

canadianwaternews



bringing water research to life





PUBLIC HEALTH | 2006



canadianwaternews

A PUBLICATION DEDICATED TO
PUBLIC HEALTH RESEARCH UNDERTAKEN BY
CWN RESEARCHERS, PARTNERS AND STUDENTS

table of contents

A message from the Scientific Director	page 1
Letters to the Editor	page 2-3
Lessons learned: Most water disease outbreaks are preventable	page 4
What have we learned?	page 5
Listening and learning from Walkerton's residents	page 6
Walkerton Inquiry inspires Hrudeys to write book	page 7
Safe water starts with better training	pages 8-9
Combating water's number one threat: complacency	pages 10-11
What you can do as a consumer	pages 12-13
Tracking viruses in drinking water	page 14
The dream of arsenic-safe water for all	page 15

EXECUTIVE EDITOR

David Cotter

EDITORS

Ashley Brown

Jennifer O'Neill

PROJECT COORDINATOR

Ashley Brown

DESIGN

University of Waterloo Graphics

CONTRIBUTING WRITERS

Debbie Lawes

Annie Locas

Matthew Retallack

TRANSLATION

Jean-Philippe Doyon

Annie Locas

CWN TEAM

William Borland, Board Chair

Mark Servos, Scientific Director

Bernadette Conant

Don Brookes

David Cotter

Georgia Mulholland

Corban Riley

Monica Escamilla

Stacey McFadzen

Ashley Brown

Canadian Water Network

University of Waterloo

200 University Ave. W.

Waterloo, ON N2L 3G1

www.cwn-rce.ca

info@cwn-rce.ca

Aussi disponible en français



**BESTSELLER FROM
IWA PUBLISHING**

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.

Using the rich and detailed perspectives offered by the evidence and reports from the Walkerton (2000) and North Battleford (2001) outbreaks to develop templates for understanding their key dimensions, over 60 waterborne outbreaks from 15 affluent countries over the past 30 years are explored as individual case studies. Recurring themes and

patterns are revealed and the critical human dimensions are highlighted suggesting insights for more effective and more individualized preventive strategies, personnel training, management, and regulatory control.

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.

ISBN: 1843390426
June 2004
514 pages
Hardback

Authors
SE Hrudehy,
EJ Hrudehy

IWA Members Price:
US\$139.50 / £69.75 /
€105.00

Non Members Price:
US\$186.00 / £93.00 /
€140.00

NEW - Student Price:
US\$50.00 / £25.00 /
€37.50



KEY FEATURES

- Correlate scientific and perspectives of major outbreaks not widely known or understood beyond those directly involved in the investigations.
- Technical and scientific background associated with case studies is offered in the necessary summary form.
- Does not require specialist training or experience to comprehend the details of the numerous outbreaks reviewed.
- By providing in-depth scientific reviews using a case study approach, several key recurring themes are revealed that offer insights for developing localized, multi-media preventive strategies.

Order online at www.iwapublishing.com

For further information contact publications@iwap.co.uk



A message from the Scientific Director



Dr. Mark Servos,
CWN Scientific Director

Please enjoy the first of the Canadian Water Network's series of magazines on water science and innovation. This edition focuses on public health, while over the course of the year two more magazines will be published dedicated to infrastructure and watersheds to compliment our annual magazine canadianwaternews.com.

Together with our partners in industry, government, academia and non-government organizations, we have been able to identify and address critical water issues related to the provision of clean and safe drinking water. This magazine is a reflection of this mission. It outlines and highlights CWN research initiatives that bring together water practitioners, policy makers and researchers who are actively pursuing innovative solutions to Canada's public health problems.

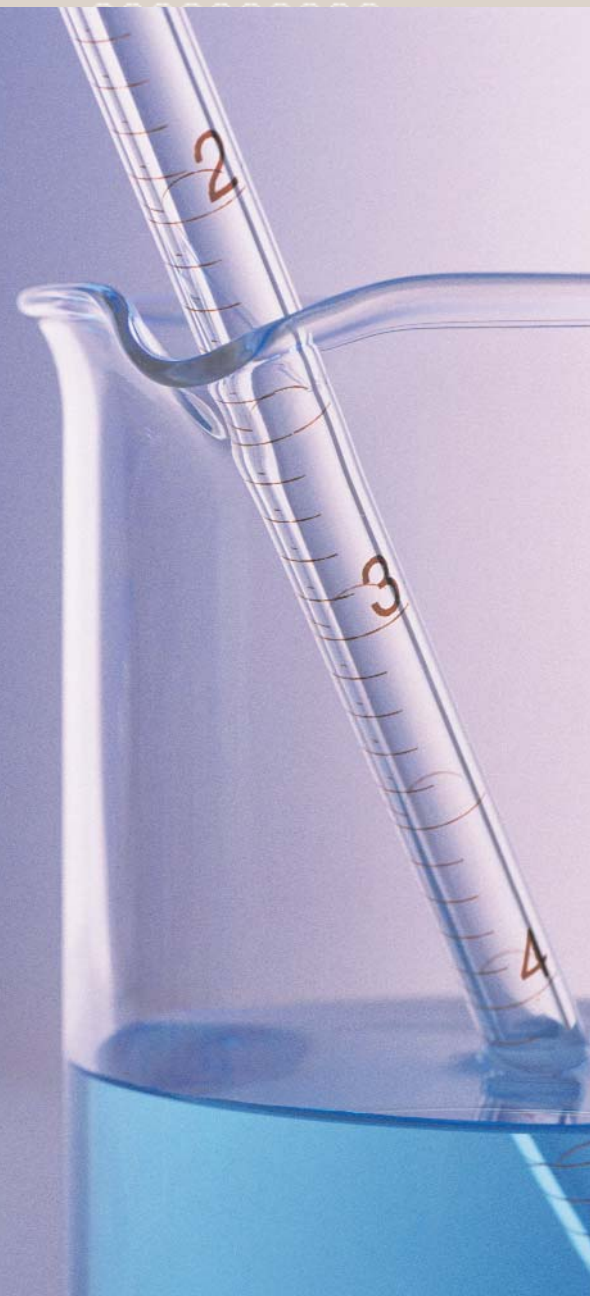
In this issue we highlight the work of several outstanding Canadian research teams that are impacting how we protect and manage drinking water nationally. Dr. Pierre Payment's team is advancing our understanding of the distribution and potential impacts of viruses in drinking water. Dr. Graham Gagnon is leading a group that is looking to remediate the widespread contamination of drinking water sources with arsenic. The critical efforts of Dr. Steve Hrudehy and others to communicate and bring a risk management approach to drinking water management are also highlighted in this issue. These represent only a few of the many internationally acclaimed Canadian researchers actively participating within the Canadian Water Network.

Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Countries, co-authored by Steve and Elizabeth Hrudehy, highlights that Canada and other first world nations are technologically advanced in terms of drinking water safety, but we are still vulnerable to contamination. Through well-documented case studies the Hrudeys point out what went wrong and how to prevent these threats to public health from occurring again in the future. Their book is a must read for everyone involved in the drinking water industry and public health. We are all responsible for the provision of safe drinking water and this book not only reinforces our roles, but inspires us to become better water purveyors and guardians. As The Honourable Dennis R. O'Connor wrote in his report on the Walkerton tragedy, "the keynote in the future should be vigilance." Also please find attached a copy of the DVD of Dr. Hrudehy's powerful presentation, *Turning Hindsight to Foresight*.

Through networking and the sharing of knowledge and expertise, we will become better equipped to handle the challenges of tomorrow. We look forward to many years of collaborative successes and thank you for your interest in the Canadian Water Network.

Mark Servos, Ph.D.
Scientific Director
CANADIAN WATER NETWORK

Letters to the Editor



BOOK A “WAKE UP CALL” FOR OPERATORS

To the Editor,

If you are involved in the public health business of providing drinking water and have not read Dr. Steve Hrudehy’s book, you are not doing everything in your power to protect your customers.

Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations does an excellent job of dissecting approximately 70 case studies of disease outbreaks from drinking water. In analyzing these outbreaks, he carefully points to those instances of personal, institutional, training, construction or regulatory lapses that we have all glimpsed from time to time. When those lapses go unaddressed, he shows how they can lead to the worst unintended consequences for a water purveyor.

For those operating in an environment where training, vigilance and resources are less than they should be, this book will serve as a needed wake up call. For those working in a good public health culture, the book provides the positive reinforcement needed to keep doing the necessary hard work that keeps your system safe.

REID CAMPBELL
PLANT OPERATIONS MANAGER
HALIFAX REGIONAL WATER COMMISSION

VIGILANCE KEY TO PREVENTING FUTURE OUTBREAKS

To the Editor,

Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations is an excellent resource for water utility staff who are concerned with water quality and provision of safe drinking water, as well as for government employees who are responsible for the oversight of public drinking water systems.

Dr. Hrudehy’s book provides numerous examples of how waterborne disease outbreaks have happened, explaining the multiple problems that have come together to overwhelm the barriers to transmission of pathogenic organisms into the public drinking water. I suspect that some who work with public drinking water may not realize that multiple adverse events, such as source water quality changes and operational problems at water treatment plants or distribution system facilities, can lead to outbreaks that could have been prevented with proper vigilance.

I think a conclusion that follows from Dr. Hrudehy’s book is that persons who work with public drinking water systems must always be alert for possible problems and must take prompt action if problems are detected. This is a valuable message that should be publicized widely.

DR. GARY LOGSDON, DSC, PE, DEE
SENIOR PROCESS CONSULTANT
FAIRFIELD, OHIO

“SAFE WATER” A MUST READ FOR STUDENTS

To the Editor,

Dr. Hrudehy’s book, *Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations*, is a must read for any student involved in water quality or water management.

My field of study is virological quality of groundwater. Since a lot of outbreaks are caused by the consumption of unsafe groundwater, this book has proven to be of great use for my work.

Unlike many “scientific” books, this one is quite easy to read. It is clear and makes its points in a concise and captivating manner. I read it from cover to cover. It is an excellent primer for students to understand how waterborne outbreaks can happen in countries that have the expertise and financial means to do better. It reminds us that good science is only one part of the equation. When it comes to safe drinking water governments, local utilities, health authorities and the public all have a shared responsibility.

ANNIE LOCAS, PH.D.
POSTDOCTORAL FELLOW
INRS-INSTITUT ARMAND-FRAPPIER, LAVAL UNIVERSITY

AUSTRALIA FINDS HRUDEY BOOK “INVALUABLE”

To the Editor,

Dr. Steve Hrudehy’s book, *Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations*, has become an invaluable resource for the Water Corporation of Western Australia, which manages the water supplies for Perth and over 220 regional and rural towns across the state.

The Corporation has purchased 55 copies of the book for our Corporate Water Quality Committee, general managers and line managers in our regions who have direct day-to-day responsibility for water quality. We have also purchased copies for key stakeholders in other departments, including the Department of Health and the Water and Rivers Commission who have a responsibility for protecting our source water quality.

The Corporation is very committed to the supply of safe water and has an impeccable record with respect to public health. In such circumstances it is easy to become complacent. While many of the incidents reviewed in the book are half a world away, we can recognize that similar vulnerabilities exist in our schemes.

Safe Drinking Water provides both motivation and inspiration. Motivation from the realization that incidents do happen, they could happen here and no one wants it on their shift. Inspiration in that all these incidents are avoidable and that the measures we are putting in place (as recommended in *Safe Drinking Water*) should go a long way to reducing our risk.

RICHARD WALKER
MANAGER DRINKING WATER QUALITY
WATER CORPORATION OF WESTERN AUSTRALIA

IMPORTANT MESSAGES FOR AFFLUENT COUNTRIES

To the Editor,

Dr. Steve Hrudehy and Elizabeth Hrudehy’s straight forward assessment of outbreaks provides valuable information to those involved in the water industry.

As the head of a large water utility in Canada, the most important message I took away from this book is that affluent nations can never take drinking water quality for granted. Consumers, water utilities, governments and regulators must remain diligent to stop outbreaks from occurring. Complacency will only lead to more outbreaks in the future.

Dr. Steve Hrudehy has had a profound positive influence on the realization that we are in the public health business at EPCOR Water Services. I believe his book should be required reading for all of us involved in the water industry as it reinforces the relationship between drinking water and public health and provides the history to learn how to improve for the future.

STEPHEN STANLEY, PH.D., P.ENG
SENIOR VICE PRESIDENT
EPCOR WATER SERVICES INC.
EDMONTON, ALBERTA



Dr. Steve Hrudehy

BY DEBBIE LAWES

Lessons learned

Most water disease outbreaks are preventable: CWN researcher reveals

CANADA AND OTHER AFFLUENT COUNTRIES ARE NOT IMMUNE TO WATERBORNE DISEASE OUTBREAKS. A BOOK BY CANADIAN WATER NETWORK RESEARCHER DR. STEVE HRUDEY AND ELIZABETH HRUDEY EXAMINES WHAT FAILED IN THESE COUNTRIES – AND WHY.

We all hope to learn from our mistakes.

But when it comes to safe drinking water, it's far better to learn from the mistakes of others.

Dr. Steve Hrudehy has seen the results of such mistakes up close. A public health engineer in the Department of Public Health Sciences at the University of Alberta, he served on the Research Advisory Panel to the Walkerton Inquiry from August 2000 to May 2002. Seven people died and 2,300 became ill in this small Ontario town from the worst E. coli water tragedy in Canadian history.

It wasn't the first such tragedy, or the last. In 2001, only 11 months after Walkerton, more than 7,000 residents in North Battleford, Saskatchewan were infected by water tainted with sewage. In both cases, inquiries concluded that the outbreaks were preventable.

"Most outbreaks are caused by common pathogens, good old fashioned bugs found in sewage and animal waste," says Dr. Hrudehy, a researcher with the Canadian Water Network. "We know how they cause disease and we know how to treat and disinfect water to prevent this from causing disease. If we implemented the things we are capable of doing, none of these outbreaks needed to have happened."

LEARNING FROM WALKERTON

Dr. Hrudehy has drawn on his experience with Walkerton to write *Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations*, released by International Water Association Publishing in London England. Co-authored with his wife Elizabeth, the book documents the human and institutional errors that have led to water contamination in countries that have the money and know-how to prevent such outbreaks.

The book examines 98 outbreaks which caused approximately 600,000 illnesses and 97 deaths. Some 70 outbreaks are developed as case studies looking at what failed and why.

The authors hope their book will inform drinking-water and health professionals including operators, managers, engineers, chemists and microbiologists, regulators, as well as students, policy-makers and politicians.

Key features include:

- Details and perspectives of major outbreaks not widely known or understood beyond those directly involved in the investigations
- Technical and scientific background associated with case studies is offered in an accessible summary form
- A review of key recurring themes and patterns that offer insights for developing localized, tailor-made prevention strategies

"Our goal was to convert hindsight into foresight to prevent future tragedies," explains Dr. Hrudehy. "This was a real opportunity to put existing research into practice by making it easily accessible to water and public health officials."

What have we learned?

Affluent countries have done a remarkable job at reducing serious health consequences from waterborne outbreaks for 150 years. However, we've dropped our guard over the past decade by allowing a number of serious, yet eminently preventable outbreaks to occur.

In reviewing the case studies, the authors note that the same kinds of mistakes continue to be made. "Some of these (outbreaks) have been caused by our inability to learn quickly enough and implement effective responses to the serious treatment challenges posed by Cryptosporidium. Other outbreaks have had fatal consequences by allowing proven, basic barriers like chlorination to be overlooked or neglected and rendered ineffective."

To help prevent such outbreaks in the future, the Hrudeys have developed a list of six guiding principles for providing safe drinking water.

Lessons Learned:

1. Pathogens pose the greatest and most tangible risk to drinking water safety, making pathogen removal and disinfection the paramount concern
2. Robust, effective multiple barriers to drinking water contamination are needed to suit the level of contamination challenge facing the raw water source
3. Trouble is usually preceded by change – so change should be taken as warning to be on alert for trouble
4. Operators must be capable and responsive
5. Drinking water professionals (providers, regulators and health officials) must be accountable to drinking water consumers
6. Ensuring safety is an exercise in risk management, requiring sensible decisions in the face of uncertainty

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

GEORGE SANTAYANA (1863-1952)
PHILOSOPHER AND POET

CASE STUDY COUNTRIES		
Australia	Finland	Norway
Bermuda	Japan	Scotland
Canada	Ireland	Sweden
Denmark	Italy	Switzerland
England	New Zealand	United States



Co-author of *Safe Drinking Water: Lessons From Recent Outbreaks in Affluent Nations*, Steve Hrudehy.

Safe Drinking Water: Lessons for Recent Outbreaks in Affluent Countries examines 98 waterborne disease outbreaks from communities in 15 countries, including Walkerton, the North Battleford cryptosporidium outbreak in 2001 and Edmonton's brush with beaver fever (giardiasis) in 1982-83.



bringing water research to life

CANADIAN WATER NETWORK

BY ANNIE LOCAS AND MATTHEW RETALLACK,
CWN COMMUNICATIONS INTERNS

Listening and learning from Walkerton's residents

WALKERTON HAS COME TO REPRESENT THE HUMAN FACE AND THE TRAGIC CONSEQUENCES OF THE BLIND APPLICATION OF THEORY AS OPPOSED TO UNDERSTANDING THE PRACTICAL NEEDS OF CANADIAN COMMUNITIES.



CWN conference participants

Walkerton Workshop Partners

- Canadian Water Network
- Concerned Walkerton Citizens
- Walkerton Water Centre
- Ontario Centres of Excellence Inc.
- Municipality of Brockton

It was late May 2005 – five years after the Walkerton tragedy – when 35 post-graduate students and young professionals from across Canada traveled to this rural Ontario town to learn first-hand the human consequences of unsafe water. Organized by the Canadian Water Network and local partners, the “Converting Hindsight to Foresight” seminars were designed to give young water professionals a better understanding of the importance of water and public health.

The workshop provided a unique opportunity to move beyond theoretical training to understand the practical aspect of working in water. “I may have a good education and technical knowledge,” said Matthew Retallack of the Dalhousie School of Engineering. “But if I don’t understand the impact and human dimensions of my decisions I may miss the opportunity to prevent another Walkerton-like tragedy.”

The Canadian Water Network is committed to connecting young professionals and students from different backgrounds to develop and improve ways of thinking about the delivery of safe water.

Matthew lives in the Halifax area and intends to work overseas before settling back in the Maritimes. “Many of the lessons that I learned here will help me to provide clean, safe water to communities in developing countries. While some of the circumstances will be different, everyone in the world deserves to have access to safe water.”

Simone Magwood of Walkerton recently completed a Masters of Science in Resource Management at the University of British Columbia. For her, returning to Walkerton was a deeply personal experience.

“I wasn’t sure what I was going to do after my undergraduate degree. The events in Walkerton in 2000 gave me a passion and direction,” said Simone. “I am really pleased that CWN came to Walkerton for this conference. They are very committed to see it doesn’t happen again and they treated the community with the respect and dignity they deserve.”

The CWN conference drew participants from Nepal, Australia, China, Colombia and Pakistan and from varying disciplines, including hydrogeology, chemistry, engineering, microbiology, social sciences and public health.

“It was important for us to bring the students to Walkerton,” said CWN Scientific Director, Dr. Mark Servos. “They are future leaders in the water field and it’s necessary for them to understand what happened here. To understand the true extent of the tragedy you can’t just read about it. You have to hear from the people who were affected.”

Walkerton Inquiry inspires Hrudeys to write book



Elizabeth Hrudey

CANADIAN WATER NEWS SPOKE RECENTLY WITH ELIZABETH HRUDEY, THE CO-AUTHOR OF *SAFE DRINKING WATER* ABOUT HER EXPERTISE IN RESEARCHING AND WRITING THIS LANDMARK BOOK WITH HER CO-AUTHOR AND HUSBAND, STEVE HRUDEY.

CWN: Is this your first book?

E.H.: A first for me, although Steve has written several books and several chapters for books.

CWN: How did you become involved in *Safe Drinking Water*?

E.H.: It started with the Walkerton Inquiry in 2001. Steve served on the Research Advisory Panel and I began helping him as a research assistant, compiling information from published reports about outbreaks in Canada and other countries.

CWN: How did that research evolve into a 486-page book?

E.H.: When we first started this, we thought it would be about 200 pages. We hadn’t anticipated that there would be so many outbreaks in affluent countries. These outbreaks caused illnesses and even deaths, yet they didn’t appear to be widely known, even within the water research community. With this book, we saw a real opportunity for more people to read about these outbreaks and hopefully learn from them.

CWN: What is your professional background?

E.H.: I have a bachelor of science from Carleton University and was registered as a laboratory technologist in clinical microbiology. I worked at the Provincial Laboratory of Public Health in Edmonton doing diagnostic microbiology for over five years.

CWN: Were you able to bring a different perspective to the research and to the book?

E.H.: Since we weren’t trying to write a highly technical book, both Steve and I wanted to make sure that it was accessible to as many people as possible. Anytime I came upon something that wasn’t clear to me, I would suggest that we re-write it in a way that more people could understand.

CWN: Why do you think this book is important?

E.H.: It’s the fact that these outbreaks are happening in affluent countries where you would think the citizens should expect that their water would be safe and come to them properly treated. You would also think that people in other communities would learn from these experiences. We’re hoping this book will create a greater awareness – not only among utility operators and managers, but among regulators and others who have a position of oversight – that things can and do go wrong.

CWN: Do Canadians take their water for granted?

E.H.: I’m afraid most do. People look around them and see that Canada has lots of water. What they don’t see are the treatment plants, the distribution systems or any of the other infrastructure that has to be put in place, maintained and run properly for water to be delivered safely.

CWN: Have all these outbreaks shaken your confidence in the municipal water supply?

E.H.: In most communities across Canada, consumers should assume their water is good. But don’t be complacent. Be demanding of your municipality to ensure that the quality is maintained. That’s why we put together a list of 17 consumer questions in the book. Since most people know very little about water distribution, they need help in knowing which questions to ask.

CWN: What lessons have you taken away from this book?

E.H.: That people at all levels have to accept that there should be a personal level of responsibility. From the person in the lab, to the water plant technician, the supervisor, municipal staff, elected officials, regulators – at each level, people have to be alert and pay attention and do their jobs to the best of their ability. Complacency is often our worst enemy.

Bringing water research to life

CANADIAN WATER NETWORK

Safe water starts with better training

“The greatest protection that consumers can achieve from the dangers posed by contaminated water is to be assured that operators of their drinking water system know and fully understand the system, its capabilities and its limitations.”

SAFE DRINKING WATER

DRINKING WATER OPERATORS ARE OUR FIRST LINE OF DEFENCE AGAINST PATHOGENS. WHY, THEN, ARE SO MANY INADEQUATELY TRAINED?

When Canadians think of poorly trained drinking water operators, many think of Stan and Frank Koebel. The general manager and foreman, respectively, of the Walkerton Public Utilities Commission provided shocking testimony at an Ontario inquiry in 2001 that woke up an entire nation to the life and death consequences of inadequate operator training.

In hindsight, the errors seem obvious and easily preventable. The Walkerton operators failed to use adequate doses of chlorine or no chlorination at all. They failed to measure the chlorine residual, made false entries about chlorine residuals in their daily operating logs and misstated where they had collected samples.

Yet, it did not appear to be done with malice or intent to harm. The Inquiry found that the operators continued to drink the water themselves during this period and concluded that they “had neither the training nor the expertise needed to recognize the vulnerability of Well 5 to surface contamination, nor the possible consequences of that contamination.” Justice O’Connor also concluded in the Inquiry that the best protection against contamination of drinking water is to have well trained operators and sound operating systems.

Walkerton is the most thoroughly documented case ever of a waterborne outbreak, but as *Safe Drinking Water* highlights in several case studies, inadequate operator training has contributed to outbreaks at one time or another in all of the 15 countries cited.

The book not only alerts governments, utilities and regulators to the importance of operator training, it provides a handy reference guide for understanding the major classes of waterborne pathogens, the capabilities of water safety barriers and what can be done to minimize the occurrence of outbreaks.

Reid Campbell at the Halifax Regional Water Commission was so impressed with the book’s findings that he ordered copies for his general manager, three water quality supervisors, the chief engineer and the technician who runs the distribution system.

“This book illustrates how very small mistakes can turn into major public health problems,” says Mr. Campbell, the Commission’s Plant Operations Manager. “Most people in the drinking water business are engineers. We know we have to disinfect the water and remove particles to make it safe. We don’t always understand the classes of bugs and which are dangerous. The book is an excellent public health/epidemiology primer for water quality people.”

CASE STUDIES

DRUMHELLER, ALBERTA, FEBRUARY 1983

Approximately 3000 people became ill and two died following an outbreak of viral gastroenteritis caused when the town’s sewage spilled upstream of the drinking water intake. Even though employees worked for the same organization, the waste water operators didn’t inform the drinking water operators about the spill until six weeks after the outbreak.

CABOOL, MISSOURI, DECEMBER 1989–JANUARY 1990

Some 239 people became ill and four died from exposure to E. coli 0157.HS – the largest waterborne outbreak of this pathogen until Walkerton 10 years later.

High quality ground water that was not treated became contaminated by sewage in the distribution system. Several water mains broke during extreme cold weather and the repairs were done improperly. Chlorination, which would have killed the pathogen, was not used.

LA NEUVEVILLE, SWITZERLAND, AUGUST 1998

A multiple pathogen outbreak of gastroenteritis affected more than 2200 people in this town of about 3300 when a pump failure caused sewage to back-up and overflow into the surrounding groundwater. The pump was alarmed to warn of a failure, but it had been shut off years earlier because technical problems were causing frequent false alarms.

HAWKES BAY, NEW ZEALAND, MAY 2001

Between 95 and 185 students and staff of a boarding school were affected by an outbreak of campylobacteriosis in this rural community. Drinking water supplied by a local spring was contaminated by cattle manure.

The school filtered the water and disinfected it with ultra violet light. The bulb burned out on May 18 but was not replaced until May 21 or 22, meaning fecally contaminated raw water received no disinfection for up to four days.



What operators can do to prevent outbreaks

- Know your system: capabilities of your barriers in relation to nature of the hazards
- Translate system knowledge into operational monitoring to detect imminent hazards
- Establish operational limits to trigger alarms
- Work with management to plan responses to abnormal conditions and use problem-solving as events unfold
- Recognize when you are in over your head and call for help
- Document near failures for future learning
- Recognize vulnerabilities that demand improvement
- Take ownership of the problems to ensure that managers do know about problems so that they cannot claim ignorance

Combating water's number one threat: complacency

HAVING CONSISTENTLY GOOD QUALITY WATER CAN HAVE ONE MAJOR DRAWBACK – SUCCESS BREEDS COMPLACENCY.

Canada's single greatest threat to its supply of safe drinking water is not pollution or a potential system failure. After reviewing 98 outbreaks that caused more than 600,000 cases of disease and 97 deaths in countries that could afford to do better, Dr. Steve Hrudey found that in every single case, complacency on the part of operators, and/or municipal officials and the public was the biggest culprit

"In each of these cases it would be nice to find a villain," he says. "But ultimately, we're complacent about drinking water safety, particularly in Canada, and public indifference often translates into political and institutional indifference."

The problem is that success breeds complacency. The industrialized world has done a remarkable job in providing a consistent supply of safe drinking water to its residents. In the preface to *Safe Drinking Water*, Dr. Hrudey and Elizabeth Hrudey say they "would be delighted if our neighbourhoods, our highways or even our healthcare facilities could be as safe."

And, therein, lies our Achilles Heal. A community may go for years or even decades before experiencing a significant outbreak. With success comes the temptation for cash-strapped municipalities to delay infrastructure upgrades, cutback on operator training or discount the need for multiple safeguards.

"The common response you often get from people in communities is, 'Nothing has happened here, nobody is sick so we can ignore the warnings

from elsewhere,'" Dr. Hrudey told Members of Parliament and Senators in Ottawa during one of his many cross-country presentations on his findings.

Walkerton, Ontario and North Battleford, Saskatchewan are two cases in point. They are also the most thoroughly documented case studies in *Safe Drinking Water*, as a result of comprehensive public inquiries into what went wrong.

In Walkerton, the inquiry found that the basic flaws had existed for more than 20 years before the outbreaks in 2000. A 1978 hydrogeologist's assessment warned that agricultural runoff endangered one of the municipality's shallow wells. The Walkerton Inquiry found that the town's outbreak was caused by contamination from cattle manure being washed from an adjacent farm into this same well.

North Battleford's cryptosporidium outbreak in 2001 infected more than 7000 people when sewage infiltrated the drinking water supply. This case is particularly surprising considering that it happened less than a year after the tragedy at Walkerton, which received unprecedented media coverage. And like Walkerton, North Battleford's vulnerabilities were known. The primary risk came from the sewage outfall for an inadequate wastewater plant which, for decades, had been located upstream from the drinking water intake.

North Battleford had been warned by the provincial regulator about the bacteriological contamination of the North Saskatchewan River caused by its own sewage treatment plant since 1963. Fixing the problem was not a priority for the city, or the provincial regulator, the Hrudeys write in their book.

"If we implemented the things we are capable of doing, and have been for some time, none of these outbreaks needed to have happened."

DR. STEVE HRUDEY, CO-AUTHOR, *SAFE DRINKING WATER*

"There seemed to be unwarranted confidence that the water treatment process at North Battleford would prevent any health consequences from this flawed situation..." they write. "There was considerable evidence that water treatment personnel were concerned, but they were unsuccessful in convincing the City administration and politicians to address the problems by investing in the necessary improvements."

MULTIPLE SAFEGUARDS NEEDED

While there is no way to fully eliminate the risk of contamination, there are effective ways to minimize those risks. Drawing from nearly a century of proven practices, the Hrudeys recommend a multiple barrier approach (see chart) that creates a robust system able to

respond to extreme weather conditions, catch human errors and provide a back-up to system failures.

For this to happen Dr. Hrudey stresses that governments and the public must not lapse into complacency. Rather, drinking water must become a much higher priority than it is now. When it comes to such a critical human resource, public safety must trump budget belt tightening.

"So many outbreaks appear to have been caused by neglect or complacency that is incompatible with recognizing safe, clean drinking water as a top priority in life," the book states. "No amount of economic rationalization can make sense of providing mediocre service to the public for something so vitally important."

Main elements of a multiple barrier approach:

- Source protection and selection to keep the raw water as clean as possible, to reduce the risk of contamination breaching the drinking water system;
- Treatment, often involving more than one process, to remove or inactivate contaminants, must be effectively designed, operated and maintained;
- Distribution system security to protect against intrusion of contaminants and disinfectant residual use to assure delivery of safe water to consumers;
- Monitoring to control treatment processes and detect contamination in a timely manner to inform risk management responses;
- Response capabilities to adverse conditions that are well-conceived, thorough and effective.

Outbreak Facts

- Treatment failures, inadequate treatment and poor source selection are the most apparent causes of drinking water outbreaks in affluent countries
- Domestic sewage (human and animal) is most common source of pathogen contamination
- Severe weather was prominent among the worst outbreaks
- Several outbreaks involved contamination in aging distribution systems



Dr. Steve Hrudey and Elizabeth Hrudey



bringing water research to life

CANADIAN WATER NETWORK

What you can do as a consumer

Empowering consumers to make safe drinking water a top priority



“The public must value the safety of their public drinking water supplies enough to show the financial and moral support necessary amid the many competing priorities in life.”

DR. STEVE HRUDEY AND ELIZABETH HRUDEY, SAFE DRINKING WATER

Consumers in affluent societies rightly expect that their drinking water should be safe. Yet most know very little about treatment processes, distribution systems or the proven versus hypothetical risks of tap water.

Relatively rare, but high profile outbreaks such as Walkerton, Ontario and North Battleford, Saskatchewan have undermined consumer confidence in municipal water, prompting a growing number of people to buy expensive in-home filtration systems or more bottled water.

In addition to providing a valuable resource to governments, regulators and drinking water professionals, *Safe Drinking Water* also serves as a wake-up call to consumers to get involved, to speak out and to make municipal tap water a top priority.

As the book points out, consumers have a huge role to play in determining the safety level of their water. Local officials, for example, may be reluctant to invest in infrastructure upgrades or better treatment processes in an effort to keep taxes low. As well, public opposition to the use of chlorine can lead to reductions in the use of this disinfectant and an increased risk of outbreaks (see Erickson, British Columbia and Bramham, England case studies).

Dr. Steve Hruhey believes consumers would willingly pay more to safeguard their local drinking water if they fully understood both the risks and consequences.

KNOWING THE FACTS

- Pathogens pose a proven risk to human health contrasted with speculative risks associated with byproducts of chlorine and other disinfectant chemicals
- For many outbreaks, it is often tourists, visitors, the elderly and young children who get sick. Local adults can build up immunity to pathogens in the water
- Safe tap water is up to 1000 times cheaper than bottled water
- Safe drinking water is not free: societies must be willing to pay to lower the risk of outbreaks
- Clean drinking water must be a top priority for governments and consumers

“How low we choose to push risk reduction is determined by how much we, as a society, are willing to pay. Unfortunately, consumers are not often consulted about whether they would be willing to pay more to achieve a safer system; these decisions are often made without any explicit debate about the relative merits of risk reduction measures.”

DR. STEVE HRUDEY AND ELIZABETH HRUDEY, SAFE DRINKING WATER

WHAT CONSUMERS SHOULD BE ASKING (a partial list from book)

- What is the raw water source for our drinking water?
- What are the main threats of contamination to that raw water source?
- What influence can unusual weather events have on raw water quality?
- How is the raw water treated to assure consistently safe water?
- What are the training levels of your water treatment operators?
- What incentives are they provided for identifying problems and improving performance?
- Who is in charge of water quality and safety?
- Who monitors the water quality routinely?
- Who regulates our water?
- What information on water quality and operational performance is available to consumers?

Consumer Power

THE OUTBREAK: BRANHAM, ENGLAND, JULY 1980

Drinking water operators in this historic village just west of York began minimizing their use of chlorine after consumers complained about the taste. This decision resulted in about 3000 residents becoming ill from gastroenteritis after a blocked sewer contaminated their ground water supply.

THE OUTBREAK: ERICKSON, BRITISH COLUMBIA, JANUARY-APRIL 1990

Local residents opposed to the use of chlorine succeeded in keeping this disinfectant out of their community, despite outbreaks in 1985 and 1990 caused by contamination from beavers (giardiasis).

The community refused to allow chlorination even after Walkerton in 2000, stating concern that chlorine-treated water causes cancer, miscarriages and serious birth defects (Dr. Hruhey counters in his book that: “... more than 25 years of epidemiological research has provided limited evidence and has left substantial uncertainty about which, if any, disinfection by-products pose any cancer risk to consumers.”)

A final resolution was achieved by building a water treatment plant that provides membrane filtration and UV disinfection, with minimal use of chlorine, at substantially greater cost than a basic treatment plant using chlorine.



Tracking viruses in drinking water



The dream of arsenic-safe water for all

New Canadian technologies could help small communities



Dr. Pierre Payment

DR. PIERRE PAYMENT HAS ALREADY HELPED THE QUEBEC GOVERNMENT IDENTIFY VIRAL POLLUTION IN APPARENTLY SAFE GROUNDWATER. NOW, THE CANADIAN WATER NETWORK RESEARCHER IS WORKING WITH ONTARIO AND ALBERTA TO RAISE THE BAR FOR SAFE DRINKING WATER ACROSS CANADA.

While most public attention has focused on E. coli and other bacterial contamination in drinking water, many viruses go undetected – and untreated. Many people have become ill from drinking water that was considered safe.

Research funded by the Canadian Water Network is working to change that. A Canada-U.S. team, led by Dr. Pierre Payment in Laval, Quebec, is collaborating with provincial and local governments on new test indicators for viruses that accompany human fecal pollution. The research could result in the application of proven or new treatment processes for small communities.

"In a previous study that also received support from the Ministry of Environment of Québec and the CWN, our lab tested for viruses and bacteria at 12 sites in Quebec," says Dr. Payment, a virologist and epidemiologist with the INRS-Institut Armand-Frappier at the Université du Québec. "Even though the water had been found clear of indicator bacteria and met all the regulatory requirements, we have found viruses."

In that project, researchers applied recently developed methods for detecting coliphages –

the viruses that affect fecal coliform bacteria, particularly E. coli. The presence of coliphages suggests that water may be contaminated with sewage or human feces. The new test is now in place in Quebec, and as part of this new two-year CWN project, Dr. Payment is transferring this methodology to Ontario and Alberta.

Knowing that water contains viruses is an important first step. But provincial regulators also need to know how the viruses are getting into the groundwater and what can be done to prevent it.

"People in government need a full scientific assessment that includes both a microbiology report and a hydrogeology report in order to make decisions about what should be done in terms of groundwater," he explains. "The CWN encourages collaboration with other scientific disciplines to find solutions."

The CWN team has also brought together microbiologists and civil engineers from Canada and the U.S. to test groundwater in about 20 small communities in Ontario, another 20 in Alberta and five new sites in Quebec. These are communities where the ground water is considered safe.

The Canadian government is promoting a new approach for water treatment and water protection that will help the provinces and territories establish new guidelines for protecting water from source to tap.

"The CWN is helping governments by providing data to develop policies for safeguarding drinking water," says Dr. Payment. "Its research that has real potential to effect everyone's lives in a very positive way."

REMOVING ARSENIC FROM DRINKING WATER IS A STANDARD WATER TREATMENT PRACTICE IN LARGER TOWNS AND CITIES. NOW, A CANADIAN WATER NETWORK TEAM IS WORKING TO BRING EFFECTIVE, LOW-COST SOLUTIONS TO SMALL COMMUNITIES AND RURAL HOMES.



Dr. Graham Gagnon

Health Canada has introduced new stricter guidelines for arsenic levels in groundwater which could prove particularly problematic in Nova Scotia. High concentrations of arsenic occur naturally in underlying bedrock in areas throughout the province, including Halifax and Guysborough Counties.

The province estimates that some 12,000 households with private wells will be affected by the new rules, which now limit arsenic levels to 10 micrograms per litre, from 15 micrograms per litre. Installing treatment systems could cost residents more than \$12 million.

"Because of the natural geology of Nova Scotia, we could have quite a few homes and

small communities that will have problems meeting the new Health Canada guidelines so we decided to partner with the CWN in search of cost-effective solutions," says Judy MacDonald, Supervisor, Drinking Water Management at the Nova Scotia Department of Environment.

Dr. Graham Gagnon, a Canada Research Chair in Water Quality and Treatment at Dalhousie University, is leading a two-year CWN project that is working with the province and private industry to assess the performance of existing commercial systems and to develop and commercialize two arsenic treatment technologies that will meet the new regulations.

One of those technologies is already showing results at a mine site in Trail, British Columbia. Developed by Nature Works Remediation Corp., the system uses inexpensive biodegradable nutrient sources (i.e. manure, spent mushroom compost) to filter arsenic. The process produces less contaminated sludge than chemical systems.

To understand what makes this particular biofiltration system so effective, the CWN has brought together an arsenic specialist (Dr. William Cullen) and a microbiologist (Dr. William Mohn) from the University of British Columbia, an analytical chemist (Dr. X. Chris Le) from the University of Alberta and a chemist with experience with remediation technologies (Dr. Ken Reimer) from the Royal Military College.

"There's a definite demand out there for a system like this," says Dr. Reimer. "If we can understand the microbiology and the chemistry behind the system, there are opportunities to remove other metals in the wastewater stream."

A second technology under development would use a chemical absorption process to remove arsenic. The research builds on a previous CWN project in which Dalhousie University Ph.D. student Maruf Mortula developed a low-cost system for removing phosphorus using sludge from water treatment plants.

The researchers move from the lab to field testing at two sites in Nova Scotia in 2006. The next step will be market studies and further talks with companies interested in bringing the technologies to market.

PARTNERS

- Brook Oceans Technology, Inc.
- CANMET, Natural Resources Canada
- City of Brampton
- Enviro Soil
- Halifax Regional Municipality
- Halifax Regional Water Commission
- McGuire Environmental
- Nature Works Remediation Corp.
- Nova Scotia Department of Transportation and Public Works
- Nova Scotia Department of Environment and Labour
- Regional Municipality of Waterloo
- Veolia Water International

THE 3RD CANADIAN WATER NETWORK

Connecting Water Resources national conference

Water Management in Canada
Leadership at Every Level

Le Centre Sheraton Montréal

November 20 – 23, 2006

Visit www.cwn-rce.ca for more information

CANADIAN WATER NETWORK ADMINISTRATIVE CENTRE

University of Waterloo

200 University Avenue West

Waterloo, Ontario N2L 3G1

519-888-4567, ext. 36367 | Fax: 519-883-7574

www.cwn-rce.ca