

Water and Science



Water Challenge (4th-6th)

As part of a water education day, challenge your students to try to make it through the day using only one gallon of water. Have each student bring to school a recycled plastic jug (one gallon jug or two half gallon jugs) as well as a cup or water bottle. Students must use this water for drinking, washing hands and any other water uses at school (except for flushing the toilet). Give a demonstration of how you might wash your hands with this water or anything else. Then have a discussion about whether or not this was difficult. What if you had to use that one gallon to also brush your teeth, clean your clothes, clean yourself by shower or bath? What if you had to walk and carry enough water for your whole family each day?

Measuring rainfall (5th-6th)

Measure rainfall in your area and compare it to other places around the world

Materials:

- Rain vial to measure rainfall

Set up a rain vial outside your classroom to measure rainfall. Over a time period of one month, measure the amount of rainfall once a week (alter time depending on the amount of time your class has). Then compare the rainfall at your school with other national or international cities. Then have students calculate whether rainfall could be enough to support water needs.

Student rain log

Rainfall	Week 1	Week 2	Week 3	Week 4
Amount (inches)				

Links

Global rainfall patterns

<http://www.teachersdomain.org/resources/ess05/sci/ess/watcyc/rainfall/index.html>

Taking it further

Continue your exploration of rain by setting up a classroom rain barrel and using the rain water to water your school garden.

Materials:

- Rain barrel- Call your local public utilities company and ask where to buy a rain barrel or get one donated.

As a classroom, set up a rain barrel to collect water over time somewhere about a 10 minute walk away. Then after significant rainfall, as a classroom, choose a day to water your entire garden with water from your rain barrel. Create that day into an experience of what it might be like to walk and get your own water. Have each student bring their own water container (milk jug, water bottle, Tupperware). Then together as a class, walk to the water source as many times as needed for the day in order to have enough water to water their student garden. Then have a follow up discussion in which the students respond to the difficulty of the challenge and whether they felt protective of this precious resource. Continue to discuss what would happen if you lived in a region where water was scarce and you had to use that water to support your family for drinking as well as by growing your own food?

Water and Science (continued)

Water Uses (4th +)

Using your Water1st Water Survey, compare your water use with the Global Water Use Fact Sheet.

How much drinkable water is left for the whole world to share?

Materials:

- Two colors of paper
- White paper
- World map
- 1000 ml beaker
- 100 ml graduated cylinder
- small dish
- salt
- eye dropper
- bucket of ice

What percentage of the earth is covered with water? What percentage of that water is drinkable?

Have students work in pairs to make their estimation. Have each pair draw a circle on a white sheet of paper, representing the world. Then identify one color as drinkable (potable) water and one as non-potable. Have them tear the two colors of paper into a total of 100 pieces to fill the globe, with the amount of each color representing the amount of water of that water they think is present in the world. Have them record their estimations.

Activity: Demonstration

1. Show the class a liter (1000 ml) of water and tell them it represents all the water on the earth
2. Ask where most of the water on earth is located (refer to a world map). Pour 30 ml of the water into a 100 ml graduated cylinder. This represents the earth's fresh water, about 3% of the total. Put salt in the remaining 970ml to represent ocean water, not drinkable by humans.
3. Ask students what is at the Earth's poles. Almost 80 percent of the earth's fresh water is frozen in ice caps and glaciers. Pour 6ml of fresh water into a small dish or cylinder and place the rest in an ice bucket. The 6ml represents the non-frozen fresh water (about .6% of the total). Only about 1.5 ml of this water is surface water, the rest is underground.
4. Use an eyedropper or to remove a single drop of of water (0.003 ml). Release this one into a small metal bucket, making sure that the students hear the drop. This represents clean, fresh water that is not polluted or otherwise unavailable for use, about 0.003 % of the total water in the world.
5. Continue with a discussion of why we must care for our water and how we can care for it.

Quantity to be divided among people on Earth	Amount available Liters/person	% of total water
All the water on Earth	233.3 billion	100%
Only the fresh water (calculate 3% of the amount available)		3%
Only the non-frozen water (calculate 20% of the remaining amount available)		0.6%
Available fresh water that is not polluted, trapped in soil, too far below ground, etc. (calculate 0.5% of the remaining amount available)		.003%

Source: *The Watercourse and Council for Environmental Education 1995, Project Wet, Curriculum and Activity Guide*

Water and Science (continued)

Transmission of a Water-Borne Disease (Grade Level: 6th-12th)

Objectives

Students will be able to:

Understand essential concepts about maintaining and promoting personal health

Know essential concepts about the prevention and control of disease

Define infectious disease

Describe symptoms, mode of transmission, and causes of the disease cholera

Explain the destruction cholera had on the people living in and traveling through the West in the 1800's

Compare the cholera outbreaks of the 1800's to the 1990's

Examine the symptoms of, modes of transmission, and causes of several (selected) infectious diseases

Materials

- Background on Infectious Disease
- Highlights in the History of Microbiology
- Cholera Fact Sheet
- John Snow and the Broad Street Pump – a story of the London cholera epidemic of the mid-1800s
- The West Episode 3: My Share of the Rocks – a story of the U.S. cholera outbreak during the gold rush in the mid 1850s
- Water-related Diseases Homework Assignment

Activities

1. After reviewing the background reading on infectious disease, write the following journal prompt on the board or overhead; "Using a paragraph format, how would you describe the term infectious disease?"
2. Pair students: have them discuss their responses and come up with a definition of
3. infectious disease to share with the class.
4. Write each definition of infectious disease on the board or overhead.
5. Answer: An infectious disease is a clinically evident disease that damages or injures the host that results from the presence of one or more pathogenic microbial agents, including viruses, bacteria, fungi, protozoa, multi-cellular parasites, and aberrant proteins known as prions. These pathogens can cause diseases in both animals and plants. Transmission of an infectious disease may occur through several pathways; including through contact with infected individuals, by water, food, airborne inhalation, or through vector-borne spread. *From McGraw-Hill Encyclopedia of Science and Technology. The McGraw-Hill Companies, Inc., 2005*
6. Read "John Snow and the Broad Street Pump" or "The West"
7. Hold a class discussion on cholera. Ask students the following information about cholera (that they might have picked up from reading the John Snow or The West pieces). Write their responses on the board:
 - Is cholera an infectious disease? How do you know?
 - What are some symptoms of cholera?
 - Is cholera a potentially fatal disease? Always?
 - What conditions from the life during that time might lead to getting this disease?
8. Hand out the Cholera resource sheet and repeat the questions, this time using the information sheet with the questions: add any new information on the board next to their previous answers. They should have a bit more data using the information from the resource sheet.
9. Students will research a water-related disease and report their findings back to the class. A list of water-related diseases is attached.

Water and Science (continued)

Younger students:

What are some infectious diseases they/people they know have had? What were some of the symptoms that they had with that illness? How did they treat it? What can be done to limit the outbreak of a particular infectious disease?

Students could create a disease prevention poster. This poster should include a “tip” on how to avoid getting or spreading an infectious disease. For example, a person washing their hands with soap & warm water or someone covering their mouth as they sneeze. They could post their work in the school as reminders to other students and staff or create a class book.

Older Students:

Using the web, investigate epidemics from the past and present. Compare the past epidemics to current ones. Do any similarities exist? Are there any obvious differences. Create a class timeline of epidemics throughout history. Do any patterns emerge? How can collecting and organizing data like this help people?

Background on Infectious Disease¹



Bacteria existed long before humans evolved, and bacterial diseases probably co-evolved with each species. Many bacterial diseases that we see today have been around for as long as we have, others may have developed later. In either case, for the longest time we were not aware of the cause of infectious diseases. With the beginning of microbiology, bacterial pathogens became apparent.

Ancient man recognized many of the factors involved in disease. Early civilizations on Crete, India, Pakistan and Scotland invented toilets and sewers. Restrooms, dating around 2800 BC, have been found on the Orkney islands and in homes in Pakistan about the same time. One archaeologist has stated, "The high quality of the sanitary arrangements [in about 2500 BC] could well be envied in many parts of the world today". In Rome, 315 AD, the public lavatories were places where people routinely socialized and conducted business. Ten to twenty people could be seated around a room, with their wastes being washed away by flowing water. The Chinese used toilet paper as early as AD 589. In Europe moss, hay and straw were used for the same purpose.



The first cities to use water pipes (of clay) were in the Indus Valley of Pakistan around 2700 BC. Metal water pipes were used in Egypt (2450 BC) and the palace of Knossos on Crete around 2000 BC had clay pipes. Rome built elaborate aqueducts and public fountains throughout its empire to insure a clean supply of water for its citizens. Rome had a "water commissioner" who was responsible for seeing that the water supply was kept adequate and clean; the punishment for pollution of the water supply was death. Lead was commonly used for Roman pipes and the subsequent fall of the Roman empire has been related by some to the effects of lead on the Roman brain.

Most ancient peoples recognized that some diseases were communicable and isolated individuals thought to carry "infections." An example of this is the universal shunning of lepers, which occurs even today. When the Black Death struck Europe, entire villages were abandoned as people fled in an effort to escape the highly infectious plague. Similarly, in the Middle Ages the rich of Europe fled to their country homes when small pox struck in an effort to escape its terrible consequences. The fact that people who recovered from a particular disease were immune to that disease was probably recognized many different times in many places. Often these survivors were expected to nurse the ill. Greek and Roman physicians routinely prescribed diet and exercise as a treatment for ill.

Ancient people had certainly seen masses of microbes, such as mold and bacterial colonies, on spoiled food, but it is doubtful if anyone considered that they were viewing living organisms.

The first person to report seeing microbes under the microscope was an Englishman, Robert Hooke. Working with a crude compound mi-

Background on Infectious Disease (continued)

microscope he saw the cellular structure of plants around 1665. He also saw fungi which he drew. However, because his lens were of poor quality he was apparently unable to "see" bacteria.

Anton van Leeuwenhoek was a man born before his time. Although not the first to discover the microscope or to use magnifying lens, he was the first to see and describe bacteria. We know that he was a "cloth merchant" living in Delft Holland and that he used magnifying lens to view the quality of the weave of the merchandise he purchased. He traveled to England in 1668 to view English cloth and there he saw drawings of magnifications of cloth much greater than any of the current lens available in Holland would do.

He returned to Holland and took up lens grinding. Being meticulous, he developed his lens grinding to an art and in the process tested them by seeing how much detail he could observe with a given lens. One can guess that he chanced to look at a sample of pond water or other source rich in microbes and was amazed to see distinct, uniquely shaped organisms going, apparently purposefully, about their lives in a tiny microcosm. He made numerous microscopes from silver and gold and viewed everything he could including the scum on his teeth and his semen.

His best lens could magnify ~300-500 fold which allowed him to see microscopic algae and protozoa and larger bacteria. He clearly had excellent eyesight because he accurately drew pictures of microbes that were at the limit of the magnification of his lens. He used only single lens and not the compound lens of the true microscopes we employ today; which makes his observations all the more amazing. He wrote of his observations to the Royal Society of London in 1676 and included numerous drawings. He astonished everyone by claiming that many of the tiny things he saw with his lens were alive because he saw them swimming purposefully about. His discovery was the equivalent of our finding life on Mars today.

¹ Washington State University, Microbiology 101/102 Internet Text. <http://www.slic2.wsu.edu:82/hurlbert/micro101/pages/Chap1.html>. Date site accessed: 9/19/07

Cholera Fact Sheet ²



Cholera outbreaks can occur sporadically in any part of the world where water supplies, sanitation, food safety and hygiene practices are inadequate. Overcrowded communities with poor sanitation and unsafe drinking-water supplies are most frequently affected.

The disease and how it affects people

Cholera is an acute infection of the intestine, which begins suddenly with painless watery diarrhoea, nausea and vomiting. Most people who become infected have very mild diarrhoea or symptom-free infection. Malnourished people in particular experience more severe symptoms. Severe cholera cases present with profuse diarrhoea and vomiting. Severe, untreated cholera can lead to rapid dehydration and death. If untreated, 50% of people with severe cholera will die, but prompt and adequate treatment reduces this to less than 1% of cases.

The cause

Cholera is caused by the bacterium *Vibrio cholerae*. People become infected after eating food or drinking water that has been contaminated by the faeces of infected persons. Raw or undercooked seafood may be a source of infection in areas where cholera is prevalent and sanitation is poor. Vegetables and fruit that have been washed with water contaminated by sewage may also transmit the infection if *V. cholerae* is present.

Distribution

Cholera cases and deaths were officially reported to WHO, in the year 2000, from 27 countries in Africa, 9 countries in Latin America, 13 countries in Asia, 2 countries in Europe, and 4 countries in Oceania.

Scope of the Problem

Control of cholera is a major problem in several Asian countries as well as in Africa. In the year 2000, some 140,000 cases resulting in approximately 5000 deaths were officially notified to WHO. Africa accounted for 87% of these cases. After almost a century of no reported cases of the disease, cholera reached Latin America in 1991; however, the number of cases reported has been steadily declining since 1995.

Interventions

To prevent the spread of cholera, the following four interventions are essential:

- Provision of adequate safe drinking-water
- Proper personal hygiene
- Proper food hygiene
- Hygienic disposal of human excreta.

Treatment of cholera consists mainly in replacement of lost fluids and salts. The use of oral rehydration salts (ORS) is the quickest and most efficient way of doing this. Most people recover in 3 to 6 days. If the infected person becomes severely dehydrated, intravenous fluids can be given. Antibiotics are not necessary to successfully treat a cholera patient.

² World Health Organization Cholera Fact Sheet http://www.who.int/water_sanitation_health/diseases/cholera/en/. Date site accessed: 9/19/07

A History of Cholera Epidemics



Cholera was originally endemic to the Indian subcontinent, with the Ganges River likely serving as a contamination reservoir. It spread by trade routes (land and sea) to Russia, then to Western Europe, and from Europe to North America. Today in the United States and other wealthy countries, because of advanced water and sanitation systems, cholera is not a major threat.



- 1816-1826 - First Cholera pandemic: Previously restricted, the pandemic began in Bengal, then spread across India by 1820. It extended as far as China and the Caspian Sea before receding.
- 1829-1851 - Second Cholera pandemic reached Europe, London and Paris in 1832. In London, it claimed 6,536 victims³; in Paris, 20,000 succumbed (out of a population of 650,000) with about 100,000 deaths in all of France.⁴ It reached Russia (Cholera Riots), Quebec, Ontario and New York in the same year and the Pacific coast of North America by 1834.
- 1849 - Second major outbreak in Paris. In London, it was the worst outbreak in the city's history, claiming 14,137 lives, ten times as many as the 1832 outbreak. In 1849 cholera claimed 5,308 lives in the port city of Liverpool, England, and 1,834 in Hull, England.⁵ An outbreak in North America took the life of former U.S. President James K. Polk. Cholera spread throughout the Mississippi river system killing over 4,500 in St. Louis⁶ and over 3,000 in New Orleans⁷ as well as thousands in New York.⁸ In 1849 cholera was spread along the California and Oregon trail as hundreds died on their way to the California Gold Rush, Utah and Oregon.⁹
- 1852-1860 - Third Cholera pandemic mainly affected Russia, with over a million deaths. In 1853-4, London's epidemic claimed 10,738 lives.
- 1854 - Outbreak of cholera in Chicago took the lives of 5.5 per cent of the population (about 3,500 people).¹⁰ Soho outbreak in London stopped by removing the handle of the Broad Street pump by a committee instigated to action by John Snow.¹¹
- 1863-1875 - Fourth Cholera pandemic spread mostly in Europe and Africa.
- 1866 - Outbreak in North America. In London, a localized epidemic in the East End claimed 5,596 lives just as London was completing its major sewage and water treatment systems--the East End was not quite complete. William Farr, using the work of John Snow et al. as to contaminated drinking water being the likely source of the disease, was able to relatively quickly identify the East London Water Company as the source of the contaminated water. Quick action prevented further deaths.¹²

A History of Cholera Epidemics (continued)

- 1881-1896 - Fifth Cholera pandemic; The 1892 outbreak in Hamburg, Germany was the only major European outbreak; about 8,600 people died in Hamburg, causing a major political upheaval in Germany, as control over the City was removed from a City Council which had not updated Hamburg's water supplies. This was the last serious European cholera outbreak.
- 1899-1923 - Sixth Cholera pandemic had little effect in Europe because of advances in public health, but Russia was badly affected again.
- 1961-1970s - Seventh Cholera pandemic began in Indonesia, called El Tor after the strain, and reached Bangladesh in 1963, India in 1964, and the USSR in 1966. From North Africa it spread into Italy by 1973. In the late 1970s there were small outbreaks in Japan and in the South Pacific. There were also many reports of a cholera outbreak near Baku in 1972, but information about it was suppressed in the USSR.
- January 1991 to September 1994 - Outbreak in South America, apparently initiated when a ship discharged ballast water. Beginning in Peru there were 1.04 million identified cases and almost 10,000 deaths. The causative agent was an O1, El Tor strain, with small differences from the seventh pandemic strain. In 1992 a new strain appeared in Asia, a non-O1, nonagglutinable vibrio (NAG) named O139 Bengal. It was first identified in Tamil Nadu, India and for a while displaced El Tor in southern Asia before decreasing in prevalence from 1995 to around 10% of all cases. It is considered to be an intermediate between El Tor and the classic strain and occurs in a new serogroup. There is evidence of the emergence of wide-spectrum resistance to drugs such as trimethoprim, sulfamethoxazole and streptomycin.
- 2007 - The U.N. reported recently of a Cholera outbreak in Iraq.¹³

³ Tower Hamlets' Local History Library and Archives. <http://www.mernick.co.uk/thhol/1832chol.html>. Date site accessed: 9/19/07

⁴ Rabbani GH (1996). "Mechanism and treatment of diarrhoea due to *Vibrio cholerae* and *Escherichia coli*: roles of drugs and prostaglandins". Danish medical bulletin 43 (2): 173-85.

⁵ IBMS Institute of Biological Science

⁶ Bhattacharya SK, National Institute of Cholera and Enteric Diseases (2003). "An evaluation of current cholera treatment". Expert Opin Pharmacother 4 (2): 141-6.

⁷ Parsi VK (2001). "Cholera". Prim. Care Update Ob Gyns 8 (3): 106-109.

⁸ The Cholera Years: The United States in 1832, 1849, and 1866 by Charles E. Rosenberg

⁹ Trails of Hope: California, Oregon and Mormon Trails

¹⁰ Saha D, et al. (2006). "Single dose azithromycin for the treatment of cholera in adults". New Engl J Med 354 (23): 2452-62.

¹¹ On the Mode of Communication of Cholera (1855) by John Snow, M.D. (1813-1858) [<http://eee.uci.edu/clients/bjbecker/PlaguesandPeople/week8a.html>]

¹² "The Ghost Map" by Steven Johnson, pg. 209

¹³ "U.N. reports cholera outbreak in northern Iraq" (<http://www.cnn.com/2007/WORLD/meast/08/29/iraq.cholera/index.html>), CNN. Date site accessed: 8/30/07

Water-related Diseases Homework

Select an infectious disease from the list and research the nature of the disease and your understanding of pathogens using web-based and book resources.

Remember to record your bibliographic details as you go.

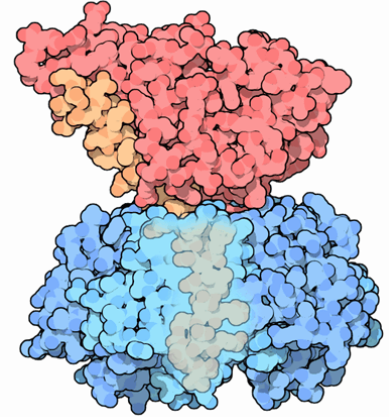
Using one of the following formats present your written report as a:

- Essay - as a survivor, a doctor, a sufferer, a relative of a sufferer, or a pathogen
- Pamphlet
- Cartoon
- Poster
- PowerPoint

Areas to be researched are :

1. Type of pathogen
 - What organism causes the disease?
 - What does the organism look like?
 - How big is it? Is it microscopic?
2. Transmission
 - How do you catch the disease?
 - Is it passed by air, touch, or other means?
3. Is it easy to catch?
 - Does it spread quickly or slowly?
 - What conditions cause it to spread
4. Course of the disease
 - What are the symptoms of the disease?
 - Does it go through definite stages? If so, what are they?
 - How long does it last?
 - Does it have any long lasting effects?
 - How serious is the disease?
5. Treatment
 - Are there any drugs used?
 - Is there a quarantine period? If so, what is its duration?
 - Is it necessary to isolate the patient?
 - Is the disease easy / difficult to treat?
6. Control
 - Is it possible to vaccinate against the disease?
 - What is the vaccine?
 - What practices can prevent the disease from spreading?

water^{1st}
INTERNATIONAL



Cholera. Illustration by David S. Goodsell of The Scripps Research Institute

Water-related Diseases Homework (continued)

7. Special features

- Are there any unusual features of this disease?
- What is the history of the disease?
- Are there any recorded epidemics?
- Are there any advances in the treatment of the disease?

List of water and sanitation related diseases to research:

Anaemia
Ascariasis
Campylobacteriosis
Cholera
Cyanobacterial Toxins
Dengue and Dengue Haemorrhagic Fever
Diarrhoea
Guinea-Worm Disease (Dracunculiasis)
Hepatitis
Japanese Encephalitis
Leptospirosis
Malaria
Onchocerciasis (River Blindness)
Ringworm (Tinea)
Scabies
Schistosomiasis
Trachoma
Typhoid and Paratyphoid Enteric Fevers

JOHN SNOW AND THE BROAD STREET PUMP ON THE TRAIL OF AN EPIDEMIC

Source: *Cricket* 31(3), pp. 23-31, Nov. 2003

By Kathleen Tuthill, Illustrated by Rupert Van Wyk

British doctor John Snow couldn't convince other doctors and scientists that cholera, a deadly disease, was spread when people drank contaminated water until a mother washed her baby's diaper in a town well in 1854 and touched off an epidemic that killed 616 people.



Dr. Snow, an obstetrician with an interest in many aspects of medical science, had long believed that water contaminated by sewage was the cause of cholera. Cholera is an intestinal disease that can cause death within hours after the first symptoms of vomiting or diarrhea. Snow published an article in 1849 outlining his theory, but doctors and scientists thought he was on the wrong track and stuck with the popular belief of the time that cholera was caused by breathing vapors or a "miasma in the atmosphere".

The first cases of cholera in England were reported in 1831, about the time Dr. Snow was finishing up his medical studies at the age of eighteen. Between 1831 and 1854, tens of thousands of people in England died of cholera. Although Dr. Snow was deeply involved in experiments using a new technique, known as anesthesia, to deliver babies, he was also fascinated with researching his theory on how cholera spread.

In the middle 1800s, people didn't have running water or modern toilets in their homes. They used town wells and communal pumps to get the water they used for drinking, cooking and washing. Septic systems were primitive and most homes and businesses dumped untreated sewage and animal waste directly into the Thames River or into open pits called "cesspools". Water companies often bottled water from the Thames and delivered it to pubs, breweries and other businesses.



Dr. Snow believed sewage dumped into the river or into cesspools near town wells could contaminate the water supply, leading to a rapid spread of disease.

CHOLERA IS PRONOUNCED
KOL-cr-uh.

CONTAMINATED MEANS
IMPURE, HARMFUL,
AND UNUSABLE.

MIASMA MEANS A BAD
ATMOSPHERE; GERMS OR
BAD SMELLS OR
POLLUTANTS IN
THE AIR.

ICK.



A SEPTIC SYSTEM
IS HOW YOU GET
RID OF SEWAGE.



In August of 1854 Soho, a suburb of London, was hit hard by a terrible outbreak of cholera. Dr. Snow himself lived near Soho, and immediately went to work to prove his theory that contaminated water was the cause of the outbreak.

“Within 250 yards of the spot where Cambridge Street joins Broad Street there were upwards of 500 fatal attacks of cholera in 10 days,” Dr. Snow wrote “As soon as I became acquainted with the situation and extent of this irruption (sic) of cholera, I suspected some contamination of the water of the much-frequented street-pump in Broad Street.”

Dr. Snow worked around the clock to track down information from hospital and public records on when the outbreak began and whether the victims drank water from the Broad Street pump. Snow suspected that those who lived or worked near the pump were the most likely to use the pump and thus, contract cholera. His pioneering medical research paid off. By using a geographical grid to chart deaths from the outbreak and investigating each case to determine access to the pump water, Snow developed what he considered positive proof the pump was the source of the epidemic.

Besides those who lived near the pump, Snow tracked hundreds of cases of cholera to nearby schools, restaurants, businesses and pubs.

According to Snow’s records, the keeper of one coffee shop in the neighborhood who served glasses of water from the Broad Street pump along with meals said she knew of nine of her customers who had contracted cholera.

A popular bubbly drink of the time was called “sherbet”, which was a spoonful of powder that fizzed when mixed with water. In the Broad Street area of Soho, that water usually came from the Broad Street pump and was, Snow believed, the source for many cases.



Snow also investigated groups of people who did not get cholera and tracked down whether they drank pump water. That information was important because it helped Snow rule out other possible sources of the epidemic besides pump water.

He found several important examples. A workhouse, or prison, near Soho had 535 inmates but almost no cases of cholera. Snow discovered the workhouse had its own well and bought water from the Grand Junction Water Works.

The men who worked in a brewery on Broad Street which made malt liquor also escaped getting cholera. The proprietor of the brewery, Mr. Huggins, told Snow that the men drank the liquor they made or water from the brewery’s own well and not water from the Broad Street pump. None of the men

A PROPRIETOR IS
THE OWNER OF
A BUSINESS.

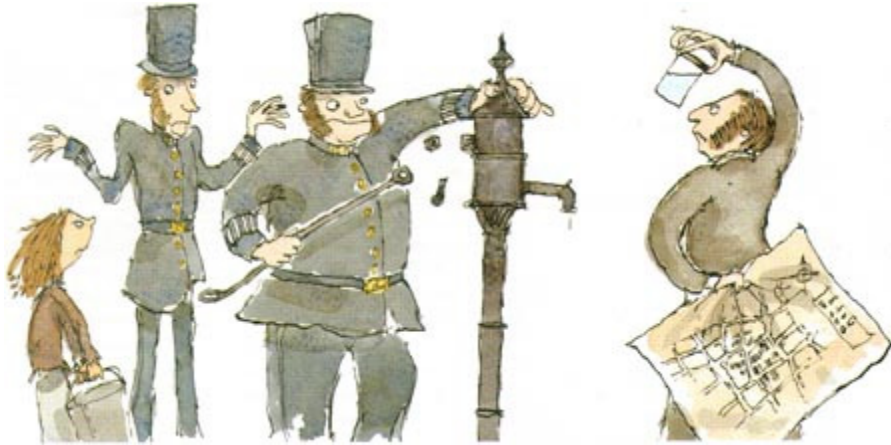


contracted cholera. A factory near the pump, at 37 Broad Street, wasn't so lucky. The factory kept two tubs of water from the pump on hand for employees to drink and 16 of the workers died from cholera.

The cases of two women, a niece and her aunt, who died of cholera puzzled Snow. The aunt lived some distance from Soho, as did her niece, and Snow could make no connection to the pump. The mystery was cleared up when he talked to the woman's son. He told Snow that his mother had lived in the Broad Street area at one time and liked the taste of the water from the pump so much that she had bottles of it brought to her regularly. Water drawn from the pump on 31 August, the day of the outbreak, was delivered to her. As was her custom, she and her visiting niece took a glass of the pump water for refreshment, and according to Snow's records, both died of cholera the following day.

Snow was able to prove that the cholera was not a problem in Soho except among people who were in the habit of drinking water from the Broad Street pump. He also studied samples of water from the pump and found white flecks floating in it, which he believed were the source of contamination.

On 7 September 1854, Snow took his research to the town officials and convinced them to



take the handle off the pump, making it impossible to draw water. The officials were reluctant to believe him, but took the handle off as a trial only to find the outbreak of cholera almost immediately trickled to a stop. Little by little, people who had left their homes and businesses in the Broad Street area out of fear of getting cholera began to return.

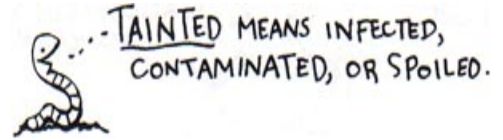
Despite the success of Snow's theory in stemming the cholera epidemic in Soho, public officials still thought his hypothesis was nonsense. They refused to do anything to clean up the cesspools and sewers. The Board of Health issued a report that said, "we see no reason to adopt this belief" and shrugged off Snow's evidence as mere "suggestions."

For months afterward Snow continued to track every case of cholera from the 1854 Soho outbreak and traced almost all of them back to the pump, including a cabinetmaker who was passing through the area and children who lived closer to other pumps but walked by the Broad Street pump on their way to school. What he couldn't prove was where the contamination came from in the first place.

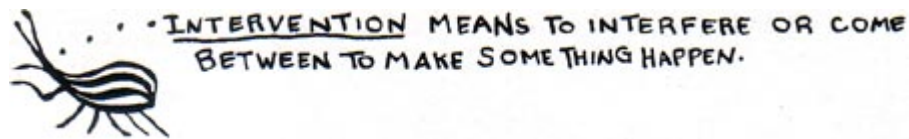
A HYPOTHESIS
IS A POSSIBLE
EXPLANATION.



Officials contended there was no way sewage from town pipes leaked into the pump and Snow himself said he couldn't figure out whether the sewage came from open sewers, drains underneath houses or businesses, public pipes or cesspools.



The mystery might never have been solved except that a minister, Reverend Henry Whitehead, took on the task of proving Snow wrong. The minister contended that the outbreak was caused not by tainted water, but by God's divine intervention. He did not find any such proof and in fact, his published report confirms Snow's findings. Best of all, it gave Snow the probable solution to the cause of the pump's contamination.



Reverend Whitehead interviewed a woman, who lived at 40 Broad Street, whose child who had contracted cholera from some other source. The child's mother washed the baby's diapers in water which she then dumped into a leaky cesspool just three feet from the Broad Street pump, touching off what Snow called "the most terrible outbreak of cholera which ever occurred in this kingdom."

A year later a magazine called *The Builder* published Reverend Whitehead's findings along with a challenge to Soho officials to close the cesspool and repair the sewers and drains because "in spite of the late numerous deaths, we have all the materials for a fresh epidemic." It took many years before public officials made those improvements.

In 1883 a German physician, Robert Koch, took the search for the cause of cholera a step further when he isolated the bacterium *Vibrio cholerae*, the "poison" Snow contended caused cholera. Dr. Koch determined that cholera is not contagious from person to person, but is spread only through unsanitary water or food supply sources, a major victory for Snow's theory. The cholera epidemics in Europe and the United States in the 19th century ended after cities finally improved water supply sanitation.

The World Health Organization estimates 78 percent of the people in Third World countries are still without clean water supplies today, and up to 85 percent of those people don't live in areas with adequate sewage treatment, making cholera outbreaks an ongoing concern in some parts of the world.



Today, scientists consider Snow to be the pioneer of public health research in a field known as epidemiology. Much of the current epidemiological research done at the U.S. Centers for Disease Control, which still uses theories such as Snow's to track the sources and causes of many diseases.



THE WEST

Episode Three (1848 - 1856)

SPECK OF THE FUTURE

THE WEST is an eight-part documentary series which premiered on PBS stations in September 1996. Episode 3 covered the years 1848 to 1856. The Gold Rush brings the whole world to the West, as 49ers from Asia, South America and the eastern states scramble for "a share of the rocks," littering the hills with mining towns and creating the West's first metropolis. This segment follows William Swain and his travels from New York to California. Along the journey, he documents the cholera outbreak he encountered along the water trail.

My Share of the Rocks

By the beginning of 1849, over 50,000 American goldseekers had decided to head for California. The only question was how to get there. Since it was impossible to go overland until spring thawed the prairies and mountain passes, the most impatient prospectors started off by sea -- 14,355 nautical miles -- all the way around the tip of South America. But most of the Americans decided to wait and go by wagon train.

April 11, 1849

All my things being ready last night, I rose early and commenced packing in my trunk, preparatory to leaving home on my long journey, leaving for the first time my home and my dear friends with the prospect of absence from them for many months and perhaps for years.

William Swain



William Swain was a twenty-seven year old farmer's son from Youngstown, New York, utterly convinced he would find riches in California. His wife, Sabrina, was against his going West. She did not know if she and their infant daughter, Eliza, could bear to be apart from him. William's older brother George was for it. If pickings were as easy as the newspapers said, he would go West, too, the following spring.

Swain's plan was to take the overland route to California, make a quick \$10,000 in the gold fields, and return home. He carried with him a guidebook to the Overland Trail, a Bible -- and his diary.

I had fortified my mind by previous reflection to suppress my emotions, as is my custom in all cases where emotion is expected. But this morning I learned by experience that I am not master of my feelings in all cases. I parted from my family completely unable to restrain my emotions and left them all bathed in tears, even my brother, whose energy of mind I never saw fail before.

William Swain

He is a farmer. He lives a simple life. He's pretty well educated. He's read Shakespeare, he's read Wordsworth. His wife is a teacher. They have a very comfortable life. They don't have anything to complain about in eighteen forty-nine. This is a key point. They did not have anything that would cause them distress. His expectations were perfectly comfortable expectations of an average family, a farming family in America. The Gold Rush changed that. Suddenly he wanted more. Suddenly he wasn't satisfied.

J. S. Holliday

April 12th, 1849

At half past two o'clock we took passage for Detroit on the steamer Arrow. The lake is very smooth, and the boat shoots along like an arrow, and as she leaves, far in the distance, objects familiar to me



and bears me on to those that are strange, I feel that she bears me and my destiny.

William Swain

April 15, 1849

Dear, dear William,

I feel as though I was alone in the world. The night you left home I did not, nor could not, close my eyes to sleep.... William, if I had known that I could not be more reconciled to your absence than I am, I never could have consented to your going. However, I will try to reconcile myself as well as I can, believing God will order all things for the best.

Sabrina



May 6, 1849

Independence, Missouri

We came up from St. Louis with a company... from Marshall, Michigan. They are got up on the joint stock principle and are going with ox teams. They proposed that we should join them by paying \$100 each into the fund, furnishing a wagon and thus becoming members of their company... which we have done.

William Swain

The members of Swain's company printed "Wolverine Rangers" on their wagons with axle grease. Other companies had their own nicknames: "Wild Yankee," "Rough and Ready," "Live Hoosier," and "Never Say Die." But in honor of the momentous year they believed would change their lives, they all proudly called themselves "'49ers."

Thirty thousand people -- that's not an exaggeration -- in the spring of 1849, take off from Independence and St. Joseph, Missouri, and travel along the Great Platte. Hundreds of miles of wagons. You can look to the west and as far as you can see on a dusty day, there are wagon trains, way off into the distance. And you turn around to look back, and they're stretched all the way back as far as you can see.

The men who traveled to California in the Gold Rush years had a conscious sense of the need to organize. There are rules. For instance, no swearing -- literally! They have constitutions, they have these rules and orders: No swearing. No drinking. We will observe the Sabbath. Many a company broke up over the argument of whether or not to observe the Sabbath. 'How can we observe the Sabbath? Here it is the middle of June, we're already behind. These people are passing us on Sunday, they're rolling. How can we sit here?' So they have arguments about it, and companies split up over the moral question of whether to observe the Sabbath or not.



J. S. Holliday

For thirty days, the Forty-niners crossed rolling prairie in what is now Kansas and Nebraska. It was Indian Territory, where tribes from the East had been relocated a decade earlier. Fears of Indian raids proved mostly groundless: men were more likely to die by drowning at a river crossing, or by an accident with their own guns, than they were at the hands of Indians. The Sac and the Fox, the Pawnees and Kickapoos, charged tolls at bridges and fords. The Potawatomis sold the emigrants bacon, beef and vegetables, and charged from one to five dollars to ferry emigrants across the Kansas River.

The real danger on the plains was cholera -- with its soaring fevers, chronic dysentery and ghastly death from dehydration. Cholera was rampant all across the United States in 1849, and quickly spread through the wagon trains. Some 1,500 of the goldseekers who set out for California that spring died from it on the trail.

Youngstown, New York

Dear Brother William,

We... were in a perfect fever of anxiety about you.... We know the cholera will be with you in crossing

the plains.... Do write as soon as you get there.

George Swain

Sabbath, May 27, 1849

In violation of our principle, we travel today on account of the sickness on the route.

May 31, 1849

I was attacked at noon by dysentery very badly. I... got Reverend Hobart to make me a composition tea.

June 1, 1849

Still taking medicine, opium and astringent powders... Today I have thought much of home and of my little girl, who is today one year old.

June 7, 1849

I am... on the gain, but very weak.... My appetite is good but I cannot eat hearty for fear of the consequences.

William Swain

On June 13th, William Swain and his companions passed Fort Kearny on the Platte River. By early July, they reached Fort Laramie, in what is now Wyoming. They had gone nearly 700 miles from Missouri. But they still had more than 250 to go before they reached South Pass, which would take them through the Rocky Mountains. And nearly 1,000 more before they actually reached the gold fields.

July 4th, Independence Day

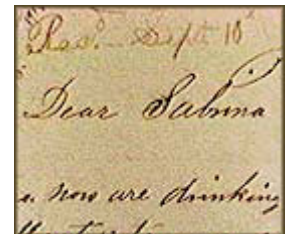
Dear Sabrina,

I have just left the celebration dinner table, where the company now are drinking toasts to everything and everybody and cheering at no small rate. I enjoy myself better in conversing with you through the medium of the pen....

I am hearty and well, far more so than when I left home.... I am also more fleshy. Notwithstanding these facts, I would advise no man to come this way to California.

Kiss my little girl for me, give my love to George and Mother, and tell them I am determined to have my share of the rocks. Your affectionate husband until death,

William Swain



Sat. Sept 10
Dear Sabrina
I am now well drinking