one year in jail (and released after four months), and the foreman was sentenced to nine months of house arrest.

The plea bargain was based on “facts” attributed to an epidemiologist, not a specialist in disinfection, who claimed that even if the chlorine level in Walkerton’s water system had been substantially increased, the illnesses and deaths would still have occurred. However, the official inquiry into the events leading to the tragedy showed that if the system had been monitored properly and the operators had responded effectively to the signs of trouble, the severe outbreak would have been prevented or substantially reduced.

A two-year, $9 million public inquiry under Justice Dennis O’Connor provided one report describing the causes of the outbreak.
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(summarized in Opflow, June 2002) and a second report that laid out a program to ensure that other Ontario water systems would not repeat the failures that contributed to the Walkerton disaster. The failures in Walkerton happened at many levels, including:

- ineffective regulatory oversight,
- inadequate watershed protection, water treatment, and monitoring of barriers for the risks facing Walkerton’s vulnerable groundwater system, and
- poor system management.

This article focuses on the roles and responsibilities of the system operators and what actions they should have taken to prevent the tragedy.

The Well and the Outbreak

The outbreak occurred after unusually heavy spring rainfall washed manure from an adjacent farm into a shallow water supply well — Well 5. The farmer was following exemplary farm practices and was not to be faulted, Justice O’Connor’s inquiry determined. However, Well 5 was particularly vulnerable to surface contamination because it produced water from an aquifer only 5–8 m (16–26 ft) deep. Also, following the initial pump test in 1978 that showed fecal contamination within 24 hours, the hydrogeologist’s report warned of the contamination risks, and microbiological monitoring results over the years confirmed the vulnerability of this groundwater supply.

Yet the only treatment barrier required by the regulator was chlorination to achieve a residual of 0.5 mg/L after a 15-min contact time. If that single requirement had been continuously met, more than 99 percent of the pathogens would have been inactivated. But, although the system foreman was supposed to measure the chlorine residual once a day, the inquiry found that chlorine residuals were not measured on most days and fictitious entries for residuals were entered on daily operating sheets.

The failure to measure chlorine residuals was critical, because the contamination most likely entered Well 5 on May 12, a week before illness became evident in the community. When asked on May 19 and 20 whether there were any problems with the drinking water quality, the general manager of the Walkerton Public Utilities Commission assured the local health authorities that the water was okay, despite having received adverse microbiological monitoring results on May 17. A boil-water advisory was not issued until May 21, when health authorities concluded the water must be involved. The first victim died on May 22. At least eight days without valid chlorine residual monitoring had passed between the contamination influx and the boil-water advisory, after illness was already widespread.

The organic loading from the manure contamination overwhelmed the inadequate, fixed chlorine dose, leaving no disinfection capacity to inactivate the pathogens entering the distribution system. Measuring the chlorine residual would have identified the problem immediately, but no chlorine residuals were measured during this critical period.

The Trial

During their criminal trial in Ontario Superior Court, the Walkerton PUC system operators — the general manager and the foreman — admitted that they failed to perform monitoring and treatment, withheld adverse monitoring results, and falsified operating records. But they were not solely to blame, nor
were they the only ones who could have prevented the disaster. The inquiry found that severe and systemic deficiencies in the operator training and regulatory systems of the Ontario government contributed to the tragedy.

Despite the operators’ admissions, to secure guilty pleas the prosecution agreed to accept as fact an epidemiologist’s opinion that dramatically increasing the chlorine level in Walkerton’s water system “would not have prevented this tragedy.” The epidemiologist, who was the sole expert cited in the official statement of facts at the trial, had acknowledged not being a specialist in disinfection during Justice O’Connor’s inquiry. From the epidemiologist’s opinion, the prosecution concluded: “It therefore cannot be said that the criminal conduct of [the operators] ... their failure to properly monitor, sample and test the well water ... was, in law, a significant contributing cause of the deaths and injuries.”

**Could Have, Should Have**

Although the plea bargain agreement presents the Walkerton tragedy as something that no person, no matter how competent, could have prevented after rain washed manure into Well 5, water professionals must recognize that this characterization is wrong. Many actions could, and should have been taken to prevent contamination of the water supply.

The heavy rains and visible flooding that occurred on May 12 should have compelled the Walkerton operators to commence more frequent checking of chlorine dosage and residuals. Even if they had kept to the limited monitoring schedule required by the regulator, the operators should have recognized that finding low to nonexistent chlorine residual was cause for alarm. They should have increased the chlorine dose immediately to try to achieve a satisfactory residual.

In this particular case, the operators should have recognized Well 5’s vulnerability and shut it down, because another, uncompromised well was capable of providing the entire supply for Walkerton. That option was not immediately available because the foreman failed to replace a defective chlorinator on the alternative well until May 19, even though he was aware of the defect weeks before.

Once the operators became aware that unchlorinated water had entered the distribution system, the water storage should have been dosed with chlorine solution and the mains flushed. The regulator and local health authorities should have been notified; if adequate chlorine residual could not be restored, a boil-water advisory should have been issued immediately. These actions could have and should have all been completed in the first 24 hours after the absence of chlorine residual signaled the problem on the morning of May 13.

**Would Have ...**

Even if these steps did not eliminate the consumption of contaminated water entirely, they would have substantially reduced the exposure of Walkerton consumers and the resulting health effects. As it was, contaminated water was distributed for a full week longer than necessary. If the policies adopted in 1994 by the Ontario Chlorination Bulletin had been applied to Walkerton PUC as they should have been, the vulnerable shallow well would have been equipped with a continuous chlorine residual analyzer. The continuous monitor should have been established in a fail-safe mode that would have automatically shut off Well 5 when the chlorine residual fell below the set point for minimum effective disinfection.

The Walkerton operators should have realized that because their system was totally reliant on a single chlorination barrier, it was not fail safe and was vulnerable to catastrophic failure. The requirement for a second barrier (source protection) was identified more than 20 years earlier, but never implemented. Water system operators must be able to recognize the threats to their system contrasted with the system’s capability to cope. They have a professional responsibility to ensure deficiencies are identified, made known to management, and effectively remedied. Pending necessary improvements, operators must increase their vigilance and develop contingency plans to cope with periods of stress. Contingency plans should be practiced using simulated incidents before a real crisis develops.

The Walkerton operators lacked the training and expertise to identify the vulnerability of Well 5 and the need for additional safety barriers. They had been certified by a grandparenting process that failed to provide them with the training needed to do their jobs properly. Their experience allowed them to handle the mechanical requirements of their jobs, but they lacked any understanding of water quality or associated public health risks. The Walkerton operators did not intend to harm their fellow citizens through their flawed practices: they continued to drink the Walkerton water even as the outbreak was unfolding.

Operators can prevent a waterborne disease outbreak if they ensure the following practices are established and followed.

- Operators must understand their water system, including major contamination hazards in relation to the system’s barriers against contamination and the capabilities of those barriers for ensuring safe water.

- Operators must translate knowledge of their system into operational monitoring parameters that warn of an increase in risk (e.g., rising source water turbidity) or inadequate performance of barriers to contamination (e.g., reduction in chlorine residual or increase in filter effluent turbidity).
Operators must establish acceptable performance limits for these operational parameters and continuously monitor them for warning signs of abnormal conditions.

Operators must work with management to anticipate plausible abnormal conditions and plan effective responses well before a serious incident occurs, including appropriate notification of regulatory authorities. Preparedness should support but does not replace the need for thoughtful analysis and problem solving as events unfold.

Operators must recognize when they are facing a problem that is beyond their understanding or training and call for assistance.

Operators need to document “near failures” so that lessons can be learned from such close calls.

Operators’ understanding of their system should include recognition of any inherent vulnerability that needs improvement to reduce contamination risks.

Operators need to be prepared to take ownership of problems and lead efforts to ensure their managers fully understand the existence of problems that must be rectified.

Justice O’Connor concluded in his second inquiry report that “Ultimately, the safety of drinking water is protected by effective management systems and operating practices, run by skilled and well-trained staff.” Ontario has committed to implementing substantial improvements in the scope and quality of operator training.

The criminal proceedings against the Walkerton operators should be the final controversial chapter in a long nightmare for those involved in the Walkerton disaster. The operators’ ultimate sentence comes in knowing that there were things they could have done that would have prevented severe illness and death among Walkerton consumers. No water treatment operator should want to face this kind of life sentence.

The Inquiry reports and supporting documents are available at <www.attorneygeneral.jus.gov.on.ca/english/about/pubs/walkerton>.
Safe Drinking Water
Lessons from Recent Outbreaks in Affluent Nations

Drinking water provides an efficient source for the spread of gastrointestinal microbial pathogens capable of causing serious human disease. The massive death toll and burden of disease worldwide caused by unsafe drinking water is a compelling reason to value the privilege of having safe drinking water delivered to individual homes. On rare occasions, that privilege has been undermined in affluent nations by waterborne disease outbreaks traced to the water supply.

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Safe Drinking Water aims to raise understanding and awareness of those factors that have most commonly contributed to or caused drinking-water-transmitted disease outbreaks - essentially a case-history analysis within the multi-barrier framework. It contains detailed analysis of the failures underlying drinking-water-transmitted disease epidemics that have been documented in the open literature, by public inquiry, in investigation reports, in surveillance databases and other reliable information sources.

The book adopts a theme of 'converting hindsight into foresight' to inform drinking-water and health professionals including operators, managers, engineers, chemists and microbiologists, regulators, as well as undergraduates and graduates at specialty level.

KEY FEATURES

- Contains details and perspectives of major outbreaks not widely known or understood beyond those directly involved in the investigations.
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