Microbial Risks
• The first recorded account of a “pestilence” or “plague” as it was often referred to, was in approximately 3180 BC in Egypt’s First Dynasty.
• “epidemic fevers” which was written in a papyrus ca. 1500 B.C. discovered in a tomb in Thebes, Egypt.
• “Plagues” were described and in particular associated with the decimation of the Greek Army near the end of the Trojan War (ca. 1190 B.C.) and with massive epidemics in Roman history in 790, 710 and 640 B.C.
<table>
<thead>
<tr>
<th>Medicine</th>
<th>Science</th>
<th>Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>3180 B.C. First recorded epidemic in Egypt</td>
<td>Boiling and sunlight radiation for drinking water</td>
<td></td>
</tr>
<tr>
<td>2000 B.C.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>430 B.C. Plague of Athens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>580</td>
<td>Wealth responsible for a dysentery epidemics</td>
<td></td>
</tr>
<tr>
<td>1403 Quarantine established</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1546 &quot;seminaria&quot; cause infection and epidemics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1590 Microscope invented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1676 Microscopic observation of bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1773 First description of bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1783 Ozone identified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800 Chlorine kills germs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1801 UV discovered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1849 Waterborne transmission of cholera</td>
<td>John Snow removed handle from water pump</td>
<td></td>
</tr>
<tr>
<td>1854</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1856 Fecal-oral transmission of typhoid fever</td>
<td>Chlorination of sewage</td>
<td></td>
</tr>
<tr>
<td>1859</td>
<td></td>
<td></td>
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<tr>
<td>1876 Germ theory by Robert Koch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1881 Culture plate technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1884 Salmonella typhi identified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1884 Vibrio cholerae identified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1893 Ozonation of drinking water</td>
<td></td>
<td></td>
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<tr>
<td>1896 Chlorination of drinking water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1901 UV for drinking water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1903 Typhoid Mary, asymptomatic carrier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1914 Largest bacterial water study</td>
<td></td>
<td></td>
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<tr>
<td>1932 Electron microscope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1949 Photoreactivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1952 Cell culture for producing viral plaques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1967 Gamma radiation of DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987 Polymerase chain reaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990 Cholera epidemic in Americas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993 Largest waterborne cryptosporidiosis outbreak in Milwaukee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dr. John Snow
Father of Epidemiology
First Examined Waterborne Cholera in London and the Broad Street Pump

- 1857
- Dr. Snow was 44 years old

From a contemporary print in the Pepysian Collection
Carts full of dead to bury.

• SCIENCE HERO: ROBERT KOCH

• 1876 Robert Koch worked in Germany (1876).
• 1883 Led an expedition to India and Egypt and discovered the cause of Cholera - *Vibrio cholerae*

First to grow bacteria in colonies in 1890.
on potato slices and his pupil "Petri"
on solid gelatin media.

• Koch’s postulates formulated
The microbe must be present in every case of the disease.

The microbe must be isolated from the diseased "host" and grown in a pure culture.
The disease must be reproduced when a pure culture is introduced to a non diseased susceptible "host."

The microbe must be recoverable from an experimentally infected host.
Disease Definitions

Disease: an impairment of health or a condition of abnormal functioning

Infection: Invasion by and multiplication of pathogenic microorganisms in a bodily part or tissue, which may produce subsequent tissue injury and/or impairment.

Epidemic: Spreading rapidly and extensively by infection and affecting many individuals in an area or a population at the same.

Outbreak: a sudden increase in disease over a short amount of time usually due to a common exposure.

Outbreak Definition
An outbreak of gastroenteritis is defined as three or more residents from a single ward or unit, or 3% or more of the entire facility.

Epidemiology: The branch of medicine that deals with the study of the causes, distribution, and control of disease in populations.
Person to Person: Direct contact, Sexual transmitted diseases
Close proximity; includes airborne-respiratory eg. TB; fecal-oral eg. Hepatitis A. Contaminated hands may play a role; cold virus.
Foodborne and Waterborne (recreation and drinking): Associated with contamination, generally fecal in origin, so fecal-oral in nature. BUT have microbes like *Legionella*, naturally occurring hazards eg *Vibrio vulnificus*
Vectorborne: diseases spread through contact with infected insects and animals, mosquito, ticks, eg. Malaria; Dengue Virus.
Zoonotic transmission: Spread from animals to humans, anthrax; Hantavirus; *E.coli* 0157H7, *Cryptosporidium*, *Giardia*.
Environmental transmission: Water, soil, air, surfaces, letters. Many times fecal-oral agents.
Percentage of Disease Due to Transmission Route

- Animal to Human
- Person to Person
- Aerosols
- Food
- Fomite
- Recreation
- Drinking Water
THE KILLER GERM

It’s turning up everywhere: in your water, your food, the pool.
How to protect yourself from E. coli
GOOD LORD, JENKINS, DON'T OPEN IT! REMEMBER THE CURSE OF MILWAUKEE!!
E. coli Death Toll Rises
Over 750 People Sickened in N.Y., Two Die

Hog Waste Polluting Water

Environmentalists, Hog Industry Continue to Battle

The hog industry brings in $1.3 billion in North Carolina. But the hogs produce a staggering 37 billion gallons of toxic waste, which festers in thousands of lagoons, or pools. (ABCNEWS)
They hoped it wouldn’t happen here, then it did. Now U.S. officials are rewriting rules and assuring consumers that beef won’t make them sick. Food safety’s uncertain future.

MAD COW: WHAT’S SAFE NOW
The new food labels are a bit more candid, but don't let that scare you.
FDA and the State of California announced October 12 that the test results for certain samples collected during the field investigation of the outbreak of *E. coli* O157:H7 in spinach are positive for *E. coli* O157:H7. Specifically, samples of cattle feces on one of the implicated ranches tested positive based on matching genetic fingerprints for the same strain of *E. coli* O157:H7 that sickened 204 people.
Water banned, dozens taken ill

Eagle Harbor sickness
Clay County and state officials yesterday confirmed more cases of an

By Beau Halton
Times-Union staff writer

About 2,500 people have been...
1,800 infected; water park blamed

- Reports of diarrheal disease began in June, New York officials say
- From Debra Goldschmidt
  CNN

- Saturday, August 20, 2005; Posted: 10:52 p.m. EDT (02:52 GMT)
- NEW YORK (CNN) -- Nearly 1,800 people from 20 New York counties have reported symptoms of a gastrointestinal illness related to a water attraction at Seneca Lake State Park in upstate New York, according to the New York State Department of Health and New York State Parks Department.
Signs and tape warn visitors to stay out of the bacteria-infested water in Huntington Beach.

Only bacteria ride waves in ‘Surf City, USA’.
"I adore the beauty and tranquillity of these raw-sewage days."
Sewage Sinking Florida Waters
Marine Environment Stretched to Limits

By Warren Richey
The Christian Science Monitor

Pollution Still Mars Beaches
Some States Lack Monitoring

Gayle Taylor, health director for the Shoalwater tribe in Washington, worries about agricultural runoff flowing into Willapa Bay. (Peter Mumford/ABCNEWS.com)
Why would anyone want to vacation in a giant litter box?
**Rapid Response to New Threats...**

- Coronaviruses
- Potentially zoonotic
- Excreted in feces and mucus and respiratory droplets
- Survives in the Environment but range is not known

- Infectivity unknown, appears to be significant
- Excretion high numbers >1 million
- High mortality

Evidence of some environmental Transmission associated with feces/surfaces and water. Only few papers on Disinfection.
ARLINGTON, Virginia: A hotel near a Washington, D.C., airport was closed for cleaning after as many as 150 guests were sickened by the highly contagious norovirus, hotel and county health officials said.
WATERBORNE PATHOGENS: THE CHANGING FOREGROUND

VIRAL DIARRHEAS

CHOLERA

OTHER BACTERIAL INFECTIONS

HEPATITIS F

PROTOZOAL DIARRHEAS

DYSENTERY

HEPATITIS A

TYPHOID
THE CHANGING FOREGROUND (cont’d..)

CHOLERA
VIRAL DIARRHEAS
TOXOPLASMA
DYSENTERY
CRYPTOSPORIDIUM

TYPHOID
ENVIRON, MYCOBACTERIA
HEPATITIS A
Coxsackie viruses and Noroviruses
Societal Changes with Known or Potential Impact on Exposure and Susceptibility to Infectious Agents

- INCREASING DRUG RESISTANCE
- WATER POLLUTION & OVERUSE
- AIR CONDITIONING & RECYCLING
- GLOBAL WARMING
- IMPACT OF TECHNOLOGY
- SHORTER HOSPITAL STAYS & MORE HOMECARE
- CHANGING DEMOGRAPHICS
- TERRORISM, WARS & POLITICAL UPHEAVALS
- INCREASING IMMUNOSUPPRESSION
- CHANGES IN FOOD PRODUCTION
- INCREASING/FASTER TRAVEL & TRADE
- INCREASING URBANIZATION
- INCREASING GROUPING OF SUSCEPTIBLES
- CHANGING COOKING & EATING HABITS

INFECTIONS

CHANGING LIFE-STYLES

INFECTIONS
Emerging Biological Hazards

- Viruses, prions, bacteria, and protozoa are more likely than fungi or helminths to be associated with emerging infections.
- Zoonotic pathogens comprise 75% of emerging infectious diseases.
- Pathogens which are subject to relatively frequent mutation or genomic reassortment events (e.g. RNA viruses and viruses with segmented genomes) are more likely to emerge.
- Pathogens which infect multiple hosts or pathogens that infect species that can harbour multiply closely related agents providing an opportunity for reassortment or recombination (e.g. SARS in cats) are likely to emerge.
- Agents transmissible by more than one route or by indirect contact, e.g. water, food, environmental contamination, vectors, etc, are likely to emerge.
Enteric Microorganisms

- **Viruses**
  - rotavirus
  - coxsackievirus
  - echovirus
  - calicivirus
  - norovirus
  - Hepatitis A and E

- **Bacteria**
  - *E.coli*
  - *Salmonella* spp.
  - *Shigella* spp.
  - *Aeromonas hydrophila*
  - *Campylobacter jejuni*

- **Protozoa**
  - *Cryptosporidium parvum*
  - *Giardia lamblia*
Why Are New Infectious Diseases Emerging?

- Population growth, rapid global travel times
- Urbanization, poverty, overcrowding
- Inadequacy of public health infrastructures
- Changes in ecology and climate
- Evolution of microbes ANTIBIOTIC resistance
- Globalization of the food market
- Changes in domestic animal practices
EMERGING DISEASE OUTCOMES

polyomaviruses

*Helicobacter pylori*

Blue Green Algae toxins

*Coxsackievirus*

*Toxoplasma*

Carcinogens

Teratogens (Birth Defects)

Hepatogens (Liver Damage)

Hepatitis A

Hepatitis E
Endocrine Disrupters

Coxsackie virus
  - orchitis

Yersinia enterocolita
  - Grave’s Disease

Giardia lamblia
  - hypothyroidism

Heliobacter pylori
  - atrophic thyroiditis (?)
Persistent Biological Hazards

- Viruses, bacteria, and protozoa are excreted in high concentrations in feces and urine.
- Parasites and viruses are robust, survive in environmental waters and survive water treatment processes particularly wastewater treatment.
- These waterborne agents have high potency (non-threshold dose-response, one organism has some probability of causing an infection).
- Viruses as colloids are readily transported in the subsurface.
- Bacteria are able to amplify (grow) in environmental waters.
Senators: EPA should coordinate with Homeland Security

Info on poisoning water found on terrorist suspects

Flights over NYC reservoir causing concern

Scientists test speedy E.coli sensor

WATER, WASTEWATER SECURITY WARNING SYSTEM BEING DEVELOPED UNDER AMWA

Water security good, but not infallible

Feds say al Qaeda studying water plants

Officials: High water safety standards needed
HOME LAND SECURITY ISSUES

- Water and Food Quality: What contaminants, What concentrations and What Harm?
- Real-time monitoring: Smart Sensors
29 Jan 2002

• The president said the United States and its allies must prevent governments that sponsor terror from spreading their weapons of mass destruction.
• To pursue this policy, Bush said he is requesting the largest increase, about $50-billion, in defense spending since the Reagan administration.
• Supplemental funding to EPA $175.6 million for science and technology
• Vulnerability assessments of drinking water, 120 million to protect again chemical biological or radiological attacks.
BioTerrorism Preparedness Act

• Includes issues associated with Biological Weapons
• Includes Food Safety and Security
• DOES NOT INCLUDE a Section on Water Security.
What are Biological Weapons?

- Infectious agents or biological toxins which can be produced in large amounts, purified, stored and delivered to large population.
- Historically most have been weaponized for aerosol dispersion as inhalation causes more severe outcomes.
Numbers Associated with Terrorism

- 104 incidents in U.S. in 1999
- 678 since 1900
- 85 Hoaxes
- 81 of these involved Anthrax
- Over half (55%) of all incidents involve BW
## Incidents of Terrorism

<table>
<thead>
<tr>
<th>Agent</th>
<th>Numbers</th>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthrax</td>
<td>83</td>
<td>81 U.S./ 1 middle east</td>
</tr>
<tr>
<td>Tear Gas</td>
<td>27</td>
<td>8 Europe/8 U.S./4 Asia/2 MidE&amp; Latin Am.</td>
</tr>
<tr>
<td>Cyanide</td>
<td>7</td>
<td>3 A/2 Latin Am/2 U.S.</td>
</tr>
<tr>
<td>HIV</td>
<td>4</td>
<td>1 Asia/1 Europe/1 Latin Am./1 Canada</td>
</tr>
<tr>
<td>Sarin</td>
<td>2</td>
<td>1 U.S./1 Asia</td>
</tr>
<tr>
<td>Ricin</td>
<td>1</td>
<td>U.S.</td>
</tr>
</tbody>
</table>
THREATS AND HOAXES

• Several hundred incidences have been documented around the world.
• Over 50% in the U.S.
• For BW mostly anthrax, letters and surface contamination
Characteristics of Category A Agents

- Easily disseminated or person to person transmission
- High mortality
- Public panic and social disruption
- Requires special public health preparedness
Biological Agents
Category A

- Anthrax
- Smallpox
- Plague
- Botulism
- Tularemia
- Hemorrhagic Fever
Botulism

- Clostridium botulinum
- Afrebrile, excess mucus in throat, weakness, dizziness, impaired speech, paralysis
- Inhalation 12 hr to 3 days, ingestion 2 to 8 days.
Plague

- *Yersina pestis*
- High fever, cough, chest pain, vomiting, nausea, headache,
- Skin lesions, respiratory failure in 1 to 6 days.
- 2 to 3 days, through aerosol droplets
SmallPox

- Variola Virus
- Fever, malaise, vomiting, nausea, headache,
- Skin lesions, 2 to 4 days
- 12 to 14 days, through aerosol droplets
Anthrax

• Bacterium, Bacillus anthracis, spore forming
• Produces a toxin
• Natural disease of hooved animals
• Forms of the disease: pulmonary, gastrointestinal and cutaneous.
Anthrax
Pulmonary Symptoms

• Flu-like
• Fever, fatigue, muscle aches, cough, headache
• Respiratory failure and shock.
• Incubation time 1 to 6 days on avg.
Anthrax
Cutaneous Symptoms

- Intense itching
- Papular lesions followed by vesicular lesions
- Possible septicemia and death.
- Incubation time 1 to 12 days on avg.
Anthrax
Gastrointestinal Symptoms

• Abdominal pain, nausea and vomiting
• severe diarrhea, GI bleeding and fever
• Mortality up to 20% or greater
• Incubation time highly variable.
Anthrax

- Weaponized and used by Japan in WWII, to contaminate food and water.
- Developed for Aerolization delivery by Iraq and others.
Viruses

- Biological nano particles
- Obligate parasites, need a host to replicate
- Generally very host-specific
- Simple structure, RNA or DNA, surrounded by protein coat and some containing lipids and other glycoproteins.
Animal Virus Structure

Capsid

DNA

Spikes

Figure 2
Enteric viruses

- Coxsackievirus most often isolated from water including drinking water
- 125 million cases & 4 to 5 million deaths in the world due to rotavirus.
- not completely removed by domestic sewage treatment
- New viruses now detected with Integrated Cell culture PCR
Adenoviruses, respiratory and enteric, higher numbers, greater resistance to uv disinfection which is being used more throughout the world for wastewater and water. Assessment of coxsackie viruses, as most prevalent. Identification of Cancer causing viruses Polyomaviruses in Wastewater. Norovirus strains emerging and rapidly spreading throughout the world. Bird flu cases jumping from birds to people Foot and Mouth disease spreading in Cattle.
Hepatitis E virus

- 79,000 cases in Kanpur in 1991 due to sewage contaminated drinking water, 30% death rate in pregnant women.
- Illness rates peak in autumn for temperate areas
- Illness in tropical or monsoon areas peaks during flooding associated with rainy season
Geographic Distribution of Hepatitis E
Outbreaks or Confirmed Infection in >25% of Sporadic Non-ABC Hepatitis
Settings of 348 Outbreaks of NLV Gastroenteritis reported to the CDC, Jan. 1996 - Nov. 2000

- Foodborne: 39%
- Waterborne: 3%
- Person-to-Person: 12%
- Unknown: 18%
- No Data: 28%
## ESTIMATED NUMBER OF CASES OF NORWALK-LIKE VIRUSES PER YEAR

<table>
<thead>
<tr>
<th>ROUTE</th>
<th>CASES</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>6,900,000</td>
<td>Mead et al., 1999</td>
</tr>
<tr>
<td>Recreational Water</td>
<td>6,900,000</td>
<td>U.S. Census, 2000</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>3,584,000</td>
<td>Haas et al., 1999</td>
</tr>
<tr>
<td>Other</td>
<td>5,616,000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>23,000,000</td>
<td>Mead et al., 1999</td>
</tr>
</tbody>
</table>
Cruise Ship Outbreaks on the Rise

- gastroenteritis outbreaks per 1,000 cruises increased overall from 0.65 in 2001 to 5.46 in 2004
- Crew 1.5-3% attack rates
- Passengers 5 to 19% attack rates
Protozoan Pathogens

• Obligate intracellular parasites
• All cause flu-like symptoms and diarrhea
• Frequently isolated from AIDS patients with chronic diarrhea
• Extremely resistant to current disinfection practices
Cryptosporidium

- 16 drinking water outbreaks in the U.S. since 1985. Largest outbreak in Milwaukee, WI 1993 400,000 cases 100 deaths
- 7 outbreaks, globally in 1998
- 3 outbreaks, globally in 1999
- 53% outbreaks in drinking water
- No treatment for the disease, risk of mortality 50 - 60% in immunocompromised population
Cryptosporidium

• Surface water occurrence: 4 - 100%
  0.1 - 10,000/100 L

• Ground water occurrence: 9.5 - 22%

• Oocysts are extremely resistant to disinfection
Life Cycle of Cryptosporidium

Host ingests oocyst

Animal reservoir

Genotype I restrictive to human to human transfer

Genotype II

Obligate intracellular parasite
Cyclospora

- Recently described protozoan parasite
- Single celled coccidian protozoan
- Oocysts are non-infectious when excreted
- Sporulation takes place in the environment
Cyclospora cayetanensis

Sporulation

Day 0  Day 5  Day 10  Rupture
Cyclospora

• 1996: 1,465 cases in 20 states in the U.S. and the Canadian provinces of Ontario and Quebec associated with suspected contaminated raspberries

• 1997: 1,450 cases in 9 states in the U.S. All cases related to the consumption of contaminated produce from a world market
New Emerging Bacterial Pathogens

Proteobacteria

A. Campylobacter

B. Arcobacter

C. Helicobacter

D. E.coli 0157H7

At the moment most species of this family are considered of great concern of public health which are most common human enteric pathogens causing acute bacterial diarrhea and ulcer.

• *Helicobacter pylori*, a microorganism included in EPA’s Contaminant Candidate List (CCL) in groundwater used as drinking water supplies (Federal Register 2004).
Walkerton, Ontario Outbreak (occurred in small community using ground water).

Source: Application of Animal Waste/Manure Monitoring and Disinfection not addressed.

2300 CASES 7 DEATHS 27 CASES of HUS

5 years later community still suffering.
E. coli 0157:H7

- Enteropathogenic strain of E. coli
- Serious waterborne outbreaks
- 243 cases, 32 hospitalizations, 4 deaths
- Water main repair with sewage overflow contamination, 1987
- Groundwater supplying Fairgrounds in NY 750 cases, 2 deaths, 1999
- Walkerton, groundwater, ~1000 cases, 6 deaths, 2000
**E.coli 0157:H7**

**Health Effects**

- Children and the elderly at greatest risk
- Severe bloody diarrhea
- Hemolytic uremic syndrome
- Kidney failure
- Death
Ulcers From Drinking?

RAH RICHARDSON

Water, that is. Ulcers are caused by a bacterial infection, and in one region of Colombia, at least, the bug is in the water supply.
The WHO has classified *H. pylori* as a Class I carcinogen because of the association of *H. pylori* and gastric malignancies.

German group, Rolle-Kampczyk et al. (2004) found a significant correlation between well water contaminated with *H. pylori* detection by PCR and colonization status in humans.

Water supplies contaminated with fecal material may be a potential source of *H. pylori* transmission (Hulten et al., 1996).
EPIDEMIOLOGY

Map showing percentages of population infected with H. pylori as determined by epidemiological studies

30-50% of the world's population are colonized with it

Source: Helicobacter Foundation website: [www.helico.com](http://www.helico.com)
Analysis of VacA gene of *H. pylori* Vs Samples

No. of *H. pylori* / 50 ml samples

Raw water from waste water treatment plant at different period of time
Campy and new emerging bacteria associated with ground water

- *Campylobacter jejuni* is a major cause of human bacterial enteritis.
- Source of transmission of *C. jejuni* to humans occurs via contaminated water, poultry, shellfish and milk.
- *Arcobacter spp* have been associated with cases of human enteritis and abortion in livestock.

Because of their phylogenetic proximity, transmission mechanisms that have been described for *C. jejuni* may be applicable to *Helicobacter* and *Archobacter spp* (Wesley V.I., 1997)
Campy and new emerging bacteria associated with ground water

- *Campylobacter jejuni* is a major cause of human bacterial enteritis.
- Source of transmission of *C. jejuni* to humans occurs via contaminated water, poultry, shellfish and milk.
- *H. pylori* is the most common chronic bacterial infection to occur in humans which leads to gastric cancer.
- Arcobacter spp have been associated with cases of human enteritis and abortion in livestock.

Because of their phylogenetic proximity, transmission mechanisms that have been described for *C. jejuni* may be applicable to *Helicobacter* and *Archobacter* spp (Wesley V.I., 1997)
TOLEDO, Ohio -- Widespread groundwater contamination on a Lake Erie resort island was the likely source of illnesses that sickened hundreds last summer, the Ohio health department said Tuesday.

Several sources, including septic tanks, have tainted the South Bass Island's groundwater over a long period, and the contamination may have been worsened last summer because of a season of heavy rains, a health department report said.

The outbreak of gastrointestinal illness sickened about 1,400 tourists and residents, ending the tourist season early for many businesses.
Percentage of Wells Positive for Fecal Indicators

8% contained Adenovirus DNA
61% of the Wells contained Arcobacter

- formerly classified as a *Campylobacter*
- aerotolerant, & are able to grow at 15 °C
- higher prevalence than *Campylobacter* spp. in a S. African environmental & drinking water survey
- Diseases caused: enteritis, septicemia (blood poisoning) & colitis
- Emerging foodborne and waterborne pathogen

Photo courtesy: Craig Taylor & Carl Wirsen, WHOI
Cyanobacteria

• Blue green algae, carry hepatotoxins and neuronotoxins, can cause allergic reactions
• outbreaks: 101 ill, 50 deaths associated with dialysis patients in Brazil (1996)
• gastrointestinal outbreaks in Australia and Zimbabwe [in China suspect as a cause of liver cancer]
What is Microcystin?

• Hepatotoxin
• Cyclic Heptapeptide
• Produced by *Microcystis*, *Anabaena* and *Oscillatoria*
• ~65 known variants
• Microcystin-LR – most common variant
• World Health Organization (WHO) 1 µg/L (1000 ng/L) – recommended guideline
Algae poisons lurk in Florida drinking water

Algae facts:
Most algae are simple plants, with no roots, stems or leaves. However, blue-green algae, called cyanobacteria, are.

Toxins are being unleashed by algae into some treated water. Scientists are unsure of the long-term health threat.

By RAMSEY CAMPBELL and ROBERT SARGENT JR.

Toxins:
- Microcystin
- Produced by several types of algae, including Microcystis (above left) and Anabaena.
- Can cause tumors.
TB an Ancient Disease

Active Tuberculosis is presented as “The presence of *Mycobacterium tuberculosis* infection with a positive chest X-ray. Treatment of active tuberculosis is mandatory by law in the US.”. The presence of the bacilli in the sputum is also indicative of infection and disease.
In the development of tuberculosis, the initial infection is usually self-limited, such that no clinical symptoms of illness are observed. The bacteria can stop replicating (become dormant) but remain viable in the lungs. This dormant stage can be termed latent tuberculosis. If the initial infection is not treated with antibiotics, these dormant bacteria can reactivate years later and cause clinical disease.
The usual statistics cited are that among those infected and not treated with antibiotics, 5% develop clinical disease within the first two years of infection, and another 5% develop clinical disease at some point in their remaining lifetimes subsequent to the first two years.
REPORTED CHOLERA BY 1995-2005
WATERBORNE DISEASE OUTBREAKS

Reported

Unreported
Individual is ill goes to Doctor or clinic. Community level, must see above background.

Diagnosis made on symptoms

Correct Lab tests are available and requested

Results are documented and reported at State level.

Data are assessed for why or how disease is occurring?
Outcomes of infection process for quantification

Exposure → Infection → Asymptomatic infection

Chronic Disease → Acute symptomatic illness

Infections: mild to moderate

Reactive days loss from work

Arthritis, health care costs

Myocarditis, sensitive populations

Arthritis, health care costs

Mortality → hospitalizations

Myocarditis, sensitive populations

Cancer
Health outcomes associated with E. coli 015H7 infections during a foodborne outbreak

Exposure through burgers
Asymptomatic infections
infection rate?

55 developed HUS 7.86%

700 illness
Acute symptomatic illness, mild to moderate 95% w/bloody diarrhea, lasting 6 to 8 days

Sensitive populations mostly children

Mortality: 4 died (0.57%)

Hospitalizations: 195 (28%)
Exposure to muffins (12) potentially 45 exposed

Chronic Infections: none evaluated

Infection 12/12

Disease 12/12 (100%)

Asymptomatic Infection not evaluated

Acute Symptomatic illness moderate 5/12 (42%) visited the emergency room

Mortality none

Hospitalization 4/12 (30%)

Sensitive Populations
Exposure to lettuce total ?? potentially infected 4,081

Chronic Infections: none evaluated 1% (11 cases) secondary transmission

Infection 74 stools +/-231 for employees (32%)

Disease 692 cases 53% attack rate 39/74 ill employees

Asymptomatic Infection 19/74 (26%)

Acute Symptomatic illness mild (16/74 with only 1 symptom)

Hospitalization 45/692 (6.5%)

Sensitive Populations

Mortality none
Sensitivity of Epidemiology in Detecting Risks of Regulatory Concern

Excess Risk

1 in 10
1 in 100
1 in 1000
1 in 10,000
1 in 100,000

Exposure Assessment

ppt  ppb  ppm  %

Clinical observation
Most epidemiologic studies
Largest epidemiologic studies
Extrapolation from animal studies
Infectious Disease

- How does one assess the risk of disease spread a priori?
- What is the role of the environment?
- What is the role of sanitation and hygiene in the modern world?
- Can better approaches be used to “clean” and prevent transmission?
- What is the risk of national or global epidemics?
- How can one assess and control bioterrorism?
Methods and Microbes

- No method for concentration and detection is 100% efficient
- Microbes are individual particulates not solutes, and are not necessarily evenly distributed in a given media (air, water, soil)
- Concentrate; Purify; Separate
- Detect & Quantify (culture, microscopic, indirect)
- Determine viability (CULTURE)
- Determine Hazard (carrying virulence genes)
Methods and Microbes

- Culture: Cell growth on media; virus growth in cell culture
- CFU for bacteria
- PFU for viruses
- Microscopic counts Cysts for Giardia, oocysts for Cryptosporidium
- Indirect Detect proteins or DNA
- QUANTITATIVE: Actual counts (eg. quantify cells, colonies, plaques, numbers of genomes)
- QUALITATIVE: Presence/Absence (can estimate number with Most Probable Number)