

Bruce-Grey-Owen Sound Health Unit

EXECUTIVE SUMMARY

This report describes the findings of investigations led by the Bruce-Grey-Owen Sound Health Unit (BGOSHU) with the assistance of Health Canada and the Ontario Ministry of Health and Long-Term Care into an outbreak of gastroenteritis in Walkerton, Ontario, May and June, 2000. The purpose of these investigations was to determine the scope, the likely cause and the contributing factors of the outbreak. This incident represents the first documented outbreak of *Escherichia coli* O157:H7 infection associated with a municipal water supply in Canada and the largest multi-bacterial waterborne outbreak in Canada to date.

Identification of the Walkerton outbreak was initiated by the early recognition of pediatric cases from Walkerton of bloody diarrhea and severe abdominal cramps reported to the BGOSHU on May 19, 2000. After inquiries by the Health Unit revealed an increase in diarrheal illness in long-term care facilities, elementary schools and emergency departments in the Walkerton area, an outbreak investigation was launched. While most of the ill were residents of Walkerton, a number of individuals lived in outlying communities. Two days of exhaustive investigation failed to identify any common food exposure or community event that could account for the cases. Since residing in, or visiting Walkerton was the only common factor between those ill, the municipal water supply appeared to be the plausible vehicle for the outbreak.

A stool culture taken from one of the initial cases was reported on Saturday, May 20 to be presumptive positive for sorbitol negative *E. coli* (a marker for *E. coli* O157:H7), and a preliminary report early on May 21, identified the stool culture isolate as *E. coli* O157. Despite reassurances from the Walkerton Public Utilities Commission (PUC) that the water was safe and secure, a Boil Water Advisory was issued to the town of Walkerton by the Health Unit at 1:30 p.m. May 21. Subsequent testing of the municipal water distribution system confirmed contamination with *E. coli* and coliform bacteria.

On May 22, the BGOSHU made a request to the Ontario Ministry of Health and Long-Term Care (OMHLTC) for a federal field epidemiologist to assist. Due to the nature and scope of the outbreak, a team of epidemiologists from Health Canada was assembled and dispatched to Owen Sound. The OMHLTC also provided an epidemiologist to collaborate in the investigation.

The epidemiological investigation included both a descriptive study and a cross-sectional study. Intensive case-finding for the descriptive study ultimately led to the identification of 1346 reported cases of gastroenteritis with exposure to Walkerton municipal water. Among these, 799 were residents of the town of Walkerton. Based on estimates derived from the cross-sectional study, the number of Walkerton residents that became ill was approximately 1286. The overall estimated number of cases associated with the outbreak was over 2300 people.

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Of the 1346 reported cases, 1304 were considered to be primary (exposed to Walkerton municipal water), 39 were secondary (exposed to a primary case and not to Walkerton municipal water) and 3 were unclassified. In total, stool samples from 174 people had presumptive laboratory evidence of *E. coli* O157; 167 of which were confirmed as *E. coli* O157:H7. Stool samples from 116 people were confirmed with *Campylobacter* species (spp.). Sixty-five patients were admitted to hospital and of these 27 developed hemolytic uremic syndrome (HUS). Six people died as a result of the outbreak. The median age of reported cases was 29 years (range <1 to 97 years), 57% were female. While 92% of the ill individuals resided in Bruce and Grey Counties, 8% resided in other parts of the province, and two individuals lived in other provinces.

The onset for illness of the majority of cases occurred after May 12, and continued until late June, with a peak in illnesses between May 17 and 19. Within five days of issuing the boil water advisory, the number of new cases dropped substantially. Several cases were identified with onset of illness as early as April 15. This included some individuals infected with the same strain of *E. coli* O157:H7 as the majority of the outbreak cases, according to genetic finger-printing. Based on these early cases and several positive total coliform samples in the water in April, it is possible that low numbers of bacteria were entering the Walkerton municipal water distribution system in April and early May. It is hypothesized, however, that heavy rainfall in mid-May was responsible for gross contamination of the distribution system resulting in the majority of the illnesses. Mapping of the cases in Walkerton by location of residence confirmed the widespread nature of the illnesses and supported the hypothesis that municipal water was the cause of the outbreak.

Analysis of the cross-sectional study of Walkerton households conducted in June, confirmed that people residing in homes connected to the municipal water supply and consuming Walkerton water were 11.7 times more likely to develop gastroenteritis than those not exposed to Walkerton water. A dose response relationship was demonstrated in that the risk of illness increased with the quantity of water consumed. This study also found that despite the boil water notice and extensive publicity, a small portion of the residents in Walkerton continued to expose themselves to the water through various routes, including brushing teeth with the water and occasionally drinking it.

Examination of well records from the PUC indicated that Wells 5 and 6 were supplying the town during the critical exposure time prior to onset of illnesses. Testing of water samples from the distribution system on May 21 and of water from Well 5 on May 23 demonstrated significant contamination with coliform and *E. coli* bacteria. Subsequent DNA analysis of these samples by polymerase chain reaction (PCR) confirmed the presence of the O157, H7 and verotoxin genes, supporting the likelihood that *E. coli* O157:H7 had been present in these samples. Test results of Wells 6 and 7 on May 23 were negative for coliforms, including *E. coli* bacteria. Historic well reports and the August 18, 2000 interim report by Golder Associates¹ confirmed that Well 5 is subject to surface water contamination and elevated turbidity.

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Environmental testing of 13 livestock farms within a four kilometer radius of the three wells, identified human bacterial pathogens in animal manure on all, but 2 farms. On nine farms, *Campylobacter* spp. were identified and, on two farms, both *E. coli* O157:H7 and *Campylobacter* spp. were found; this included a farm adjacent to Well 5. The molecular subtyping and phage-typing of the *E. coli* O157:H7 and the *Campylobacter* spp. isolates from this farm were identical to those found in the majority of the human cases. While investigators could not prove the pathogens were present prior to the outbreak, the evidence suggested the pathogens that entered Well 5 likely originated from cattle manure on this farm. A simulation model of rainfall and the drainage pattern in the vicinity of Well 5 indicated that rain falling on the barnyard and adjacent fields would have drained toward Well 5.

A series of unfortunate circumstances occurred to cause an outbreak of this magnitude. These included heavy rains accompanied by flooding, *E. coli* O157:H7 and *Campylobacter* spp. present in the environment, a well subject to surface water contamination and a water treatment system that may have been overwhelmed by increased turbidity. This situation emphasizes the importance of secure water sources and adequate water treatment in ensuring a safe water supply to a community. Bacterial monitoring can only identify a contaminated source after the contamination has spread through the water system and put the public at risk.

The Walkerton outbreak calls into question the safety of groundwater sources that may be under the influence by surface water especially under flood conditions. Historically, groundwater sources have been assumed to be secure and treated with chlorination only. However, in light of this tragedy, this approach needs to be re-evaluated. Such an evaluation should take into account all current and future pressures on land use including human population density and agricultural activities.

¹ Golder Associates Ltd. Interim Report on hydrogeological assessment, well integrity testing, geophysical surveys and land use inventory, bacteriological impacts, Walkerton Town wells, Municipality of Brockton, County of Bruce, Ontario. London, ON: Golder Associates Ltd., August 18, 2000.

Source: Bruce-Grey-Owen Sound Health Unit with the assistance of the Division of Enteric, Foodborne and Waterborne Disease, Bureau of Infectious Diseases, Centre for Communicable Disease Prevention and Control, Field Epidemiology Training Program, Centre for Surveillance Coordination, National Laboratory for Enteric Pathogens, Laboratory of Human and Animal Health, Population and Public Health Branch, Health Canada; Public Health Branch and Central Public Health Laboratory, Laboratories Branch, Ontario Ministry of Health and Long-Term Care.