Waterborne Outbreak of Cryptosporidiosis in North Battleford, Canada

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Summary

Only 11 months after the highly publicized, fatal Walkerton waterborne disease outbreak, the City of North Battleford, a rural community of ~15,000, in west-central Saskatchewan experienced a drinking water outbreak of gastroenteritis attributed to *Cryptosporidium parvum*. An estimated 5,800 to 7,100 people from the Battlefords area were ill between March 20 and April 26, 2001. Hundreds of additional water consumers from other communities and other provinces who had visited North Battleford, which is located on the Yellowhead route of the Trans-Canada highway, were also affected, making the total magnitude of the outbreak unknown. The underlying causes of this outbreak were recognized as problems for decades before the outbreak , but neither the City of North Battleford nor the provincial regulator dealt with the evident problems.

Keywords: drinking water, safety, *Cryptosporidum*, source water protection

Context & Logistics

Learning Objectives

Through this case study, students will:

1. learn about the multiple barrier concept for providing safe drinking water;
2. understand that public health officials and water treatment personnel must be able to communicate clearly and understand each other to assure safe drinking water;
3. understand the relevance of process monitoring (clarification efficiency and turbidity removal) in assuring the performance of the disinfection barrier for chlorine resistant pathogens; and
4. recognize that failures of systems often involve human failings meaning that training, supervision and validation are critically

important for assuring system function.

Accommodating Course(s) and Level

- senior undergraduate environmental engineering or science courses
- graduate drinking water course

Prerequisite Course(s)

- environmental or public health microbiology
- water treatment course

Type of Activity

- This case study is best conducted in a form that allows for class discussion of student observations and ideas to maximize personal uptake of the lessons in professional responsibility. Small group discussion would be best.

Level of Effort by Instructor

- One 50-minute class should be sufficient to allow students to read the Introduction and Case Study, then engage in discussion of as many questions as time allows.
- Web sites are provided with considerable background documentation. Instructors may use these materials to expand the level of detail according to their interests.
- A faculty member unfamiliar with this topic might require 2 to 4 hours to understand this write-up, including consultation of the supporting websites

Level of Effort by Individual Student

- One 50-minute class period to read the case study and discuss the issues, plus 1 hour to write the essay suggested below.

Suggested Assessment Methods

- Evaluate for the professional responsibility lessons learned by asking students to write a one-page essay about improving operator training and management accountability.

Introduction

The raw water source for the North Battleford surface water treatment plant is the North Saskatchewan River about 3.5 km downstream of the City's sewage outfall (Figure 1).

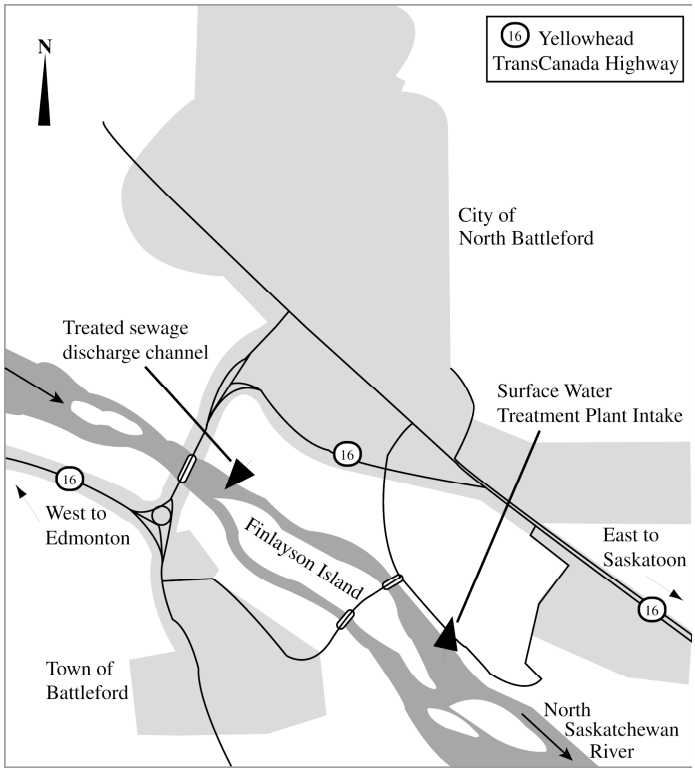

Figure 1. The Battlefords region – Town of Battleford, City of North Battleford and the North Saskatchewan River (Hrudey & Hrudey 2004)

The surface water plant was originally constructed around 1950 to serve a provincial hospital institution, but was taken over in 1961 by the City of North Battleford to deal with its growing water needs.

This acquired plant was expanded in 1981 when an up-flow clarifier, the solids contact unit (SCU), was installed to increase capacity along with two additional filters (3 and 4) and an additional treated water reservoir. The raw water intake was modified and the granular media in the original two filters (1 and 2) was changed.

In 2001, the North Battleford surface water treatment plant provided a nominal capacity (for normal operations of 16 hours per day) of 6.9 ML/d. The treatment processes included potassium permanganate raw water oxidation (during taste and odour episodes); liquid alum coagulation with

polyaluminum chloride (PACl) added only during peak spring and summer operations; chlorine as sole disinfectant; pH adjustment with lime; and an additional polymer coagulant to improve gravity clarification, followed by dual media (anthracite–sand) filtration in two filter banks (original filters 1 and 2, newer filters 3 and 4). The annual average daily production from this plant was only 3.1 ML/d in 2000.

During annual maintenance operations, treated water was run to waste when the facilities were drained. Filters 1 and 2 could be run to waste after backwashing, but the evidence given by the operators at the Inquiry was that running filtered water to waste to allow filter ripening was not performed at this plant. At times during peak water demand, operators would air scour the filters without performing a full hydraulic backwash cycle.

This case study is based on evidence entered at the public inquiry (Laing 2002) called to determine the causes. The case study is presented, for formatting purposes only, as being from the perspective of a hypothetical investigator for the Saskatchewan Office of Emergency Response. The investigator arrives in North Battleford on April 25, one day after a boil water advisory is called. Although the investigator is hypothetical, the facts are drawn from the North Battleford Inquiry (the Inquiry), a public inquiry into this disaster called by the Saskatchewan Government (Laing 2002). The following is presented as if it was being gathered in real time by interviewing the parties, but is occasionally punctuated with facts from the Inquiry.

Case Study

The Saskatchewan Provincial Laboratory reported the first positive case of cryptosporidiosis to the Battlefords Health District (BHD) on Wednesday, April 4, 2001, followed by a second case on Thursday, April 5, 2001. The first case was a child who lived on a farm 13 km outside of North Battleford. This case initiated an investigation on April 4 by Roger Piatt, a public health inspector from the BHD, leading to an interview with the child's mother the next day. During this initial interview, Mr. Piatt reviewed the possibilities for contact with cattle on the farm, along with other plausible sources of transmission. Not until some time later did investigators realize that the child attended school in the city.

The second case was not entered into the log of the Health District by the part-time communicable disease coordinator until Tuesday, April 10, when she was back in the BHD office. Roger Piatt turned over investigation of the second case to colleague Kenneth Startup because Mr. Startup knew

the family. His investigation occurred on Thursday, April 12, a full week after the initial report. The mother of the second child, who lived in Battleford, advised that she had been told that diarrhea was "*going around*" the St. Vital School in the town. Because of the delay in logging the second case, neither investigator apparently realized that two cases of cryptosporidiosis had been reported to the BHD on consecutive days. This health district would normally see only a few confirmed cases of crytosporidiosis per year, so two cases on consecutive days was unusual.

Dr. Gerhard Benadé, Medical Officer of Health for the BHD, became aware of the second case of cryptosporidiosis when he was contacted directly by the patient's physician, Dr. Geoffrey Lipsett, on the evening of April 12, 2001. The patient had first complained of abdominal pain on March 21, but she returned on March 26 with her mother advising that she had stomach cramps and experienced diarrhea up to 12 times a day for the previous 6 days. He requested stool samples that were collected on March 27 and delivered to the provincial laboratory on March 29. The *Cryptosporidium parvum* confirmation was telephoned to Dr. Lipsett on April 4.

When a sibling (age of five) of this second patient became ill, the mother requested medication for the illness. On April 12, Dr. Lipsett spoke with a local pharmacist regarding medication for diarrhea. The pharmacist indicated that she could not keep the shelves stocked with anti-diarrheal medication. Following this conversation, Dr. Lipsett called Dr. Benadé at home to advise him of the circumstances with his patient and about the pharmacist's comment.

Dr. Benadé followed up by checking the communicable disease log in the community health office the next day, -April 13, the Friday holiday of the Easter long weekend, when he learned that two cases of cryptosporidiosis had been reported to the BHD. He estimated that background rates for all gastrointestinal disease would be about ten cases per day, but he knew that not all cases would normally seek medical attention. He checked and learned that the emergency room at the hospital had seen five cases of diarrhea that day, not necessarily an exceptional number during flu season. Dr. Benadé worked at the hospital over that weekend and he ordered stool samples for pathogen identification on all patients he saw who had diarrhea. He also ordered hospital staff to review cases of enteric disease seen at the hospital during April. Dr. Benadé also telephoned local pharmacies and was able to confirm that sales of anti-diarrheal medications had increased in the community.

From April 13 to 17, 2001, schools and offices were closed for the Easter long weekend. On April 17, when family members of Dr. Benadé, as well as a physician known to him and another BHD staff member had all experienced diarrhea, Dr. Benadé discussed the situation with his staff. All who had experienced diarrhea were residents of the north end of the Town of Battleford; none were residents of the City of North Battleford. Dr. Benadé asked Kenneth Startup to find out whether the Town of Battleford had experienced any problems with its water treatment system. This inquiry revealed no problems with the town's drinking water.

Meanwhile, a third case was reported to the Health District by the provincial laboratory on April 17, a 15-year-old patient who also resided in Battleford. Kenneth Startup pursued the investigation of this case that day. Mr. Startup reported to Dr. Benadé that the parents of the second and third cases made their own inquiries that week to learn that there were many cases of diarrhea in the St. Vital School in Battleford as well as at the John Paul II School in North Battleford. His memo to Dr. Benadé stated "*these two cases have nothing in common except that both live in Battleford*." Mr. Startup did not report to Dr. Benadé that the 15-year-old was attending John Paul II School in North Battleford.

Neither of the public health inspectors was available to continue further investigations until April 23. In the interim, a fourth case infected with *C. parvum* was reported on April 19, 2001. This time, the patient lived in a community 80 km north of North Battleford, further confusing the emerging pattern of disease. The local hospital, in response to a review requested by Dr. Benadé, reported 113 cases of diarrhea had been recorded between April 1 and 19. On April 20, Dr. Benadé examined the information on the four confirmed cases, looking for some pattern as to what they had in common, but found nothing conclusive in the mix of evidence. At that time, viral gastroenteritis appeared the most plausible explanation of the widespread occurrence of diarrhea in the community.

On April 23, Dr. Benadé contacted the provincial laboratory to check results for several stool samples that had been submitted. He was advised by e-mail that the provincial laboratory had processed nine positive *C. parvum* tests in April for the entire province, with eight coming from the Battleford region. Notably, of the four new cases, three were residents of North Battleford, providing Dr. Benadé with the first connection of *Cryptosporidium* to North Battleford.

There was still no obvious thread connecting the cases. Even so, Dr. Benadé sent an urgent notice by April 24 to all physicians and healthcare facilities in the region stating (Laing, 2002, p.140):

Subsequent to the notification of a case of Cryptosporidiosis a week ago, the following alarming facts have been discovered upon closer examination:

- *113 cases of diarrhea / gastroenteritis have been seen in the Battlefords Union Hospital emergency room in the month of April alone.*
- *Of the above, only 5 cases had stool samples submitted for examination.*
- *Of the 5 lab samples, 4 tested positive for Cryptosporidium parvum.*

With the limited information at this time we cannot exclude the possibility of a Cryptosporidium parvum outbreak….From a public health perspective, we have to consider the possibility of person-to-person, food- or waterborne transmission. Attached is a fact sheet with key facts.

Dr. Benadé had not been able to reach anyone at the city administration for North Battleford to question the condition of the drinking water. On April 24, he instructed Kenneth Startup to contact the city water personnel to ask about any problems they may have experienced. Mr. Startup testified that he spoke with Randall Strelioff, Director of Public Works for the City of North Battleford, and asked him whether he was aware of any problems with the water treatment plants. According to Mr. Startup, Mr. Strelioff responded that: "*no, he was not aware of any, but he did say, however, they are having trouble forming floc at the surface water treatment plant because of low water turbidities*" (North Battleford Water Inquiry transcript of evidence, Oct. 17, 2001, p.91).

Unfortunately, Mr. Startup did not connect the difficulty with floc formation with the possibility of oocysts contaminating the drinking water supply. Instead, he reported to Dr. Benadé that Mr. Strelioff had assured him there were no problems at the water treatment plants.

Later on April 24, Kenneth Startup phoned Helen Bangura, the provincial epidemiologist, concerning an investigation of an *E. coli* case in Lloydminster. During that conversation, Mr. Startup mentioned the cryptosporidiosis investigation being conducted in North Battleford. Ms. Bangura e-mailed this information to Dr. Eric Young, the Deputy Chief Medical Health Officer for the Province of Saskatchewan in Regina. Mr. Startup contacted two officials with Saskatchewan Environment and Resource Management (SERM), the provincial regulator of drinking water providers. Mr. Startup updated them on the number of cryptosporidiosis cases confirmed and indicated that a water source might be the problem.

Mr. Startup also informed the SERM officials that the North Battleford surface water treatment plant was having problems forming a floc blanket in the SCU. SERM officials quickly contacted water laboratory personnel in Saskatoon to arrange sampling for *Cryptosporidium* in the North Battleford water supply.

Two additional positive stool samples were reported for people who resided in North Battleford by the provincial laboratory at 4:00 p.m. on April 24, bringing the total number of laboratory-confirmed cases of cryptosporidiosis to ten. Dr. Young discussed the e-mail from Ms. Bangura and a fax from Dr. Benadé with Dr. David Butler-Jones, the Chief Medical Officer for Saskatchewan Health. The latter was aware that North Battleford had experienced problems with inadequate chlorine residuals in September 2000, leading to a precautionary drinking water advisory (PDWA) being issued. There were coliform detections in distribution system samples and 70% of the chlorine residual readings from January to September 2000 had been below the provincial standard. The current patterns of disease had not revealed any common source, so Dr. Butler-Jones was concerned about the possibility of a waterborne outbreak. These provincial health officials then contacted Dr. Benadé to request a meeting that evening with Wayne Ray (the North Battleford mayor), Mr. Strelioff, representatives from the town of Battleford and various officials from BHD and from SERM. The SERM representatives were unable to attend.

Mr. Strelioff, who had no professional water treatment expertise, attended this meeting without discussing the issue of treatment plant performance beforehand with any of his water treatment plant operators. He stated that he assumed the operators would bring any problems to his attention and this had not occurred. Apparently, none of the attendees at the meeting that evening appreciated the need for effective coagulation prior to filtration to assure removal of *Cryptosporidium* oocysts. Accordingly, they were not able to appreciate the significance of the North Battleford surface water treatment plant being unable to form a floc blanket in the SCU.

A review of the outbreak to date revealed that there was no evidence supporting either a food source or person-to-person contact as the outbreak cause, leaving drinking water transmission as a viable possibility. At this point, both Dr. Butler-Jones and Dr. Benadé supported issuing a PDWA, but the mayor of North Battleford questioned this action because of the disruption the September 2000 PDWA had caused.

Early on April 25, the meeting reconvened with the addition of Scott Meekma, the local SERM representative who had been on vacation while earlier events were unfolding. He expressed concern that although a Health District investigation had been underway for two weeks, SERM had only been notified of any problem the previous day. Mr. Meekma further advised that he would have issued a PDWA upon learning of the absence of a floc blanket in the SCU. Consequently, SERM and the health officials agreed to issue a PDWA early that afternoon. This advisory was directed to the City of North Battleford and the Town of Battleford.

After it came to light that the SCU had been achieving negligible settling and resulting poor turbidity removal since March 20, a decision was made on the evening of April 26 to upgrade the PDWA to a boil water order (BWO), which was issued to North Battleford by Dr. Benadé at approximately 11:00 p.m. on April 26, 2001.

Problems were occurring at the surface water treatment plant in March, yet the evidence of a waterborne outbreak in North Battleford was patchy at best until April 24. This delay stands in stark contrast to the retrospective evidence revealed by the epidemiologic study performed by field epidemiology staff from Health Canada (Fig 2; Stirling et al., 2001). They performed a descriptive study, a cross-sectional study and a review of anti-diarrheal drug sales to outline the occurrence of diarrhea cases within the region for the period following March 20, 2001. The descriptive study revealed that the date of highest onset of diarrhea for residents of the Health District service area was April 13, while for those from outside this region, the peak was on April 24 and 25.

The surface water treatment plant relied on an upflow clarifier (the SCU) to achieve chemical coagulation, flocculation and sedimentation to clarify the water before the rapid sand filtration process. Because a crack had been noted in the concrete floor of this unit in 2000, investigation of the damage and repairs were undertaken in March 2001. In previous years, such maintenance was normally carried out earlier in the year, when raw water quality in the river was good, particularly the low raw water turbidity, while the river was under winter ice cover. In 2001, the maintenance was performed on March 20. The SCU was completely drained, all the coagulant sludge was removed and repairs were completed by 4:00 p.m. Normal practice had been to retain some coagulant sludge to efficiently re-establish a floc blanket while bringing the SCU back on line, but this sludge-seeding practice was not followed in March 2001.

Figure 2. Temporal comparison of disease burden and water quality data. Source: Waterborne Cryptosporidiosis Outbreak, North Battleford, Saskatchewan, Spring 2001 Canada Communicable Disease Report, 27(22), Nov. 15, 2001.© Adapted and Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2004. Health Canada assumes no responsibility for any errors or omissions that may have occurred in the adaptation of its material.

The operators recognized that low raw water turbidity made re-establishing an effective floc blanket in the SCU more difficult. They testified at the Inquiry that they did not believe either *Giardia* or *Cryptosporidium* posed a serious risk because they did not expect these parasites to be present when raw water turbidity was low. The location of the drinking water intake only 3.5 km downstream of the treated sewage outfall was not identified by the operators as a source of oocysts that could seriously challenge the drinking water treatment process.

The SCU was refilled with raw water with an elevated coagulant dose and water was run to waste for a period of 3.5 hours, until the SCU effluent turbidity was below 5 NTU and the free chlorine residual was above 2.0 mg/L. Poor treatment performance was observed thereafter, based on a batch-settling test that was routinely performed by the operators. They would sample from the inner, upflow region of the SCU and measure the amount of settling of the sludge interface achieved in a graduated cylinder over a 5-minute period. Historically, good performance in the SCU was associated with achieving settling of 10 to 20% by this measure. Finding 0% settling by this procedure indicated that coagulation was ineffective, signaling that, in the absence of an effective floc blanket, negligible clarification was being achieved in the SCU.

The operating records for this period showed that the SCU achieved only 0.1% settling (an essentially negligible value for this procedure) until March 30 (final turbidity ranging from 0.16 to 0.60 NTU) and then 0% settling every day until April 18, except for 0.1% settling on April 10 (final turbidity ranging from 0.31 to 0.96 NTU). From April 18 to April 25, the settling gradually improved from 1 to 8% (final turbidity ranging from 0.19 to 0.58 NTU). The plant operators had advised Randall Streiloff on at least two occasions that little or no settling was being achieved. One of these times, around April 9, Mr. Streiloff acknowledged the problem by approving the purchase of bentonite as a means to add turbidity to the raw water in order to aid in re-establishing the floc blanket in the SCU.

The operators were aware that jar tests could be used to evaluate coagulant chemical dosage for treatment performance, but according to evidence at the Inquiry, jar tests were performed infrequently. During the period of poor settling performance, the operators changed the dosages of coagulant chemicals, attempting to improve settling in the low turbidity raw water. The result during this period was higher turbidities in treated water at various times; consequently, the filters required backwashing more frequently. Filtered water was accepted immediately after backwashing rather than running that water to waste until the filters had been allowed to ripen. Although individual filters were not equipped with separate turbidimeters, one operator testified that turbidity spikes in the clearwell did occur during these post-backwash periods.

The epidemiology studies performed by Health Canada (Fig 2; Stirling et al. 2001) following the outbreak demonstrated the time correlation of the illness indicators in the community with the problems at the City of North Battleford surface water treatment plant. Figure 2 shows outbreak cases (further validated by the sales of anti-diarrheal medications) coincide closely

with the timing of the March 20 maintenance of the SCU and subsequent poor settling performance.

Under the conditions of poor treatment performance and the vulnerability of the North Saskatchewan River to contamination by *C. parvum* in runoff from agricultural activity, the cause of the outbreak may appear obvious. However, the timing of this outbreak was clearly before the spring thaw, given the low turbidities that were experienced with the raw water. At times of spring runoff, the North Saskatchewan River water turbidities will be exceedingly high (>1,000 NTU). To explain the outbreak in North Battleford during March–April 2001, a source of *C. parvum* contamination other than agricultural runoff was needed.

North Battleford's sewage treatment plant is located only 3.5 km upstream from the raw water intake for the surface water plant (Fig 1). The sewage effluent discharge is on the same bank as the water intake. The City of North Battleford argued at the Inquiry that their limited slug dye testing had shown that the effluent plume was deflected from the north bank of the river to the north side of Finlayson Island, which the plume hugged to bypass the drinking water intake. The physical reality of the mixing and dilution process in that river channel (Fig 1) raises the question of how upstream "*clean*" river water could cross through the sewage effluent plume to reach the water intake without picking up any contamination from this sewage effluent plume. The interpretation from the dye studies presented to the Inquiry that the sewage effluent plume would "*hug Finlayson Island*" on the opposite side of the river channel and thereby miss the water intake was not a realistic expectation.

The sewage treatment plant had been required to disinfect with chlorination, but ongoing treatment problems were documented. The provincial regulator (SERM) wrote to the City on January 13, 1994: "*available data indicates* [sic] *effluent disinfection has generally been poor…river samples obtained at the water treatment plant on March 10, 1993 had measured fecal coliform levels of 150,000 per 100 mL. This indicates an extremely contaminated water…*" (Laing 2002, p.51).

In 1995, an environmental engineering consulting firm was retained to evaluate the sewage treatment plant. The consultants reported in January 1997 that the plant continued to perform poorly, allowing untreated wastewater to bypass the plant during high flow periods, suffered from outdated technology and used unconventional process configurations, instrumentation and controls considered primitive by current standards. Retrofitting the sewage treatment plant to meet current effluent standards

would be difficult and relocation of the plant to a new site was suggested. These problems remained in April 2001.

Further evidence that the sewage effluent was the source of the contamination came from12 fecal samples drawn at random from 49 samples taken between May 2 and May 14 from 45 patients who had tested positive for *C. parvum*. These were analyzed by the British Columbia Centre for Disease Control to determine the genotype of the *C. parvum*. One sample could not be genotyped, but the remaining 11 were all genotype 1, the human genotype (now called *C. hominis*). These results indicate that the contamination of the water supply arose from human wastes rather than livestock.

Monitoring of the sewage treatment plant for oocysts showed that the *treated* sewage effluent contained up to 12,000 oocysts per L during early May, but declined to a few thousand per L by the end of the month (Wallis et al., 2002). *Giardia* monitoring also showed a huge peak in sewage treatment effluent concentration of cysts, suggesting that North Battleford may have also experienced an outbreak of giardiasis. These data also showed a peak of *Giardia* cysts occurring in raw intake water that corresponded with the peak of cysts observed in the treated sewage discharge, providing additional evidence of the impact of the treated sewage effluent on the raw water intake.

There was considerable evidence that water treatment personnel were concerned about the history of wastewater and water treatment problems, but they were unsuccessful in convincing the City administration and politicians to address the problems by investing in the necessary improvements. The Director of Public Works and the water treatment plant foreman during the 1990s were left to deal with the evident problems without financial support to resolve them. The City Commissioner testified that this community of 15,000 had seen its revenue from the province decrease by $1,000,000 over the period from 1991 to 1995, so the City's priorities were to cut costs or hold the line.

Notwithstanding the financial difficulties faced by North Battleford, the Inquiry revealed that water treatment personnel had been frustrated in their attempts to convince the City administration to address obvious problems. Ivan Katzell, the water plants foreman until December 2000, advised Randall Strelioff, the newly hired Director of Public Works, that all of the plants (sewage treatment, ground water and surface water treatment plants) were in bad shape, held together by patchwork repairs: operations were sustained only by the efforts of the operating staff. Mr. Katzell took two months stress leave in the fall of 1999 and submitted his resignation on July 31, 2000,

explaining that he was retiring from this job sooner than he had intended because he could no longer continue under the job pressure that was affecting his health. He retired on December 14, 2000, but his supervisory position remained vacant throughout the outbreak and was not filled until August 13, 2001. The position had been offered to a number of applicants over the period of the vacancy and was even held by a senior operator from the City for two weeks in February 2001. This individual asked to go back to his previous job, citing adverse effects on his health from the responsibility of the supervisor's job for both North Battleford's water and wastewater plants.

Questions

1. Prepare a timeline of events and indicate the opportunities for intervention that could have prevented or reduced the scope of the outbreak.

2. What actions should the operators of this facility have taken to prevent this outbreak?

3. Given that this facility was maintaining a chlorine residual above 1 mg/L, why did this outbreak happen? See Bad Bug Book:
   http://www.cfsan.fda.gov/~mow/chap24.html

4. What actions should the regulator have taken to have prevented this outbreak? See Hrudey & Hrudey 2004, pp. 331-335 and Laing 2002 Parts 7,8 & 9:
   http://www.northbattlefordwaterinquiry.ca/inquiry/Part7.pdf
   http://www.northbattlefordwaterinquiry.ca/inquiry/Part8.pdf
   http://www.northbattlefordwaterinquiry.ca/inquiry/Part9.pdf

5. What are the critical features of a drinking water safety program needed to prevent these kinds of failures? See the following references:
   IWA 2004 http://www.iwahq.org.uk/pdf/Bon_Charter_Document.pdf
   WHO 2004 http://www.who.int/water_sanitation_health/dwq/gdwq3_4.pdf
   NHMRC 2004 http://www.nhmrc.gov.au/publications/_files/awg1.pdf
   EPA 1998 http://www.epa.gov/safewater/protect/98_305b_dwchap.pdf

Analysis

Despite a phenomenal level of media coverage in Canada about the Walkerton outbreak in May 2000, this major outbreak in North Battleford was allowed to occur only 11 months later. As with Walkerton, there was a long

history of identified problems with the system, yet no remedial actions were taken to reduce the risk to drinking water safety. The Inquiry report in this case directed most of the blame to the City of North Battleford and to the provincial regulator (SERM).

The North Battleford case study provides a strong argument for the multiple barrier concept for assuring safe drinking water. No attention was directed to source water protection and when the critical coagulation – filtration barrier was compromised, a major outbreak followed. Because outbreaks of disease caused by drinking water remain comparatively rare in North America, particularly in contrast with the developing world, complacency about the dangers of waterborne pathogens has become common. Yet, the source of waterborne disease in the form of microbial pathogens is an ever present risk because these pathogens are found in human fecal waste and in fecal wastes from livestock, pets or wildlife, making any drinking water source at risk of contamination before or after treatment.

Learning Assessment

Students may be evaluated for the professional responsibility lessons learned by asking them to write a 1 page essay to describe how they would improve operator training and how they would require accountability for water utility managers to assure safe drinking water for the future.

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