



Were the lessons learned in Canada?



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# The North Battleford Outbreak

- ◆ Despite unprecedented publicity across Canada throughout 2000 and 2001, North Battleford had an outbreak caused by *Cryptosporidium* in April 2001 infecting ~5800 - 7100 in Saskatchewan
- ◆ 2 deaths had Crypto infections but ruled not causal
- ◆ Contamination arose from their own municipal sewage effluent discharge ~3km upstream of drinking water intake combined with poor treatment performance after badly scheduled process maintenance
- ◆ This failure also led to a public inquiry which revealed systemic problems similar to Walkerton





sewage outfall

North Saskatchewan River

drinking water intake

North Battleford, Sask. March to April 2001



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# The North Battleford Outbreak

- ◆ North Battleford had been warned for more than 10y about the vulnerability of its drinking water intake
- ◆ The City of 15,000 took pride in keeping its water rates low and in not spending its budget for staff training
- ◆ The water treatment supervisor was on stress leave before deciding to retire early from stress
- ◆ The plants were being operated without a supervisor because they could not recruit a replacement to the vacant position
- ◆ Outbreak occurred because of poorly time maintenance



# Failure to learn from Walkerton

North Battleford occurred 11 months after Walkerton

- ◆ Saskatchewan Environment & Resource Management (the Regulator) sent municipalities a letter immediately after Walkerton suggesting a local review of their practices
- ◆ North Battleford City Council took exception to the “*cover your butt*” letter and replied: “*We certainly understand and take our responsibility to provide safe drinking water to our citizens.*” Did not consult operators about their concerns



# NB Inquiry Findings

Justice Laing concluded about the subsequent outbreak:

*“There was a systematic failure on the part of the City of North Battleford to recognize its responsibility to produce safe drinking water. This failure was brought about by the City’s collective lack of knowledge on what it takes to produce safe drinking water, and policies that discouraged the possibility that it might acquire such knowledge.”*



# Other international outbreaks

- ◆ Hawkes Bay, Zealand, Boarding School
- ◆ In May 2001, 95 – 185 people ill with campylobacteriosis
- ◆ Spring fed water supply treated with pressure sand filter, softening, cartridge filter and UV disinfection
- ◆ Source was in fractured limestone hills above the school



Spring source area





**Close up of spring source area**

A photograph of a rural landscape. In the foreground, a wooden fence with blue wire runs across the frame. Behind the fence, a herd of cows of various colors (black, white, and brown) is grazing on a grassy slope. The background features rolling green hills under a clear blue sky, with some trees scattered across the landscape.

**Effective source  
protection?**

**Spring  
source  
area**

# Hawkes Bay, NZ

- ◆ Why an outbreak in May 2001?
- ◆ Cattle had been grazing on water source for some time
- ◆ UV disinfection was allowed to fail leading to the outbreak
- ◆ another example of multiple conditions aligning
- ◆ why did this outbreak not kill anyone? Perhaps, these cattle were not infected with *E. coli* O157:H7



# Surface Water: Damn those beavers!

- ◆ Creston & Erickson, B.C. experienced a *Giardia* outbreak in 1990 with their untreated surface water source (Arrow Creek)
- ◆ A previous *Giardia* outbreak had occurred in 1985

Contamination was tracked to a beaver who was blown with dynamite to that big dam in the sky, but not without giving up fecal samples to prove culpability



# Damn those beavers & **fear that chlorine!**

- ◆ Creston succumbed to chlorination in 1992
- ◆ Erickson resisted the evil chlorine until local MOH applied to province to take over Erickson Improvement District with a court-appointed receiver
- ◆ 200 volunteers manned a blockade for 55 days to prevent chlorine being applied
- ◆ **Immunity:** in 1990 outbreak the attack rate was 68% among 57 new residents vs. 4% among residents ill during the 1985 outbreak



**NO CHLORINE**



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# Milwaukee, 1993

- ◆ Everyone knows that ~400,000 were ill with cryptosporidiosis in March, April 1993
- ◆ Was Milwaukee also an aberration?
  - Were there any warnings in Milwaukee?
  - Were there any warnings from elsewhere?
  - Have the lessons been learned?



# Were there any warnings in Milwaukee?

Milwaukee's Health Commissioner seeking to explain how the outbreak happened said: *"It was an issue of complacency, false complacency. I think the feeling was—**Hey the water's always been fine**'*



# Were there any warnings in Milwaukee?

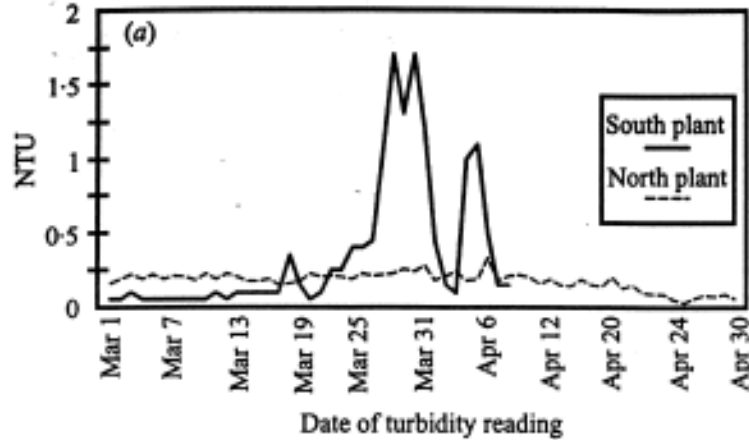
*“A striking example of what may happen is the occurrence following a day in 1916 when the chlorine was shut off for several hours. The raw water was badly polluted on this day. Within a short time, 25,000 to 100,000 cases of diarrhea resulted followed by 500 cases of typhoid fever and 60 deaths from typhoid fever.”* (Schwada, **JAWWA 1934**)



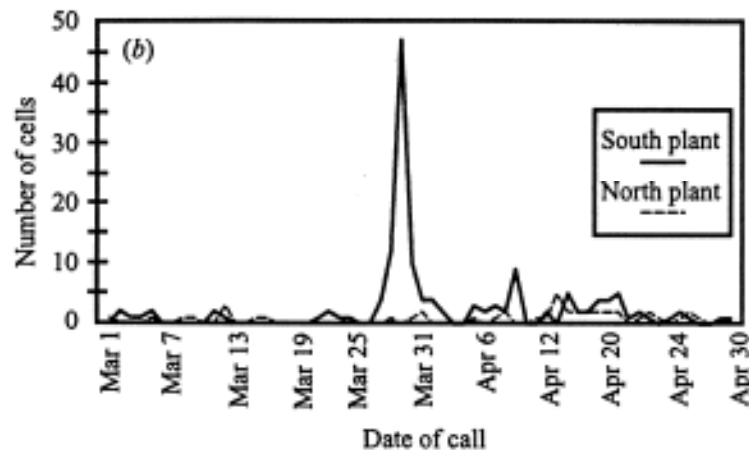
# Were there any warnings in Milwaukee?

- ◆ Milwaukee also had major outbreaks in March 1936 (unknown number) and February 1938 (~20,000 cases) both during winter storms affecting water quality and mixing in Lake Michigan
- ◆ *'Hey the water's **always** been fine' ??*

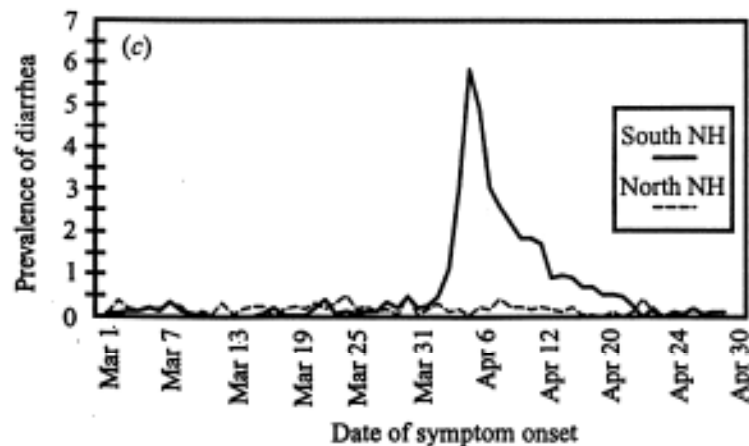




Finished water turbidity



Consumer phone complaints



Nursing Home GI Cases  
- the outbreak



# Were there any warnings from elsewhere?

- ◆ First recognized *Cryptosporidium* waterborne outbreak was groundwater in Braun Station, Texas in 1984
- ◆ Carrollton, Georgia, a full treatment surface water plant meeting standards (13,000 cases) in Jan-Feb, 1987
- ◆ Swindon – Oxfordshire, full surface water treatment meeting standards (516 lab-confirmed cases, at least 10:1 x), Dec 88 to April 89
- ◆ First Badenoch Inquiry report in July 1990



# Have lessons been learned?



Milwaukee  
official states in  
2004 AWWA  
video (*Protecting  
Against Waterborne  
Disease*)

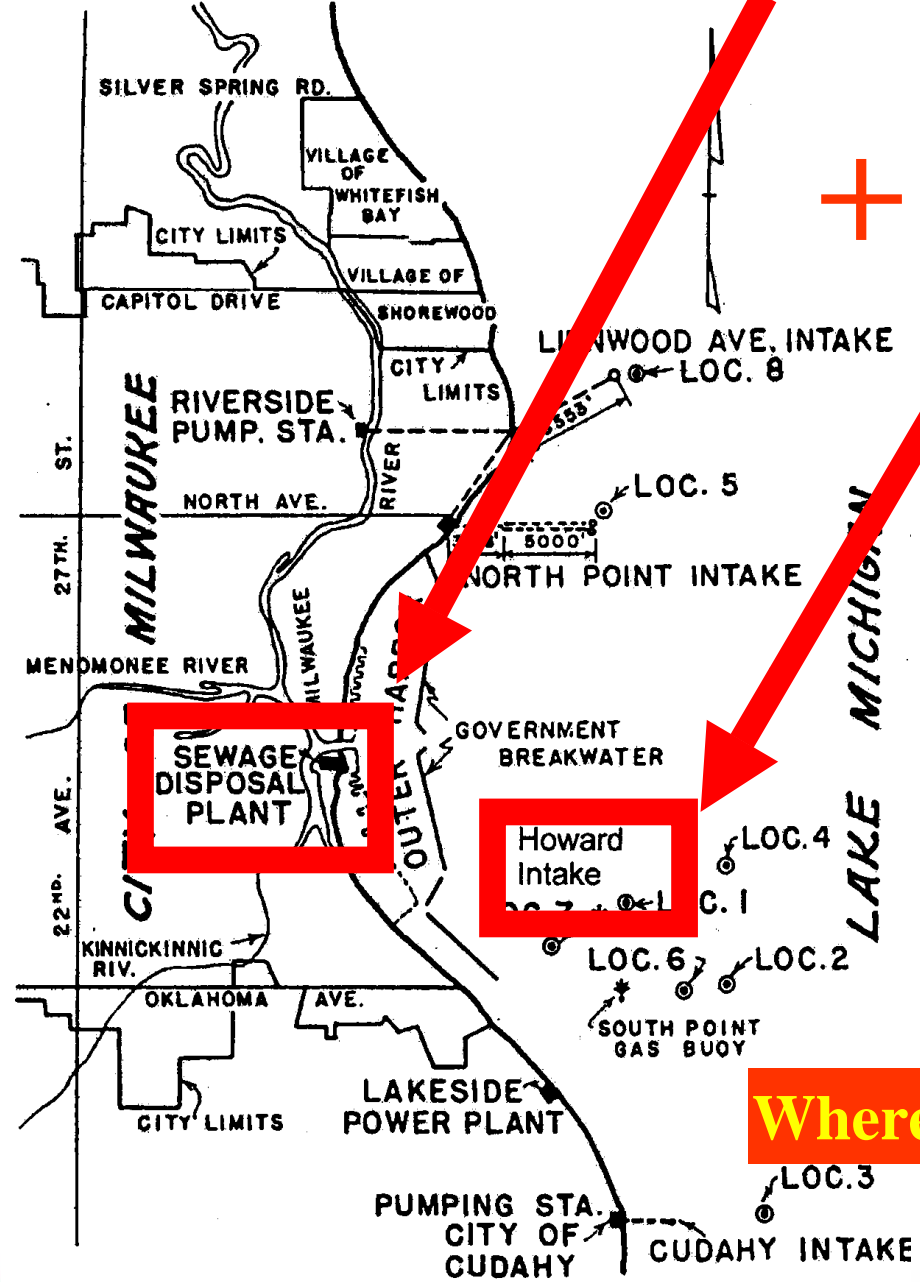
***“To this day  
we have no  
idea where the  
crypto came  
from.”***



# Have lessons been learned?

- ◆ CDC analyzed archived specimens from Milwaukee - found all are genotype 1, (human origin), i.e. sewage source.
- ◆ Christensen et al. (*J. Environ. Eng.* **123**: 492-498):  
“*Crypto is more likely to come from the Jones Island [STP] outfall than from river runoff & more likely to enter the Howard Ave. intake than the Linnwood intake*”
- ◆ Schwada (1934) found highest fecal contamination in Milwaukee harbour at the eventual (1962) location of the Howard Ave intake



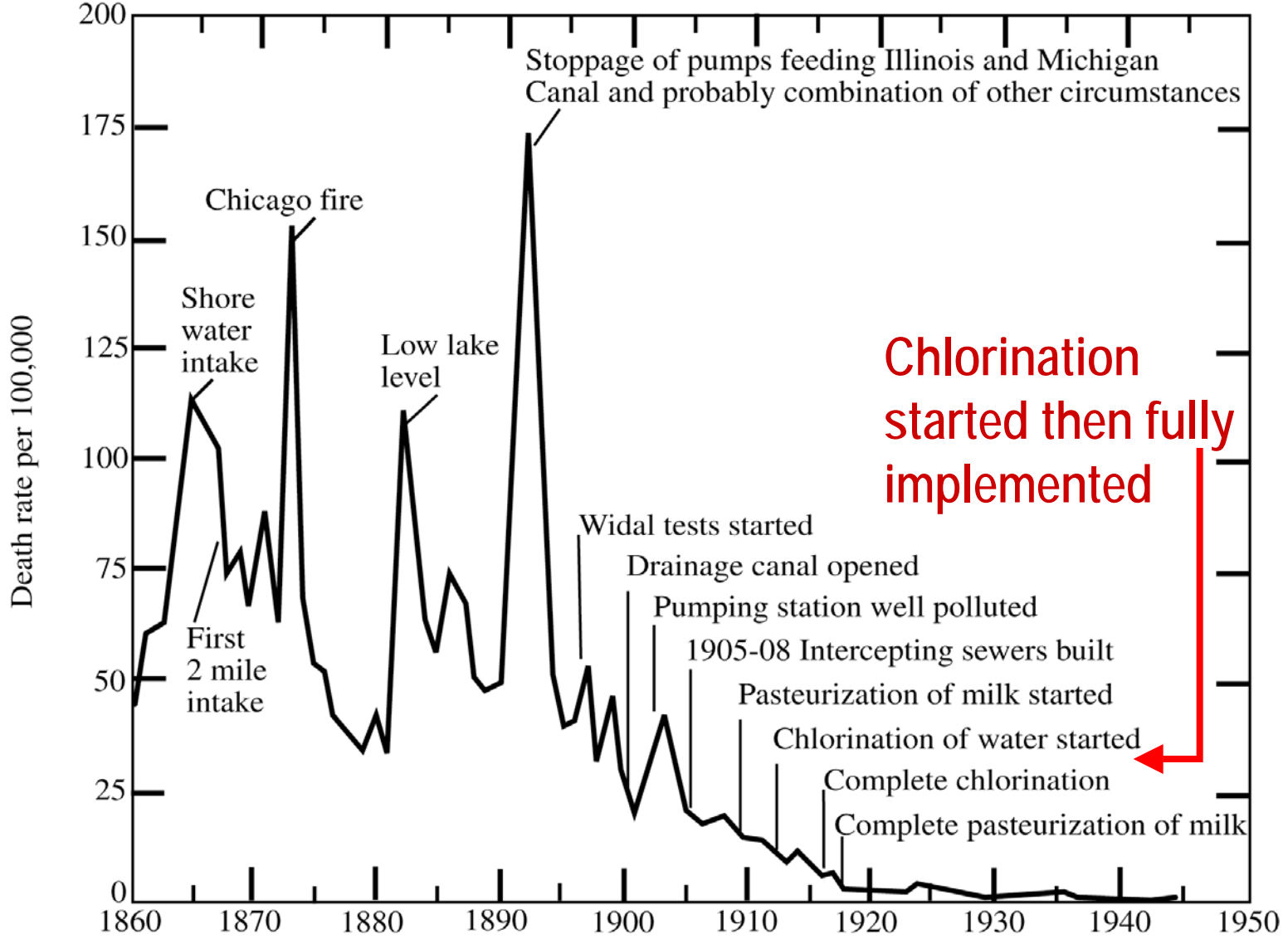


**SEWAGE DISPOSAL PLANT**

**Howard Intake**

**Where is the mystery?**





**Typhoid death rate in Chicago**



# And more neglected warnings

- ◆ La Neuveville, Switzerland, 1998



- ◆ Scenic wine growing area near Berne



# La Neuveville, Switzerland

- ◆ In August 1998, 2200 out of 3300 residents experienced gastroenteritis caused by 5 or 6 different pathogens
- ◆ Water supplied by 2 wells near Lake Biemme but sewage lift station located near wells
- ◆ Sewage lift pump failed and alarm was ignored
- ◆ Massive epidemic, but politicians did NOT wish to cancel forthcoming wine festival
- ◆ This was the second outbreak there in 11 months



# Victims of our own success?

- ◆ Complacency arises because waterborne outbreaks are rare
- ◆ **Safe drinking water is a huge bargain. How lucky we are to have, clean safe water delivered on tap!**
- ◆ What lessons can be taken from experience?



# Challenges

- ◆ Fecal contamination (& pathogens) are everywhere water is supplied to humans
- ◆ pathogen loading sufficient to cause an outbreak will generally be intermittent and infrequent - long periods of apparent safety followed by “*surprising*” disaster
- ◆ pathogens are particles that will be unevenly distributed in water and likely clumped
- ◆ variable infectivity and consumer susceptibility make for uneven disease occurrence



# Challenges

- ◆ some pathogens are difficult to filter and/or difficult to chemically disinfect (e.g. Crypto)
- ◆ conditions for pathogen challenge to a system are often event-driven (beware of change)
- ◆ multiple factors must usually align to cause an outbreak, so multiple barriers can achieve a high degree of security by making probability of total system failure more remote

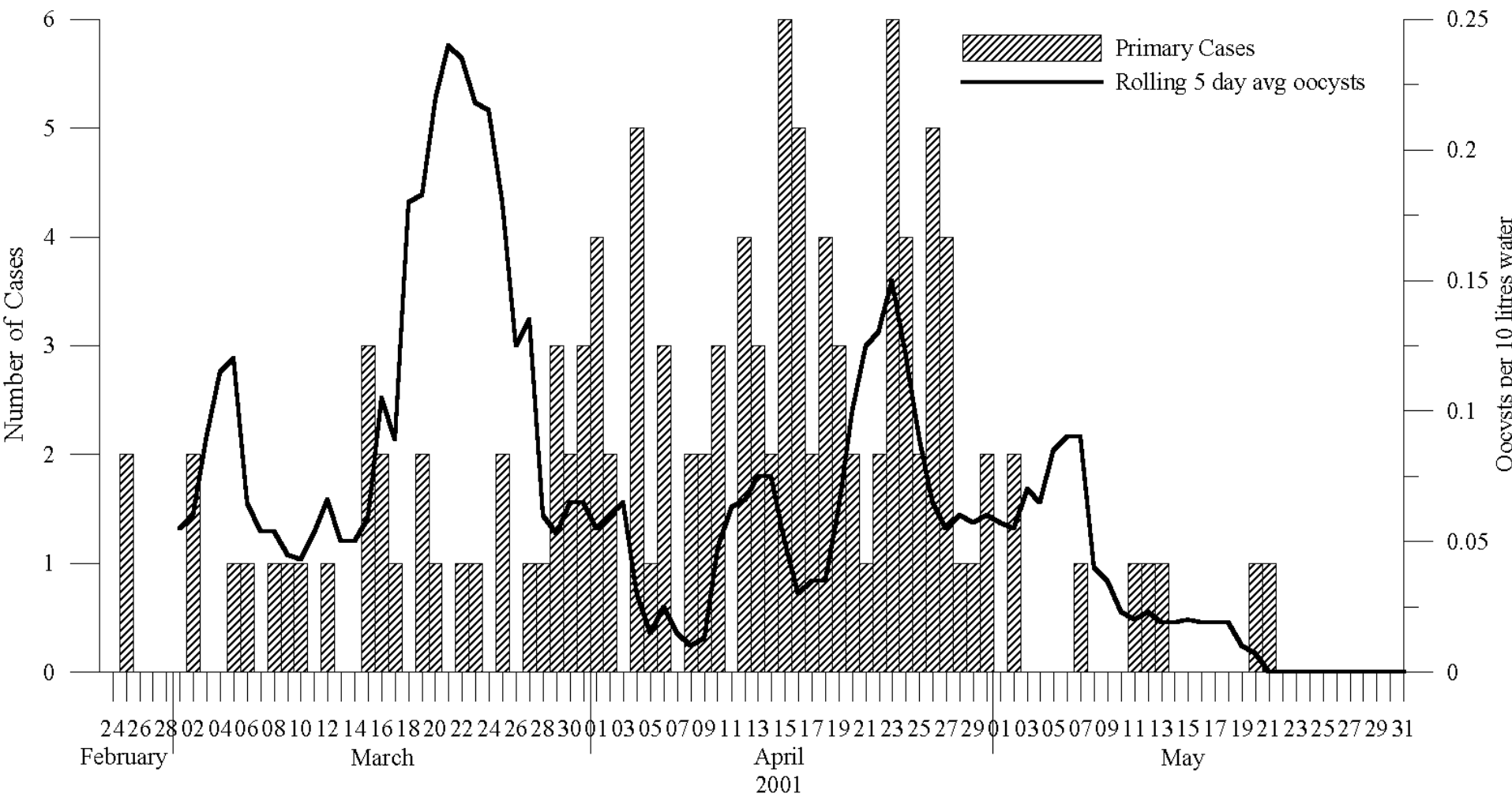


# Limitations

- ◆ Monitoring methods for pathogens and useful indicators are usually neither sufficiently sensitive, nor sufficiently specific and are not available in real time
- ◆ monitoring results cannot be directly interpreted for public health significance because of viability, infectivity and susceptibility considerations



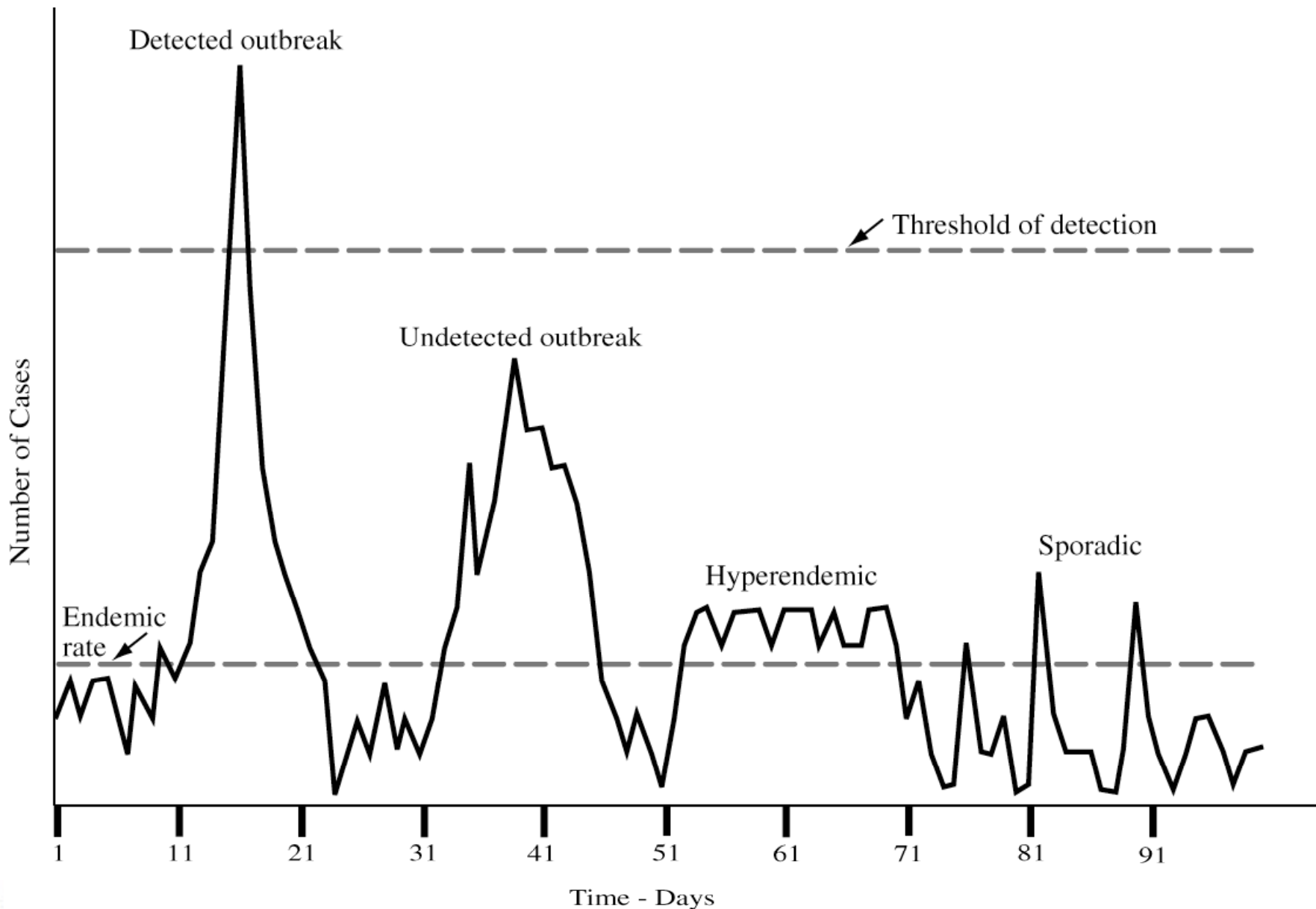
# Belfast Crypto outbreak 2001



# Limitations

- ◆ Population health surveillance is insensitive and likely blind to all but the largest outbreaks
- ◆ adaptation or tolerance in resident population may hide local, chronic problems while leaving visitors vulnerable, but visitors difficult to track back to source (e.g. Creston, B.C., Alpine, Wyoming)





# Prevention

- ◆ informed vigilance must be actively promoted and rewarded
- ◆ understanding of whole system, its challenges and limitations must be promoted and maintained
- ◆ effective real time process control must be a basic operating approach (maintaining chlorine residuals)
- ◆ fail safe multiple barriers appropriate to the challenges facing the system must be maintained



# Prevention

- ◆ Operators, supervisors, lab personnel and management all understand they have been entrusted with public's health and this is JOB 1
- ◆ Operators are afforded training and resources commensurate with their responsibilities as guardians of the public's health
- ◆ Response capabilities need to align with threats, including intentional sabotage
- ◆ Continuous improvement mentality should pervade the organization



# The Most Critical Things

- ◆ **KNOW YOUR SYSTEM!!!!**
- ◆ Know the NHMRC Framework 6-Pack
  - Pathogens are the greatest risk
  - Robust multiple barriers are essential
  - Trouble is preceded by change
  - Operators must be capable and responsive
  - DW professionals accountable to consumers
  - Risk management = sensible decision-making



*Those who cannot remember the past  
are condemned to repeat it.*

— George Santayana



## *Walkerton Memorial Park*



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# Acknowledgement



**Justice O'Connor's dedication and commitment to the truth**



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## Safe Drinking Water

Lessons from Recent Outbreaks in Affluent Nations

Steve E. Hrudcy and Elizabeth J. Hrudcy



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