North Battleford, Saskatchewan Cryptosporidiosis Outbreak Spring, 2001

Report prepared by Health Canada for Saskatchewan Health and The Battlefords District Health Unit

Presented by: Dr. Andrea Ellis
Section Head, Outbreak Response and Issues Management Division of Enteric, Foodborne and Waterborne Diseases

Health Canada’s mandate in outbreak investigations

- Health Canada becomes involved in investigating a local or provincial outbreak only when invited by the provincial public health authorities
- Report to the medical officer(s) in charge
Division of Enteric, Foodborne and Waterborne Diseases

- Outbreak Response Section
  - Conduct outbreak investigations in the area of infectious enteric, foodborne and waterborne diseases
  - Provide expertise to provincial and local officials, upon request
  - Co-ordinate national investigations
  - Conduct surveillance for enteric disease outbreaks

Introduction

Outbreak Investigation Team

- Areas of expertise
  - field epidemiologists/outbreak investigation
  - waterborne disease surveillance
  - epidemiology of cryptosporidiosis
  - medical geographer
  - statisticians

Introduction
Health Canada Investigators

Dr. Rob Stirling†
Dr. Jeff Aramini‡
Dr. Andrea Ellis‡
Gillian Lim‡
Rob Meyers‡
Manon Fleury‡
Dr. Denise Werker†

†Field Epidemiology Training Program, Centre for Surveillance Coordination, Population and Public Health Branch, Health Canada
‡ Division of Enteric, Foodborne and Waterborne Diseases, Bureau of Infectious Diseases, Centre for Infectious Disease Prevention and Control, Population and Public Health Branch, Health Canada

Introduction

Health Canada Investigators

Acknowledgements

• Battlefords District Health Unit
• Saskatchewan Health
• Health Districts and First Nations in Saskatchewan
• Municipal officials and public works employees of the City of North Battleford and the Town of Battleford
• Saskatchewan Environment and Resource Management
• The British Columbia Centre for Disease Control
• Pharmacies
April 25, 2001

- Saskatchewan contacted the Field Epidemiology Training Program and the Division of Enteric, Foodborne and Waterborne Disease to request assistance in North Battleford

- Precautionary Drinking Water Advisory (PDWA) issued

April 26, 2001

- Field Epidemiologist arrived in North Battleford

- Epidemiologist from Division of Enteric, Foodborne and Waterborne Diseases arrived on April 29.
Investigation Objectives

The purpose of the investigation was to determine the scope, magnitude, and likely source of the outbreak.
Investigation Activities

♦ Case-Series Study
♦ Anti-Diarrheal Drug Sales Review
♦ Cross-Sectional Study
♦ Environmental Review

Introduction

Case-Series Study

Purpose:

To gather information from persons reporting gastrointestinal illness believed to be related to the outbreak to better understand:

• who was being affected (age, gender)
• the symptomatology of those affected
• the time frame of the outbreak
• the geographic distribution of those affected
Case-Series Study
Methodology

- Within Battlefords Health Service Area
  - Retrospective ER Chart Review
  - Standard Line-listing Form

- Outside Battlefords Health Service Area
  - Standard Line-listing Form

Case-Series Study
Methodology

- Case Definitions
  - Epi-linked Case: a resident or visitor to the Battlefords area with onset of diarrhea after March 20, 2001
  - Confirmed Case: met criteria for epi-linked case, but also had stool specimen positive for Cryptosporidium parvum oocysts
Cases from Within the BHSA

• Information obtained from 1376 people
• 1039 met case criteria
• 110 laboratory confirmed cryptosporidiosis

Case-Series Study Results
Within BHSA - Outbreak Curve

confirmed cases (n=110)
edemiologically linked cases (n=929)
non-outbreak related diarrheal illnesses (n=119)

Maintenance of Surface Water Treatment Plant (March 20, 2001)
### Case-Series Study Results

#### Age Distribution for Cases from Within the BHSA

![Bar chart showing age distribution](chart.png)

- Total cases: 1028 (age missing for 11 cases)
- Peaks in age groups 15-19 and 20-29

### Case-Series Study Results

#### Illness Profile for Cases from Within the BHSA

<table>
<thead>
<tr>
<th>Illness</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>1039</td>
<td>100</td>
</tr>
<tr>
<td>Abd pain/cramp</td>
<td>343</td>
<td>33</td>
</tr>
<tr>
<td>Vomiting</td>
<td>299</td>
<td>29</td>
</tr>
<tr>
<td>Nausea</td>
<td>509</td>
<td>49</td>
</tr>
<tr>
<td>Malaise</td>
<td>54</td>
<td>5</td>
</tr>
<tr>
<td>Anorexia</td>
<td>486</td>
<td>47</td>
</tr>
<tr>
<td>Fatigue</td>
<td>68</td>
<td>7</td>
</tr>
<tr>
<td>Fever</td>
<td>389</td>
<td>37</td>
</tr>
<tr>
<td>Weight Loss</td>
<td>195</td>
<td>19</td>
</tr>
</tbody>
</table>
Cases from Within BHSA

Met case definition = 1039

Cases from Outside the BHSA

- Information obtained from 955 people
- 868 met case criteria
- 165 laboratory confirmed cryptosporidiosis
Case-Series Study Results
Outside BHSA - Outbreak Curve

Case-Series Study Results
Visit Dates for Cases from Outside the BHSA to the Battlefords

- Visit location available for 690 cases:
  - 86% visited the City of North Battleford, 8% the Town of Battleford, and 6% both

- Reason for visit available for 240 cases:
  - dance (53%), casino event (5%), and church camp (14%).

- Dates of visiting recorded for 578 cases:
  - majority visited between April 12 to April 26
  - among those that only visited for one day or less, visit dates ranged from March 23 to May 6.
Case-Series Study Results
Age Distribution for Cases from Outside the BHSA

$n=667$ (age missing for 201 cases)

Cases from Outside BHSA

Met case definition (and could be mapped) = 701

Other Provinces
Alberta = 141
Manitoba = 19
British Columbia = 7
Case-Series Study Results
Laboratory Investigations for Other Pathogens

• No increases in notification of bacteria or parasites, other than Cryptosporidium parvum, in stool specimens.

• No viruses were detected in 12 randomly selected stool specimens.

• Other laboratories in Saskatchewan, Manitoba, Alberta and British Columbia testing individuals with diarrhea who visited North Battleford only detected Cryptosporidium.

Overall interpretation of the case series study

♦ Many people affected across all age groups and both genders

♦ Most people who became ill were residents of the Battlefords but many visitors were affected, including many who visited for only 1 day

♦ The majority of people became ill in mid to late April although the outbreak began in late March
Anti-Diarrheal Drug Sales Review

Purpose:
To obtain further information regarding the time frame of the outbreak by using anti-diarrheal drug sales as an indicator of community gastroenteritis.

Methodology
- Convenience sample
- Unit sales of common anti-diarrheal medications
- Time frame:
  – January-May, 2000
  – January-May, 2001
Overall Interpretation of Anti-Diarrheal Drug Sales Review

- Review provides evidence to suggest an increase in gastroenteritis was occurring in North Battleford beginning at least by the first week of April.

- This review illustrates the usefulness of anti-diarrheal sales data as a measure of community gastroenteritis.
Cross-Sectional Study

Purpose:

This community survey was conducted to obtain information regarding risk factors for gastroenteritis and to allow us to make community based estimates of illness.

Cross-Sectional Study

Methodology

- Data Collection
  - Random sample of households
  - Telephone survey with structured questionnaire
  - Adult proxy
  - Household and individual level data
- Data Analyses
  - Multivariate regression and spatial analyses
Cross-Sectional Study
Methodology

◆ Case Definitions (Household Level)
  – Ill Household: one or more individuals met primary case definition
  – Non-ill Household: no person(s) had symptoms of gastrointestinal illness
  – Other Household: person(s) with gastrointestinal symptoms but did NOT meet primary case definition

Cross-Sectional Study
Methodology

◆ Case Definitions (Individual Level)
  – Primary Case is a person with:
    • onset of diarrhea between March 21 - time of survey
    • from household with NO diarrhea between February 14 - March 20
  – Secondary Case is a person with:
    • met criteria for primary case
    • symptom onset ≥7 days after initial household case
Cross-Sectional Study
Methodology

- Case Definitions (Individual Level) (cont’d)
  - Confirmed Case is a person with:
    - met criteria for primary or secondary case
    - stool specimen positive for *Cryptosporidium parvum* oocysts
  - Control is a person from any household who had no symptoms of gastrointestinal illness

---

Risk factor analysis

- Univariate analysis - compare exposures among ill to non-ill in simple 2x2 tables
- Multivariate modelling to obtain a final model which controls for relationships between different risk factors
**Cross-Sectional Study**  
**Methodology**

**Community Estimates of Illness**
- Estimate background rate of GI illness (study based and literature based)
- Calculate age-specific crude attack rates for each community
- Multiply crude attack rates by age-specific census populations for each community
- Total age-specific estimates to derive population estimates for each community

**Cross-Sectional Study**  
**Results**

**Household Level**
- 259 households surveyed
  - 65.5% North Battleford
  - 25.1% Battleford
  - 9.3% other communities
- 122 ill households (47%)
- 93 non-ill households (36%)
- 44 other (17%)
Cross-Sectional Study Results

Individual Level

Information obtained regarding 652 individuals:
- 196 classified as primary cases
- 51 classified as secondary cases. Thus, 38% (247/652) of those surveyed had gastroenteritis.
- 311 people reported no symptoms and did not have any ill household members—used as controls.

Cross-Sectional Study Results

Outbreak Curve

Maintenance of Surface Water Treatment Plant (March 20, 2001)
Cross-Sectional Study
Results
Multivariate Analyses

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Odds Ratio (95% C.I.)</th>
<th>Statistical Significance (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.B. Water in Home (OR work/school)</td>
<td>1.52 (0.90-2.54)</td>
<td>0.0019</td>
</tr>
<tr>
<td>N.B. Water in Home (AND work/school)</td>
<td>2.73 (1.55-4.81)</td>
<td></td>
</tr>
<tr>
<td>Contact with livestock</td>
<td>0.45 (0.23-0.88)</td>
<td>0.0166</td>
</tr>
<tr>
<td>Age group (10-14 yrs)</td>
<td>2.78 (1.30-5.95)</td>
<td>0.3100</td>
</tr>
<tr>
<td>Age group (20-29 yrs)</td>
<td>4.06 (1.67-9.88)</td>
<td></td>
</tr>
<tr>
<td>Age group (30-39 yrs)</td>
<td>2.28 (1.15-4.51)</td>
<td></td>
</tr>
</tbody>
</table>

Cross-sectional Study

Exploring the Significance of the March 20th Event

• Further modelling was conducted to evaluate whether or not North Battleford water was a risk factor for gastroenteritis between February 14 and March 20.

• Results suggest that the consumption of North Battleford water was not associated with gastroenteritis between February 14 and March 20.

• These results support the hypothesis that the malfunction in the SCU was a primary factor in allowing Cryptosporidium to enter the drinking water.
Cross-Sectional Study Results

Community Estimates of Illness Results

- In the City of North Battleford & Town of Battleford an estimated 5800 to 7100 people developed gastroenteritis as a result of the outbreak

- Unable to determine an estimate for those outside the Battlefords
**Environmental Review**

**Purpose:**

Determine what factors may have contributed to the contamination of the water supply

---

**Environmental Review**

**Methodology**

- Review of water treatment plant operations
- Collection of water treatment data:
  - Finished water turbidity (SERM)
  - Percent settling of Solids Contact Unit
  - Water volume contributions to community from each plant
  - Distribution system water quality
Environmental Review Results
Areas of with no significant findings

- No irregularities reported at the ground water treatment plants
- Records of bacterial water quality and chlorine residuals in the North Battleford distribution system from Jan-April 2001 showed no abnormalities

Environmental Review Results
North Battleford Surface Water Treatment Plant: Solids contact unit percent settling
Environmental Review Results

North Battleford Surface Water Treatment Plant: Average Daily Finished Water Turbidity

Comparison of Water Quality and Disease Burden Data

Data of onset of diarrheal illness within the Battlefords Health Service Area

Antidiarrheal drug sales (Pharmacy A)

Surveillance of watery diarrhoea

Infections, non-enteric

Precautionary Drinking Water Advisory
Overall Conclusions

- Battlefords area experienced an outbreak of waterborne cryptosporidiosis in spring 2001.
- An estimated 5800-7100 people from the Battlefords along with hundreds more from other communities and provinces affected.
- Outbreak most likely precipitated by a shut down of the SCU which left the system vulnerable to contamination from the river.

Conclusions continued

- Contamination most likely came from fecal contamination upstream.
- Illustrates the need for a multi-barrier approach to protecting municipal water supplies.