Microbes and Disease

Joan B. Rose Ph.D.

Michigan State University

Microbial Risks

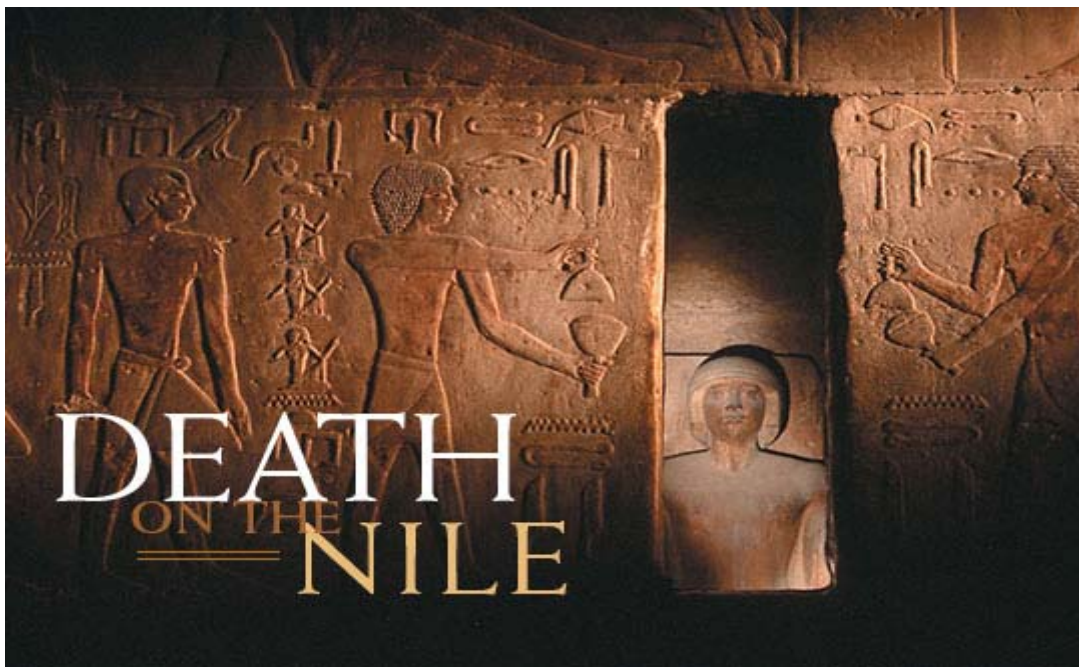
PLAGUES

CONTAGION

EPIDEMICS

OUTBREAKS

- 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

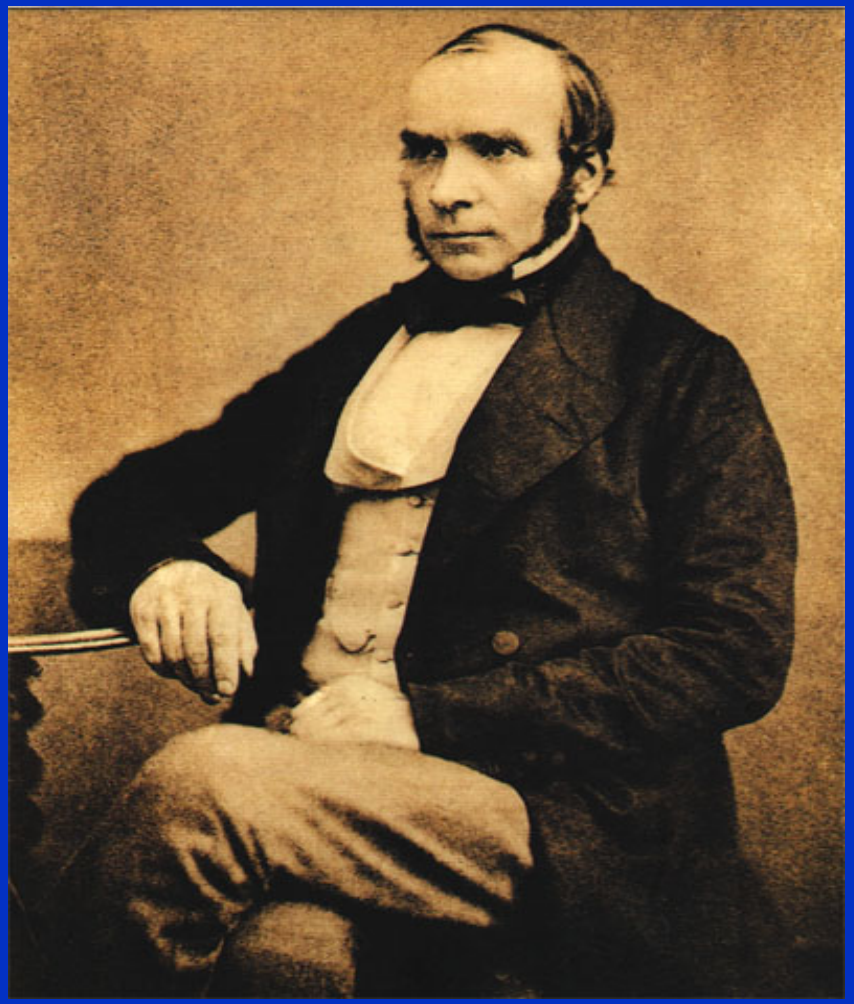


	Medicine	Science	Engineering
3180 B.C.	First recorded epidemic in Egypt		
2000 B.C.			Boiling and sunlight radiation for drinking water
430 B.C.	Plague of Athens		
580		Wealth responsible for a dysentery epidemics	
1403	Quarantine established		
1546	"seminaria" cause infection and epidemics.		
1590		Microscope invented	
1676		Microscopic observation of bacteria	
1773		First description of bacteria	
1783			Ozone identified
1800			Chlorine kills germs
1801			UV discovered
1849	Waterborne transmission of cholera		
1854			John Snow removed handle from water pump
1856	Fecal-oral transmission of typhoid fever		
1859			Chlorination of sewage
1876		Germ theory by Robert Koch	
1881		Culture plate technique	
1884		*Salmonella typhi* identified	
1884		*Vibrio cholerae* identified	
1893			Ozonation of drinking water
1896			Chlorination of drinking water
1901			UV for drinking water
1903	Typhoid Mary, asymptomatic carrier		
1914		Largest bacterial water study	
1932		Electron microscope	
1949		Photoreactivation	
1952		Cell culture for producing viral plaques	
1967		Gamma radiation of DNA	
1987		Polymerase chain reaction	
1990	Cholera epidemic in Americas		
1993	Largest waterborne cryptosporidiosis outbreak in Milwaukee		

Dr. John Snow

Father of Epidemiology

First Examined Waterborne Cholera in London and the Broad Street Pump



- **1857**
- **Dr. Snow was 44 years old**

- John Snow, Photograph, 1857. Wellcome Historical Medical Museum and Library, London **in** Gordis L. *Epidemiology*, WB Saunders, Philadelphia, 1996.

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

source: E. P. Wilson, *The Plague in Shakespeare's London,* (Oxford, 1927), p 149

- **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.
Gastroenteritis Outbreaks in Long Term Care Facilities B. 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.

Disease Transmission

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.

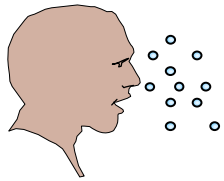
Zoonotic transmission: Spread from animals to humans, anthrax; Hantavirus; *E.coli* 0157H7, *Cryptosporidium, Giardia*.

Environmental transmission: Water, soil, air, surfaces, letters. Many times fecal-oral agents.

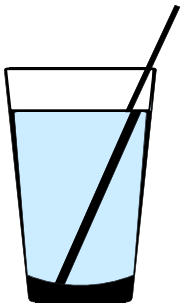
Percentage of Disease Due to Transmission Route

Animal to Human

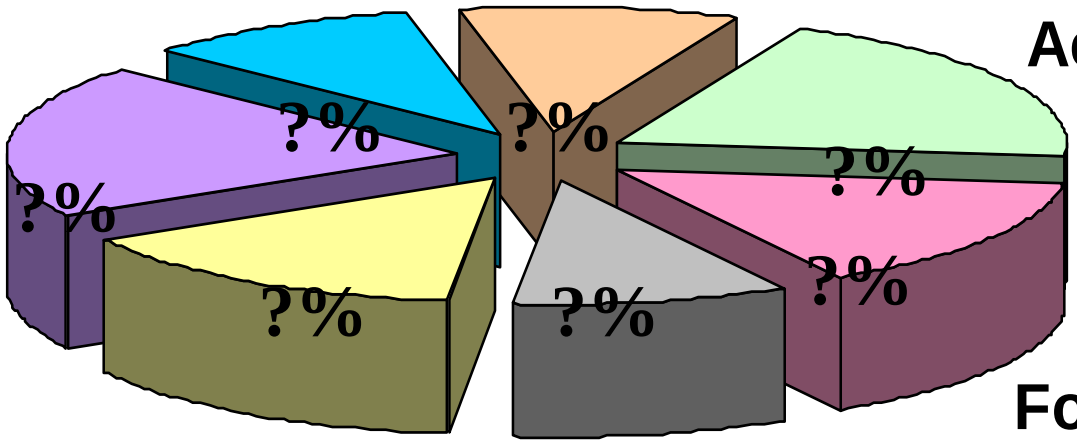
Person to Person



Aerosols



Drinking Water



Food

Fomite

Recreation


TIME
WILL CLINTON TESTIFY?
THE CAPITOL HILL GUNMAN
THE KILLER GERM
It's turning up everywhere: in your water, your food, the pool. How to protect yourself from
E.COLI


TALES FROM THE CRYPT
GOOD LORD, JENKINS, DON'T OPEN IT! REMEMBER THE CURSE OF MILWAUKEE!!
H_2O
CARLSON

E. coli Death Toll Rises

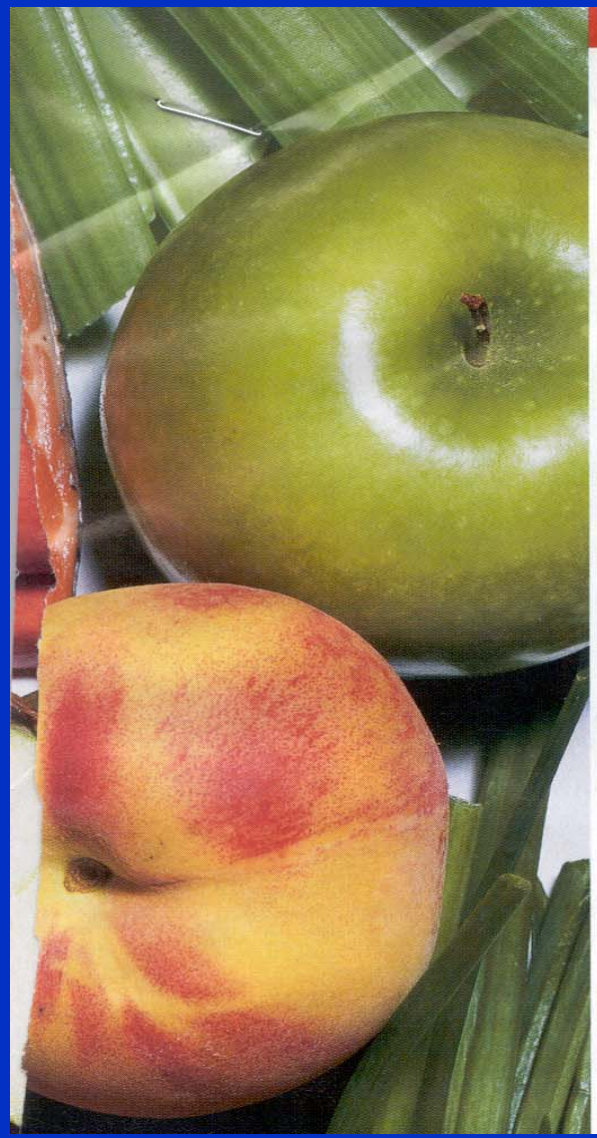
September 12. 1999

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)



Health

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


MEATS
THE NEW FOOD LABELS ARE A BIT MORE CANDID, BUT DON'T LET THAT SCARE YOU.
PREPARE TO DIE
KIRK
'72

- FDA Home Page | CFSAN Home | Search/Subject Index | Q & A | Help
- **September 16, 2006; Updated October 20, 2006**
- **Nationwide *E. Coli* O157:H7 Outbreak: Questions & Answers**

- **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.**

Times-Union ★★★ E

ober 23, 1996 131st Year — Number 297 — 4 Sections — 44 P

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 be

1,800 infected; water park blamed

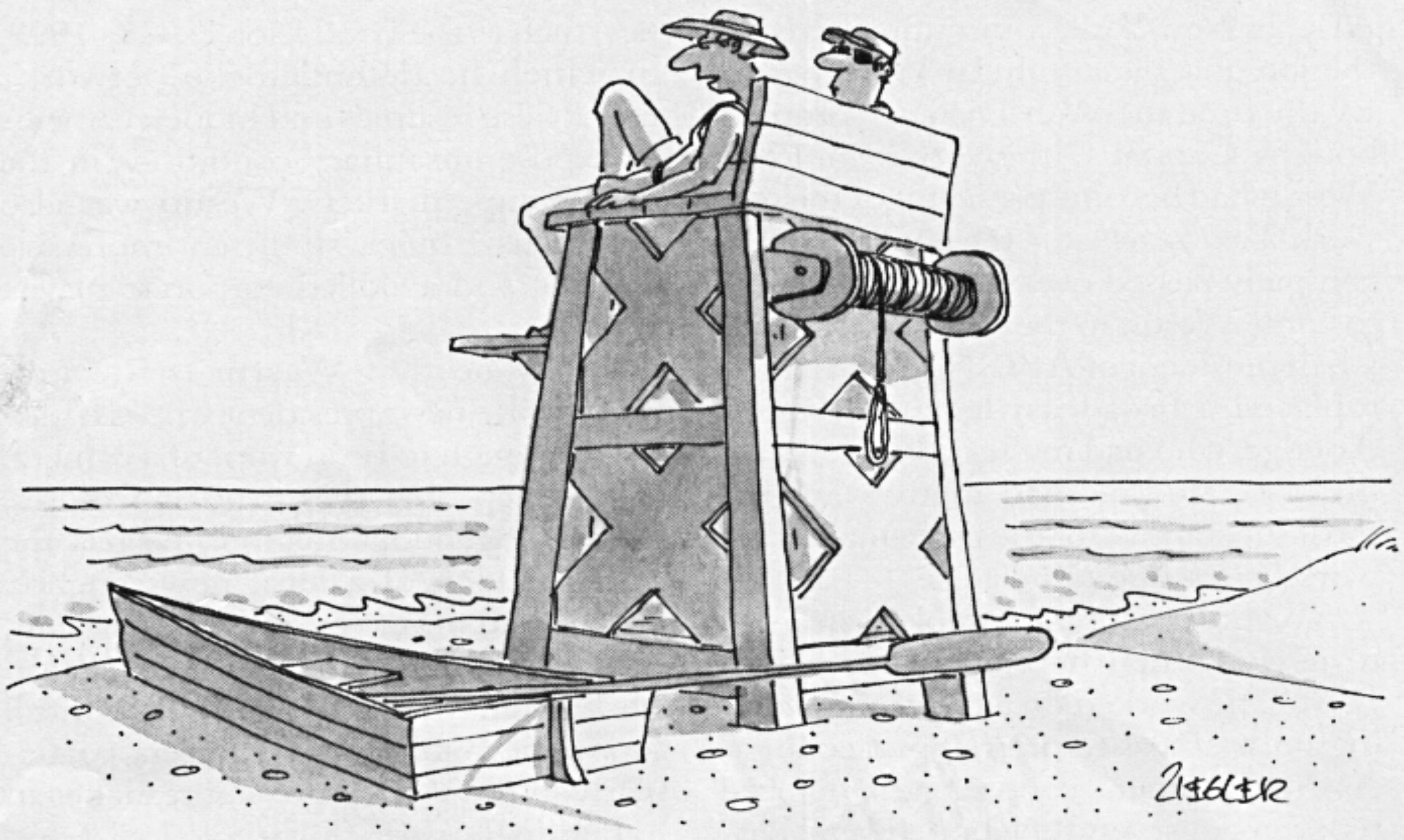
- Reports of diarrheal disease began in June, New York officials say
- From Debra Goldschmidt
  CNN

- 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.

The Associated Press

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

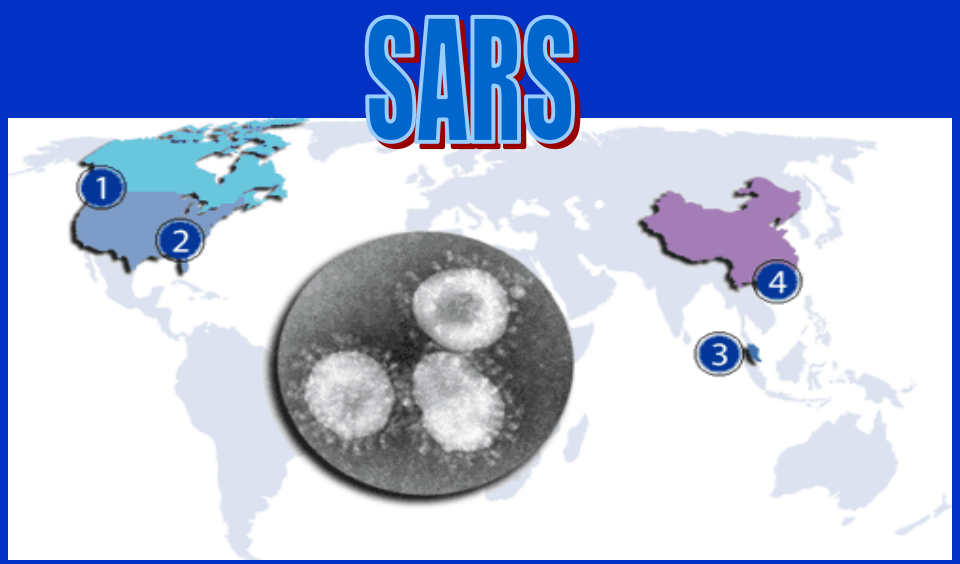
Gayle Taylor, heath director for the Shoalwater tribe in Washington, worries about agricultual runoff flowing into Willapa Bay. (Peter Mumford/ABCNEWS.com)

Bizarro | *Dan Piraro*

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



Coronavirus

Evidence of some environmental Transmission associated with feces/surfaces and water.
Only few papers on Disinfection.

By kgw.com Staff

FAIRFAX COUNTY

Senior Community Hit by Possible Norovirus

By Leef Smith
Washington Post Staff Writer
Saturday, March 10, 2007; Page B02

Washington-area hotel closes for cleaning after norovirus sickens dozens of guests

The Associated Press

Published: March 2, 2007 **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

TYPHOID

PROTOZOAL DIARRHEAS

DYSENTARY

HEPATITIS E

HEPATITIS A

THE CHANGING FOREGROUND (cont'd..)

CHOLERA

VIRAL DIARRHEAS

TOXOPLASMA

DYSENTERY

CRYPTOSPORIDIUM

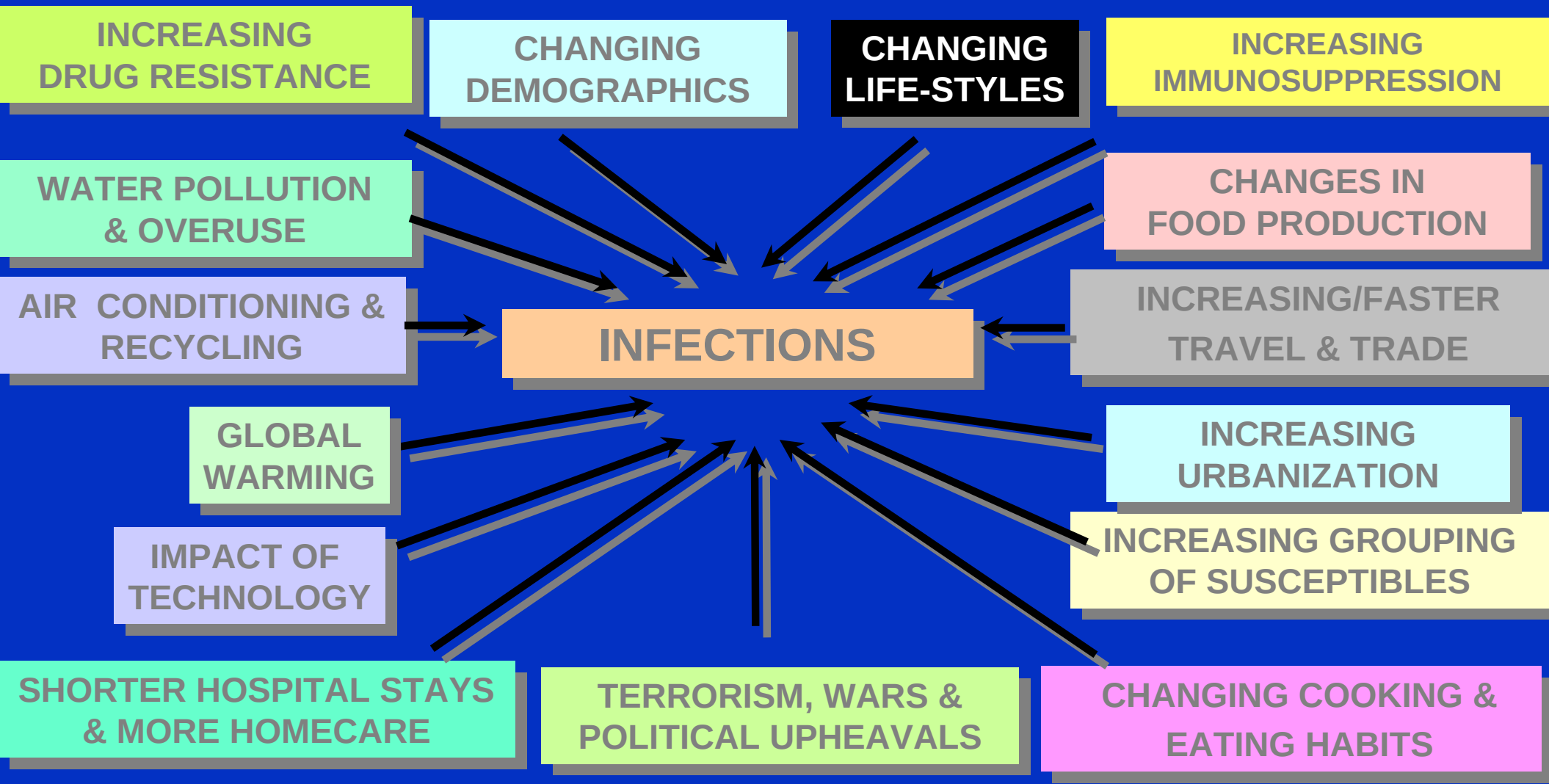
TYPHOID

ENVIRON MYCOBACTERIA

HEPATITIS A

Coxsackie viruses and Noroviruses

Societal Changes with Known or Potential Impact on Exposure and Susceptibility to Infectious Agents

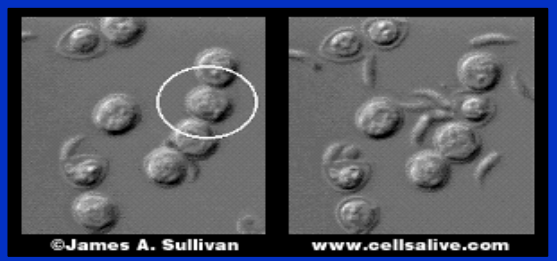


Emerging Biological Hazards

- **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

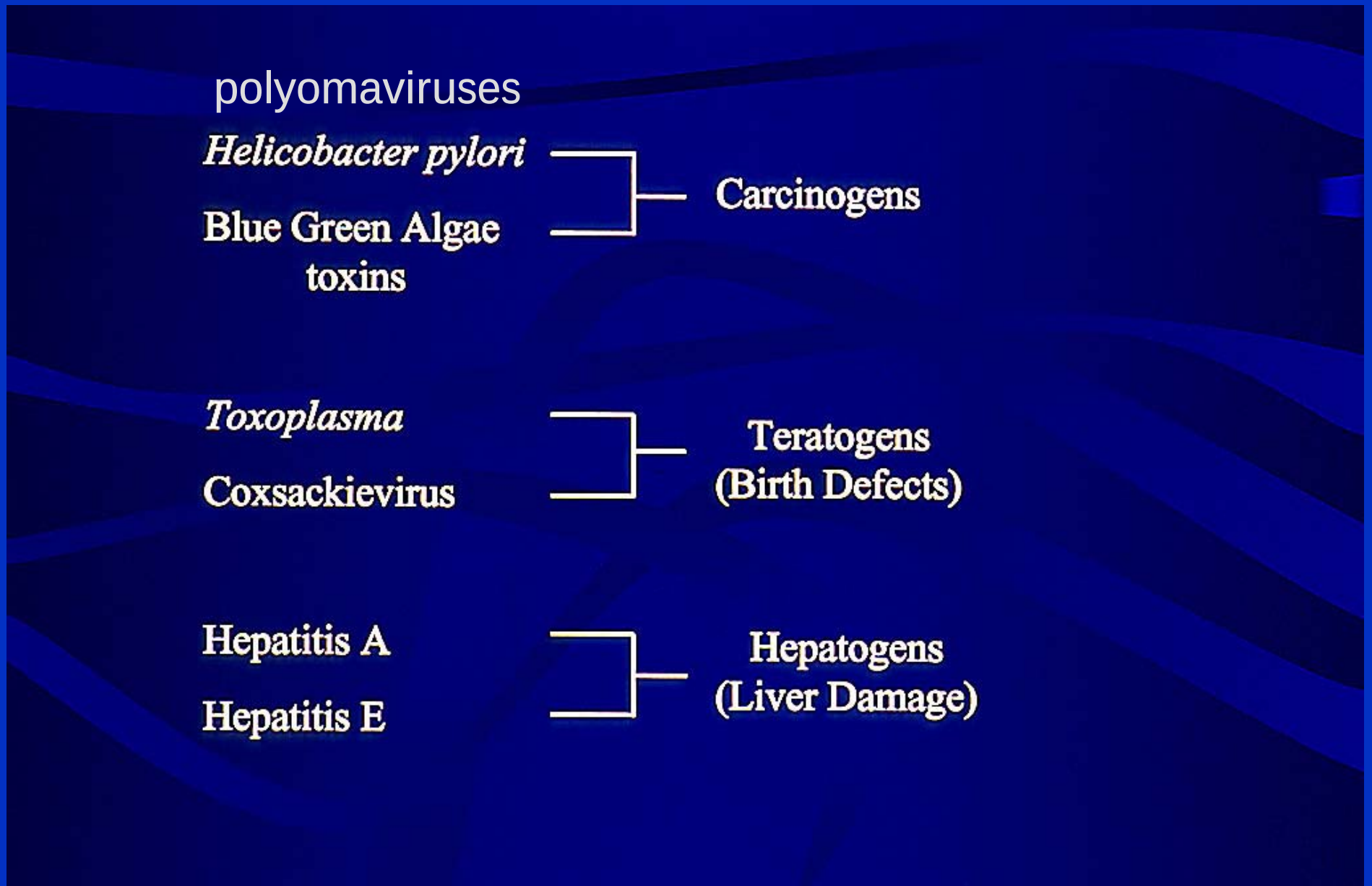
- **Viruses**
  - **rotavirus**
  - **coxsackievirus**
  - **echovirus**
  - **calicivirus**
  - **norovirus**
  - **Hepatitis A and E**
- **Bacteria**
  - ***E.coli***
  - ***Salmonella* spp.**
  - ***Shigella* spp.**
  - ***Aeromonas hydrophila***
  - ***Campylobacter jejuni***
- **Protozoa**
  - ***Cryptosporidium parvum***
  - ***Giardia lamblia***

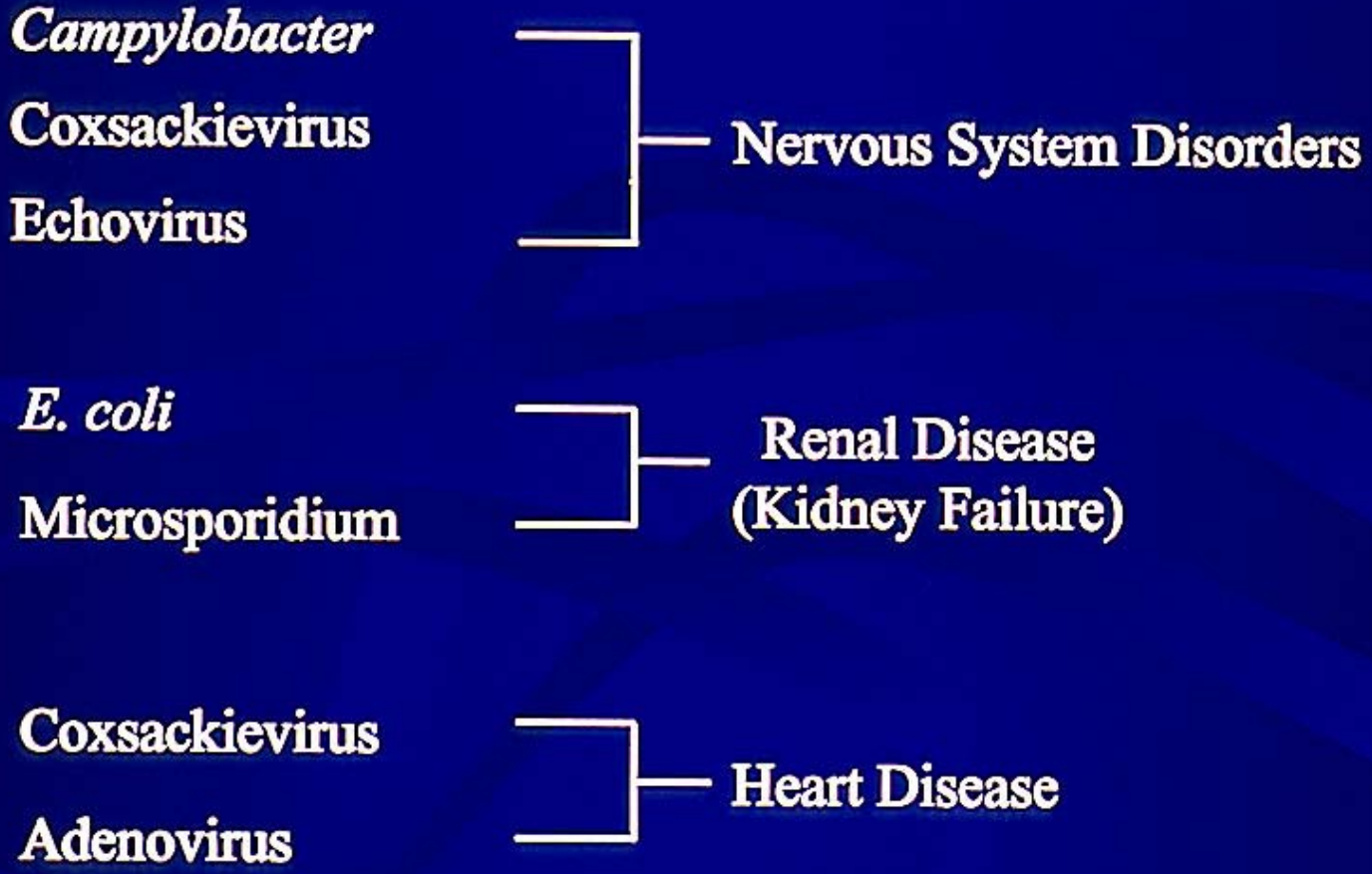


Why Are New Infectious Diseases Emerging?

- 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




Campylobacter
Coxsackievirus
Echovirus
Nervous System Disorders
E. coli
Microsporidium
Renal Disease
(Kidney Failure)
Coxsackievirus
Adenovirus
Heart Disease

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

Scientists test speedy *E.coli* sensor

Info on poisoning water found on terrorist suspects

Flights over NYC reservoir causing concern

WATER, WASTEWATER SECURITY WARNING SYSTEM BEING DEVELOPED UNDER AMWA

Officials: High water safety standards needed

Water security good, but not infallible

Feds say al Qaeda studying water plants

HOME LAND SECURITY ISSUES

- Structural Security: Dams, Intakes, Distribution Systems, Pump Stations, Treatment Facilities.
- Water and Food Quality: What contaminants, What concentrations and What Harm?
- Real-time monitoring: Smart Sensors
- Response Plans: Testing, Communication and Remediation.

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

Anthrax	83	81 U.S./ 1 middle east
Tear Gas	27	8 Europe/8 U.S./4 Asia/2MidE& Latin Am.
Cyanide	7	3 A/2 Latin Am/2 U.S.
HIV	4	1 Asia/1 Europe/1 Latin Am./1 Canada
Sarin	2	1U.S./1 Asia
Ricin	1	U.S.

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 lessions, 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

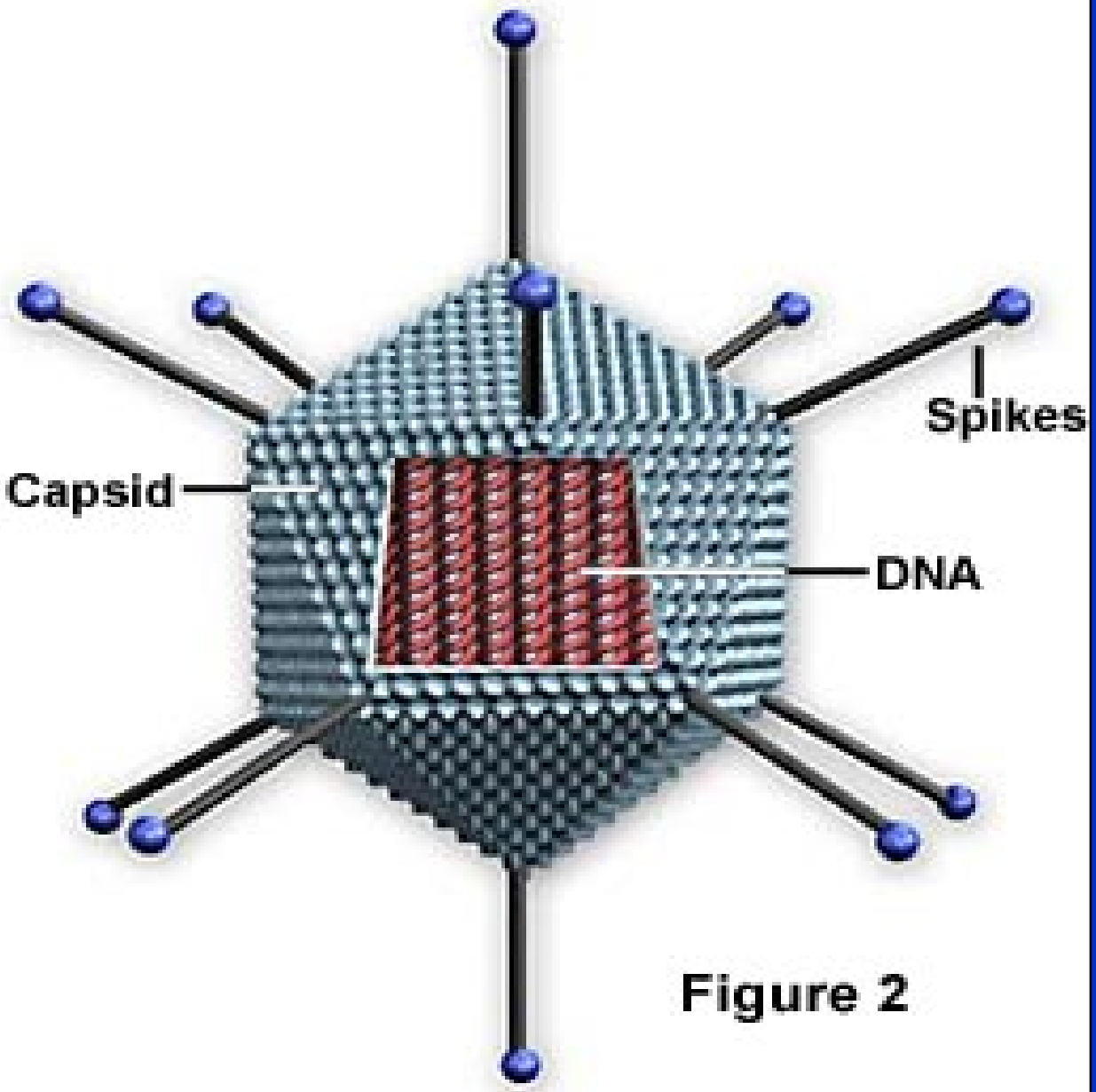
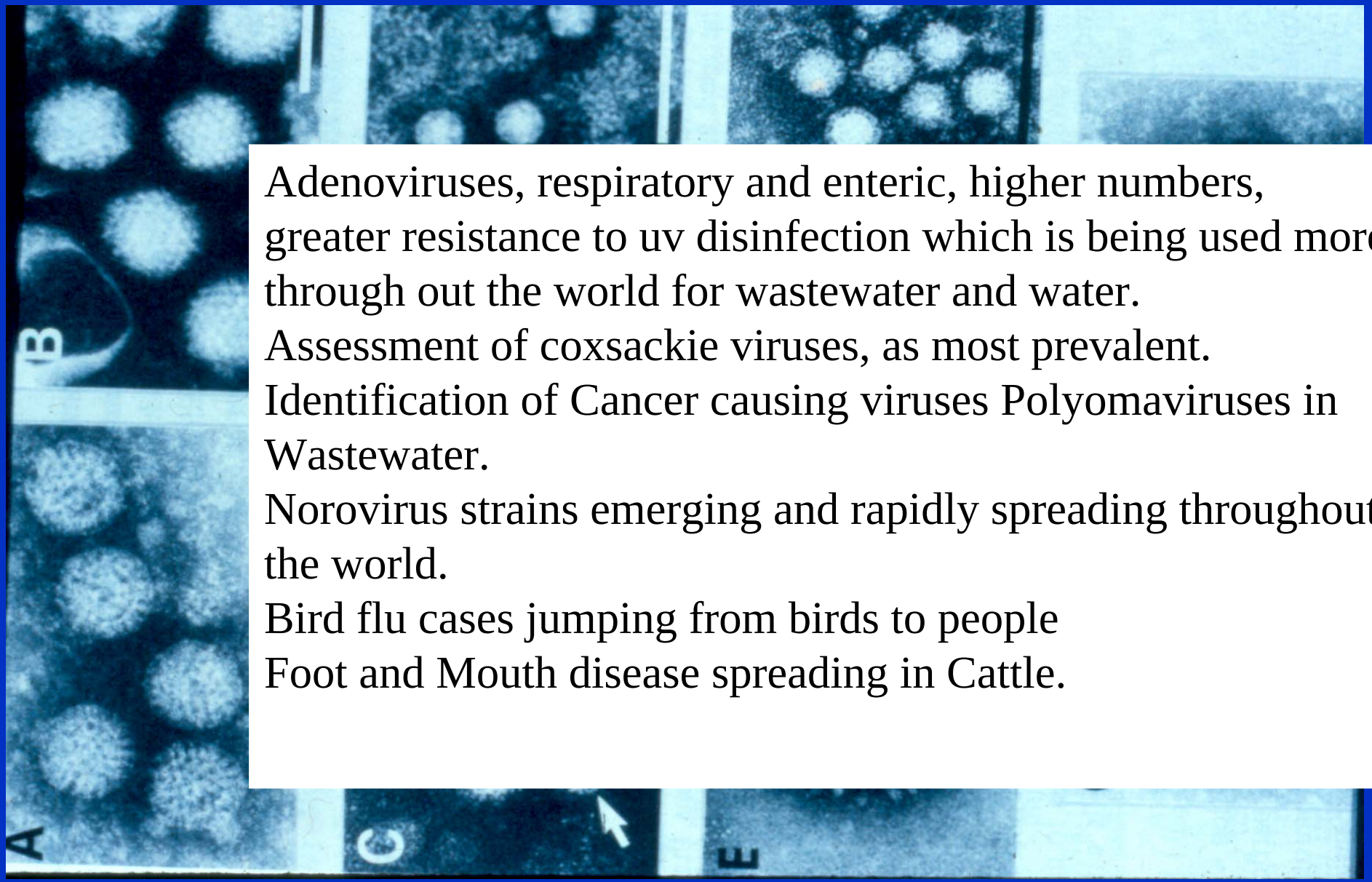


Figure 2

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 through out 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

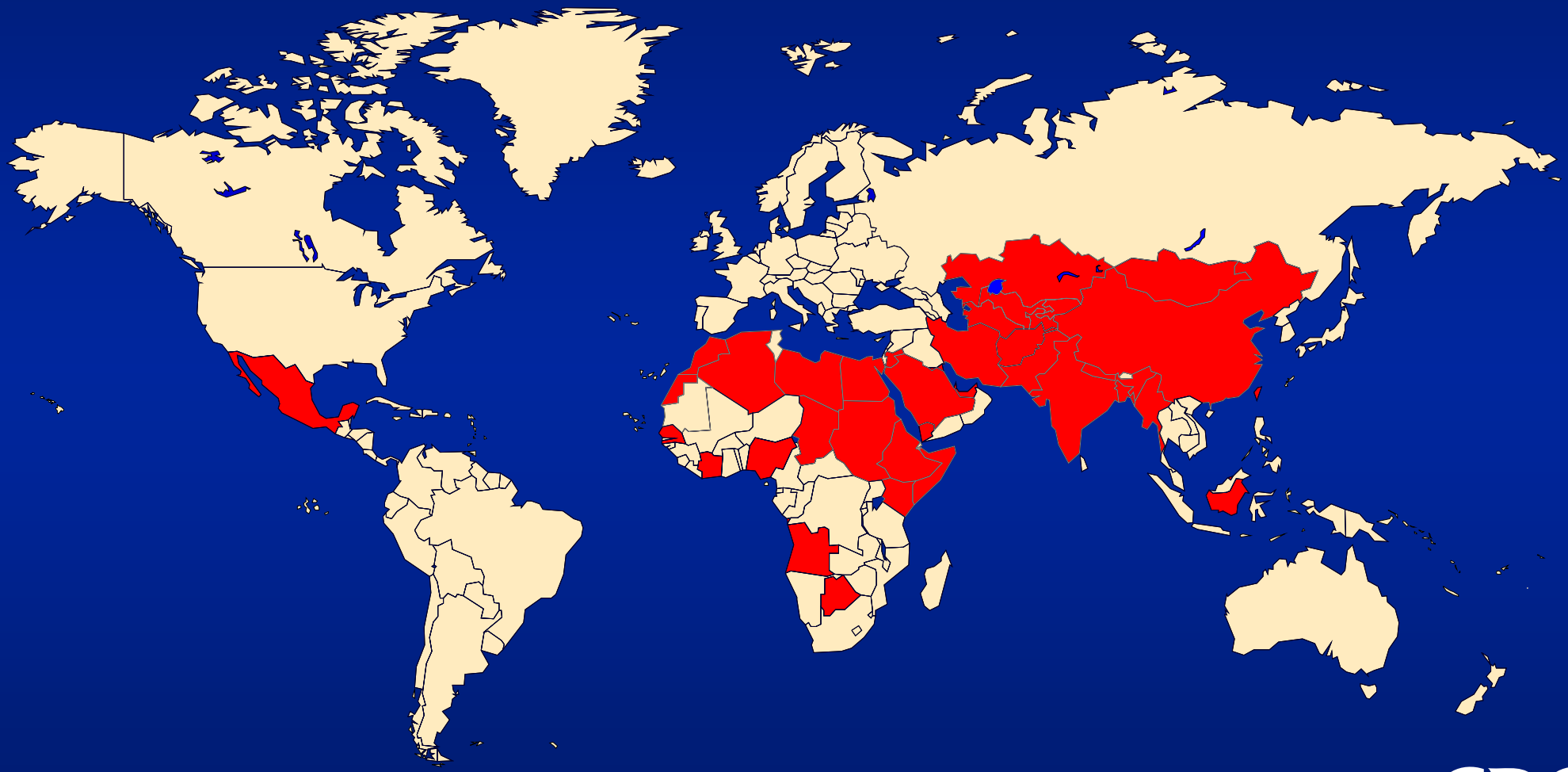
Foot and Mouth disease spreading in Cattle.

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

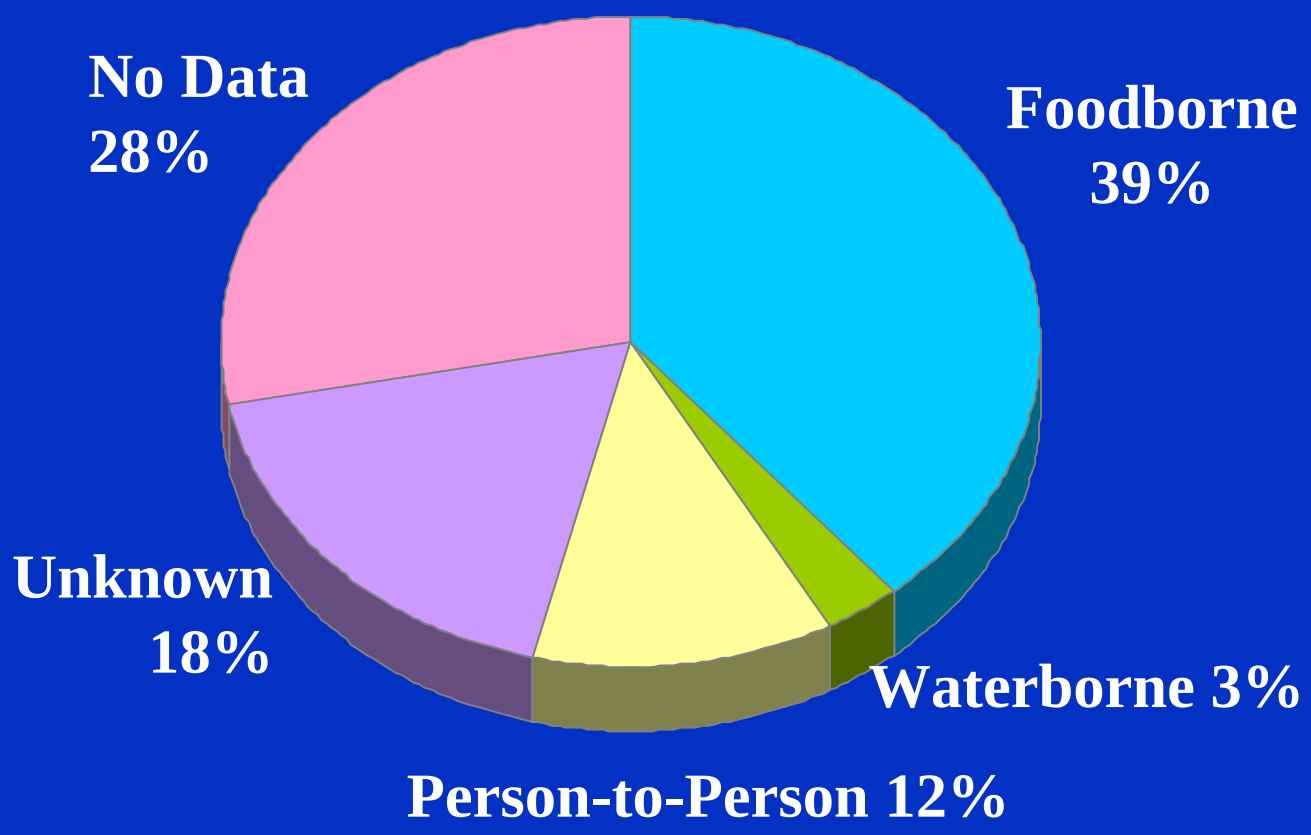
Geographic Distribution of Hepatitis E

Outbreaks or Confirmed Infection in >25% of Sporadic Non-ABC Hepatitis



CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Settings of 348 Outbreaks of NLV Gastroenteritis reported to the CDC, Jan. 1996 - Nov. 2000



ESTIMATED NUMBER OF CASES OF NORWALK-LIKE VIRUSES PER YEAR

ROUTE	CASES	REFERENCE
Food	6,900,000	Mead et al., 1999
Recreational Water	6,900,000	U.S. Census, 2000
Drinking Water	3,584,000	Haas et al., 1999
Other	5,616,000	
Total	23,000,000	Mead et al., 1999

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

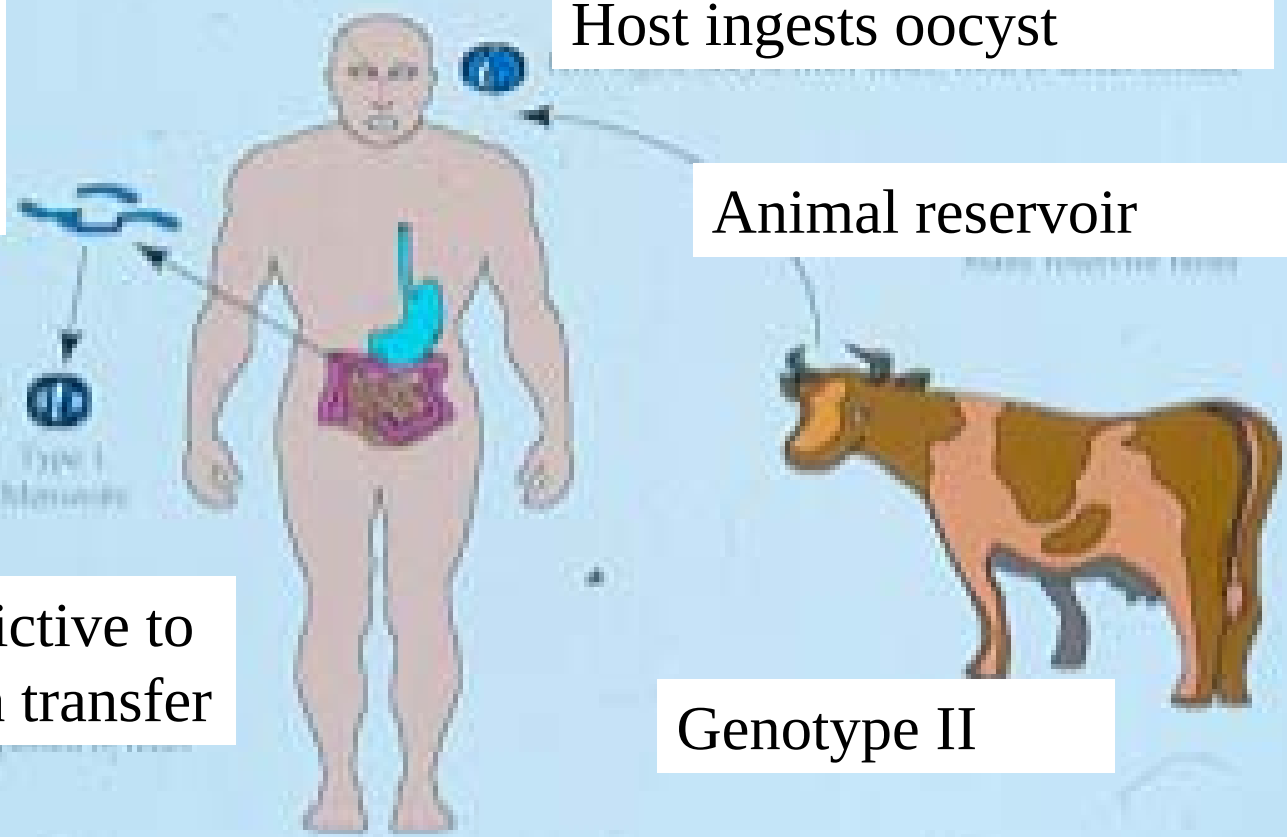
- **Surface water occurrence: 4 - 100%**
  0.1 - 10,000/100 L
- **Ground water occurrence: 9.5 - 22%**
- **Oocysts are extremely resistant to disinfection**

Life Cycle of *Cryptosporidium*

Obligate intracellular parasite

Host ingests oocyst

Animal reservoir



Genotype I restrictive to human to human transfer

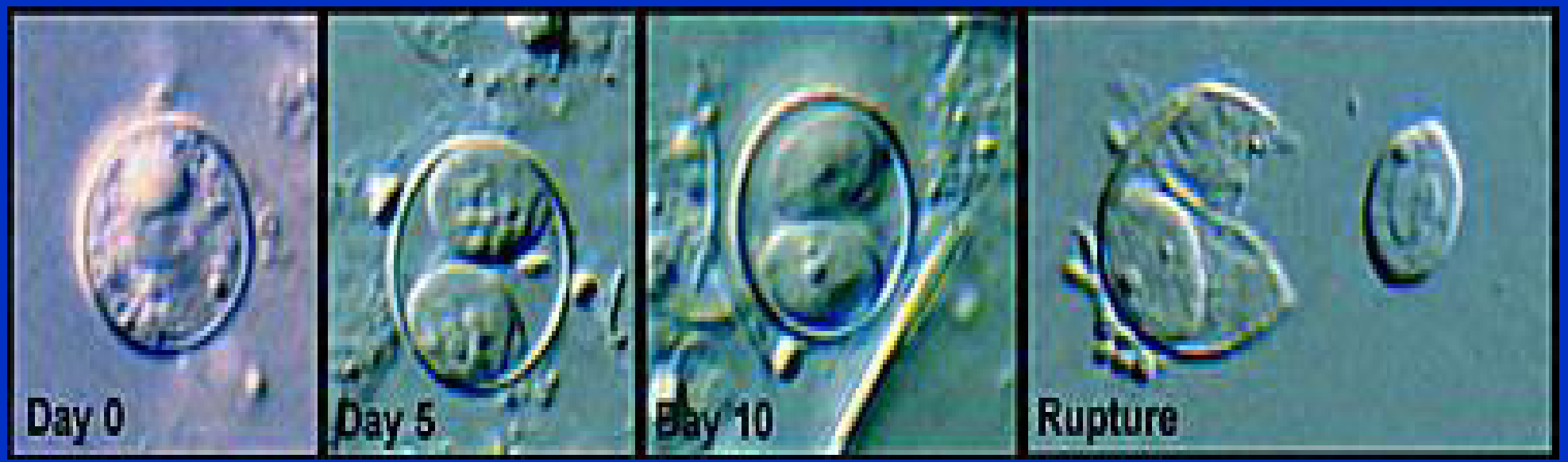
Genotype II

Cyclospora

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

Cyclospora cayetanensis

Sporulation



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) .

Groundwater Risks Lessons Learned

Walkerton, Ontario Outbreak (occured 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.

Vol. 31, No. 6 June 2005

Walkerton — 5 years later

Tragedy Could Have Been Prevented

by Steve E. Hrudey and Richard Walker

In May 2000, several serious flaws in the Walkerton, Ont., municipal drinking water system aligned to permit a breakthrough of *E. coli* O157:H7 and *Campylobacter* bacteria, causing seven deaths and more than 2,300 cases of waterborne disease. These included 27 cases of hemolytic uremic syndrome, a serious kidney ailment with potential lifelong implications. Most of the cases of kidney disease were among children aged one to four. Other Walkerton residents have also reported enduring illness.

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

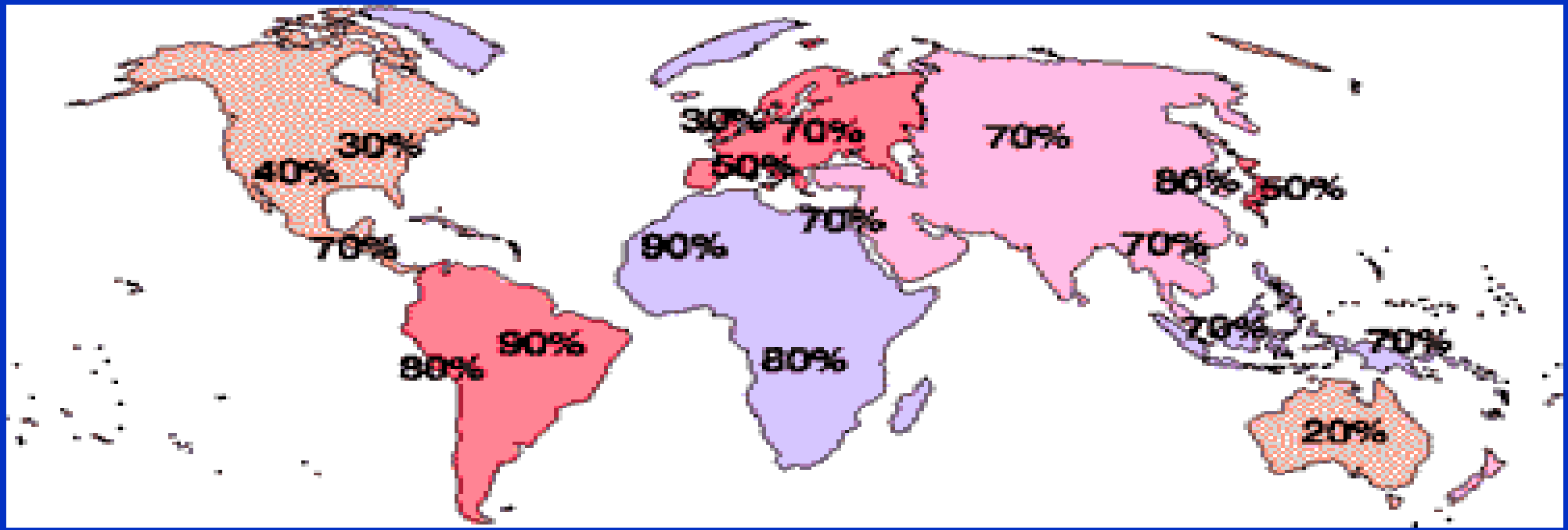
Water, that is. Ulcers are caused by a bacterial infection, and in one region of Colombia, at least, the bug is in the water supply.

- 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).

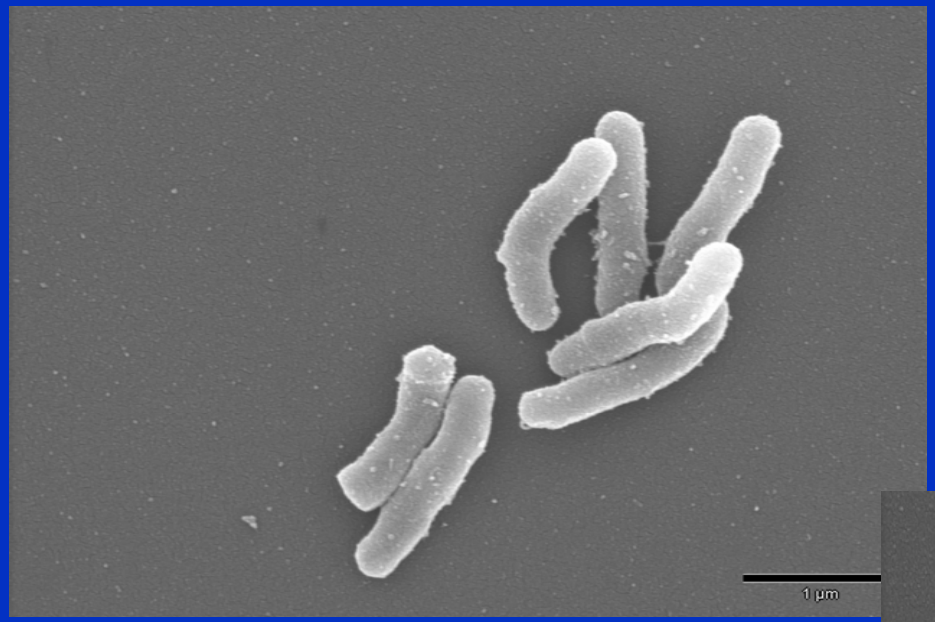
EPIDEMIOLOGY

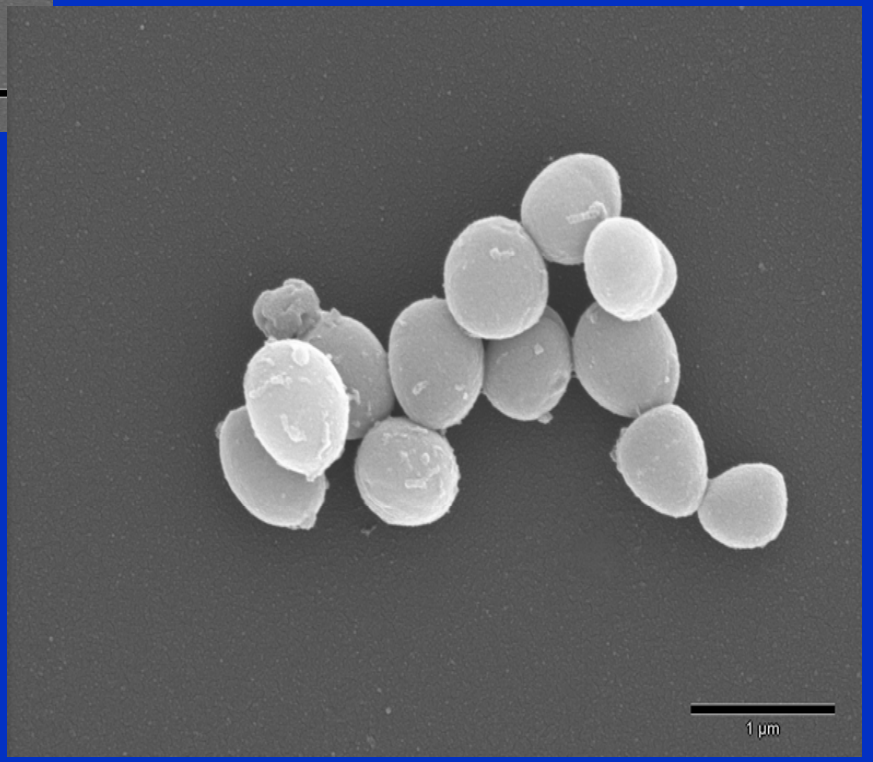


Map showing percentages of population infected with H. pylori as determined by epidemiological studies

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

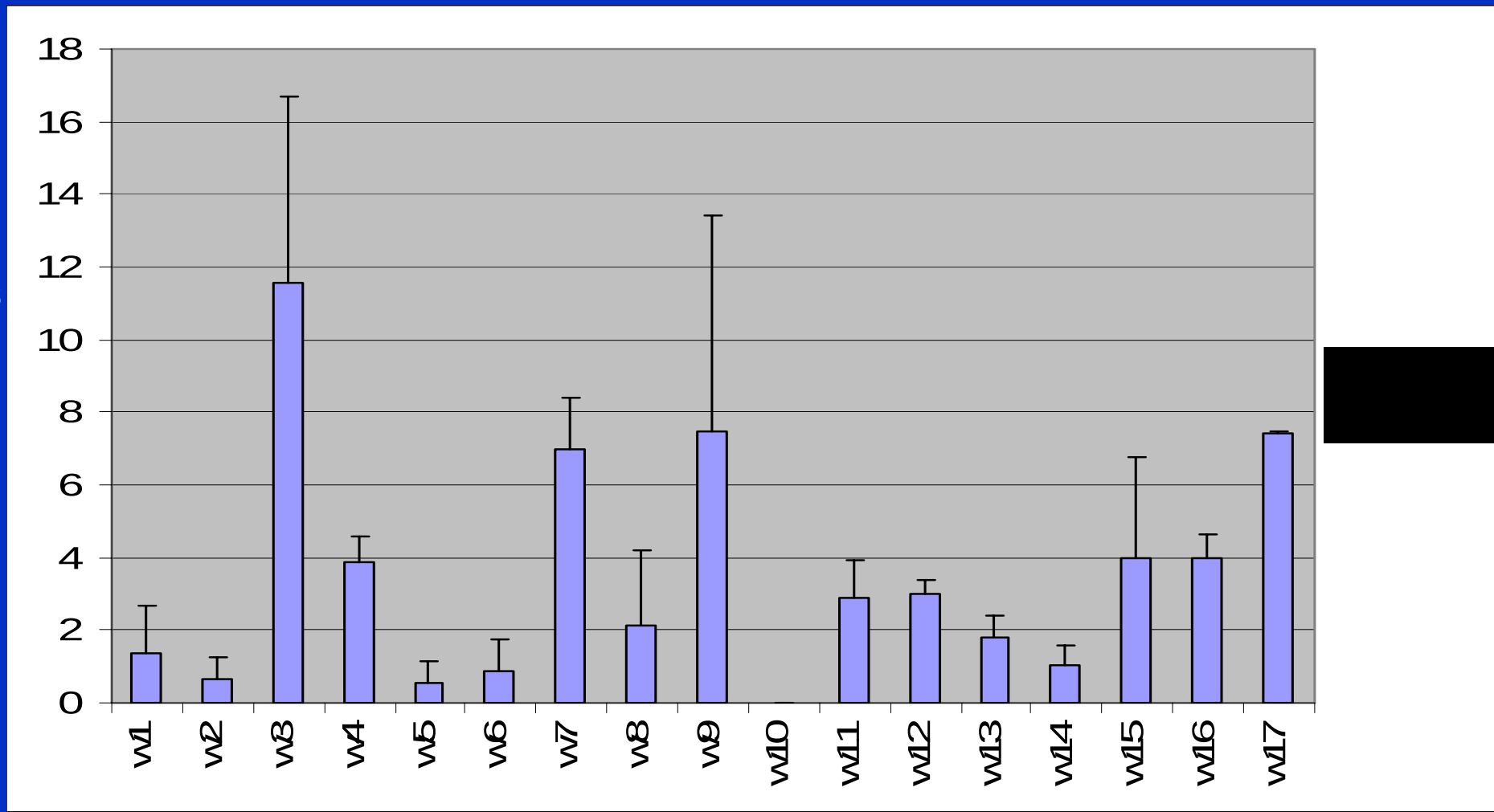
Source: Helicobacter *Foundation website: www.helico.com*


1 µm


1 µm

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.
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Ohio blames groundwater for Lake Erie island outbreak

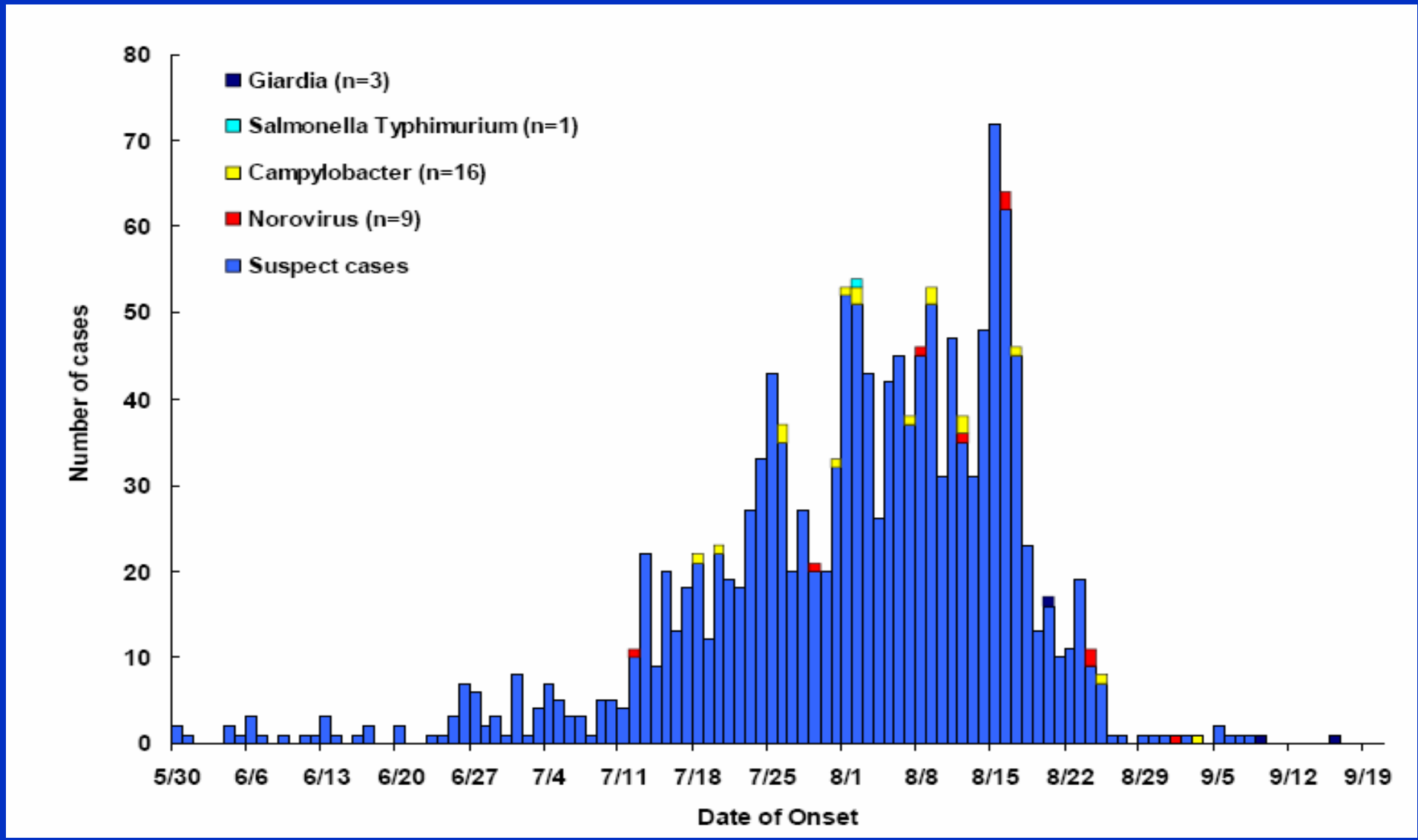
Tuesday, February 22, 2005

ASSOCIATED PRESS

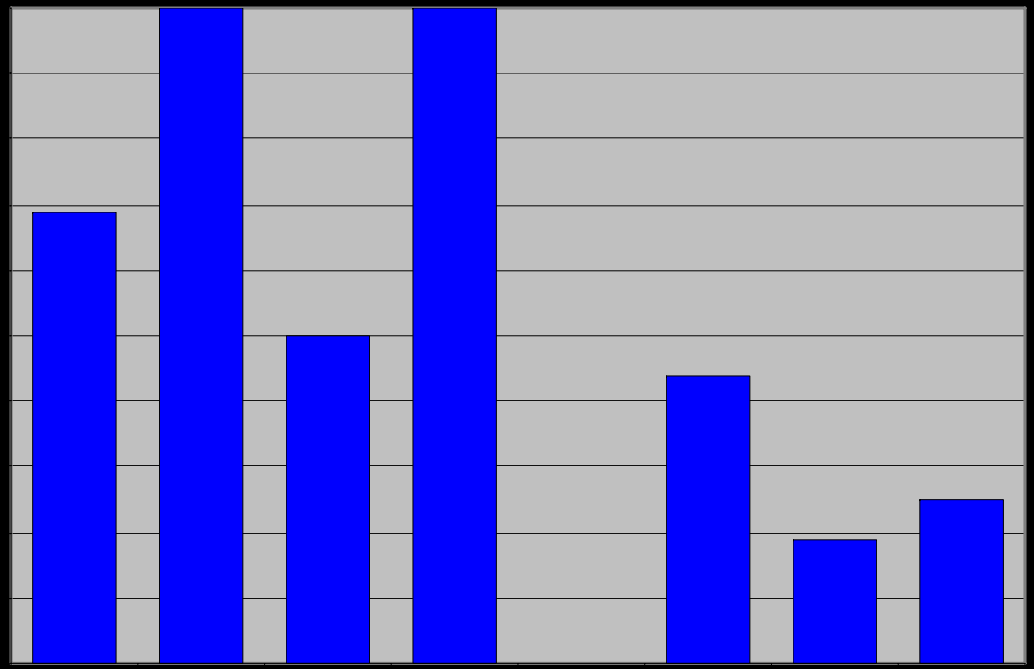
TOLEDO, Ohio -- Widespread groundwater contamination on a Lake Erie resort island was the likely source of illnesses that sickened hundreds last summer, the Ohio health department said Tuesday.

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.


Giardia (n=3)
Salmonella Typhimurium (n=1)
Campylobacter (n=16)
Norovirus (n=9)
Suspect cases
Number of cases
0
10
20
30
40
50
60
70
80
5/30
6/6
6/13
6/20
6/27
7/4
7/11
7/18
7/25
8/1
8/8
8/15
8/22
8/29
9/5
9/12
9/19
Date of Onset

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

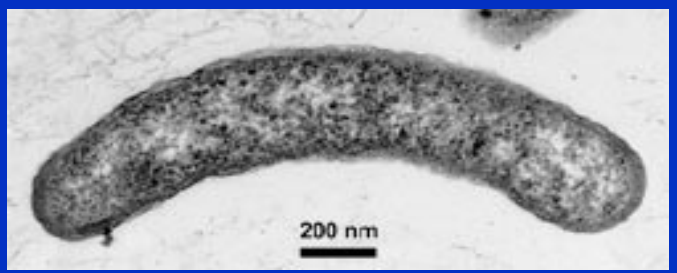


Photo courtesy: Craig Taylor & Carl Wirsen, WHOI

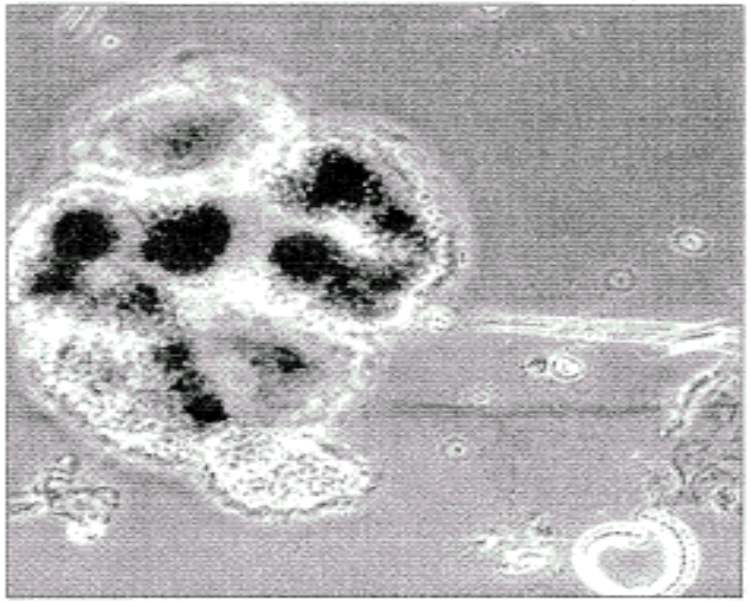
Cyanobacteria

- **Blue green algae, carry hepatotoxins and nuerotoxins, 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**

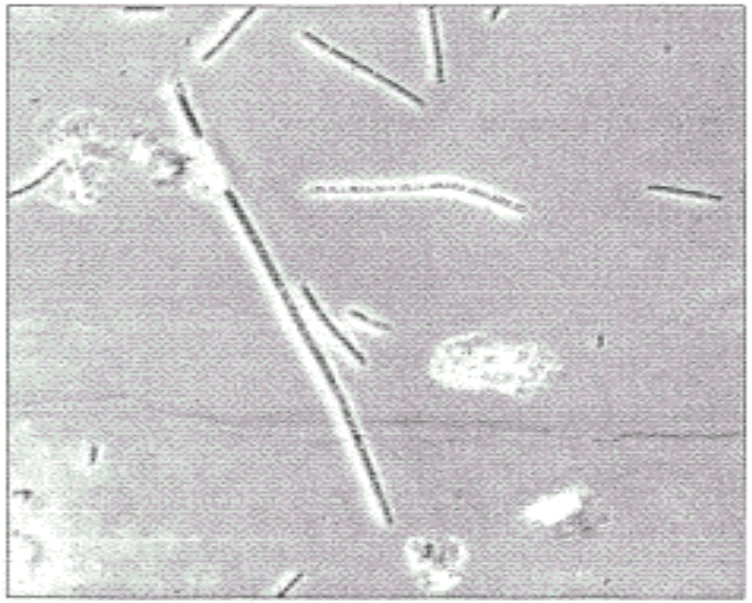
What is Microcystin?

- 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



MICROCYSTIS



CYLINDROSPERMOPSIS

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

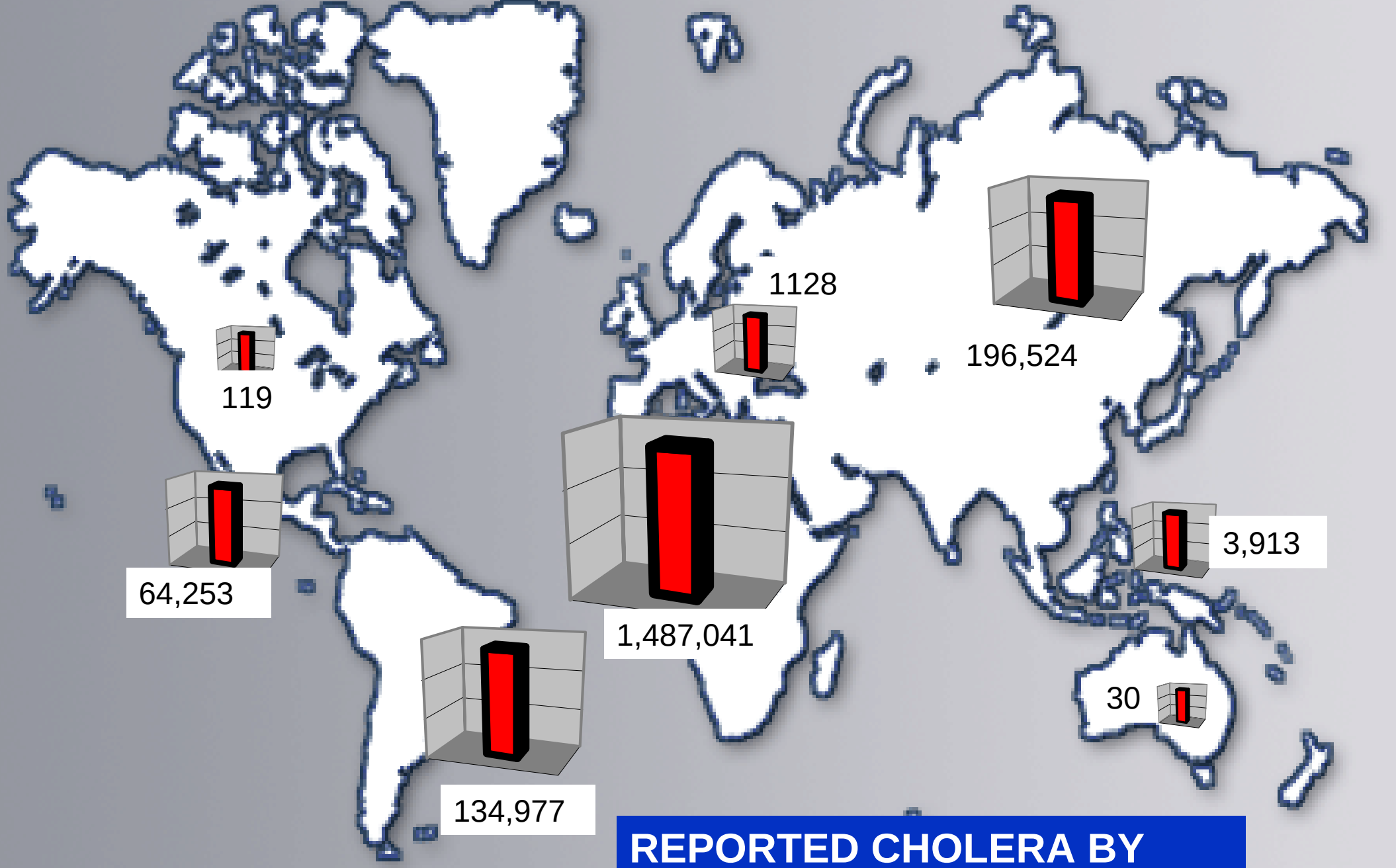
Active Tuberculosis is presented as "The presence of *Mycobacterium tuberculosis* infection with a positive chest X-ray. Treatment of active tuberculosis is mandatory by law in the US.". The presence of the bacilli in the sputum is also indicative of infection and disease.

TB

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..

TB

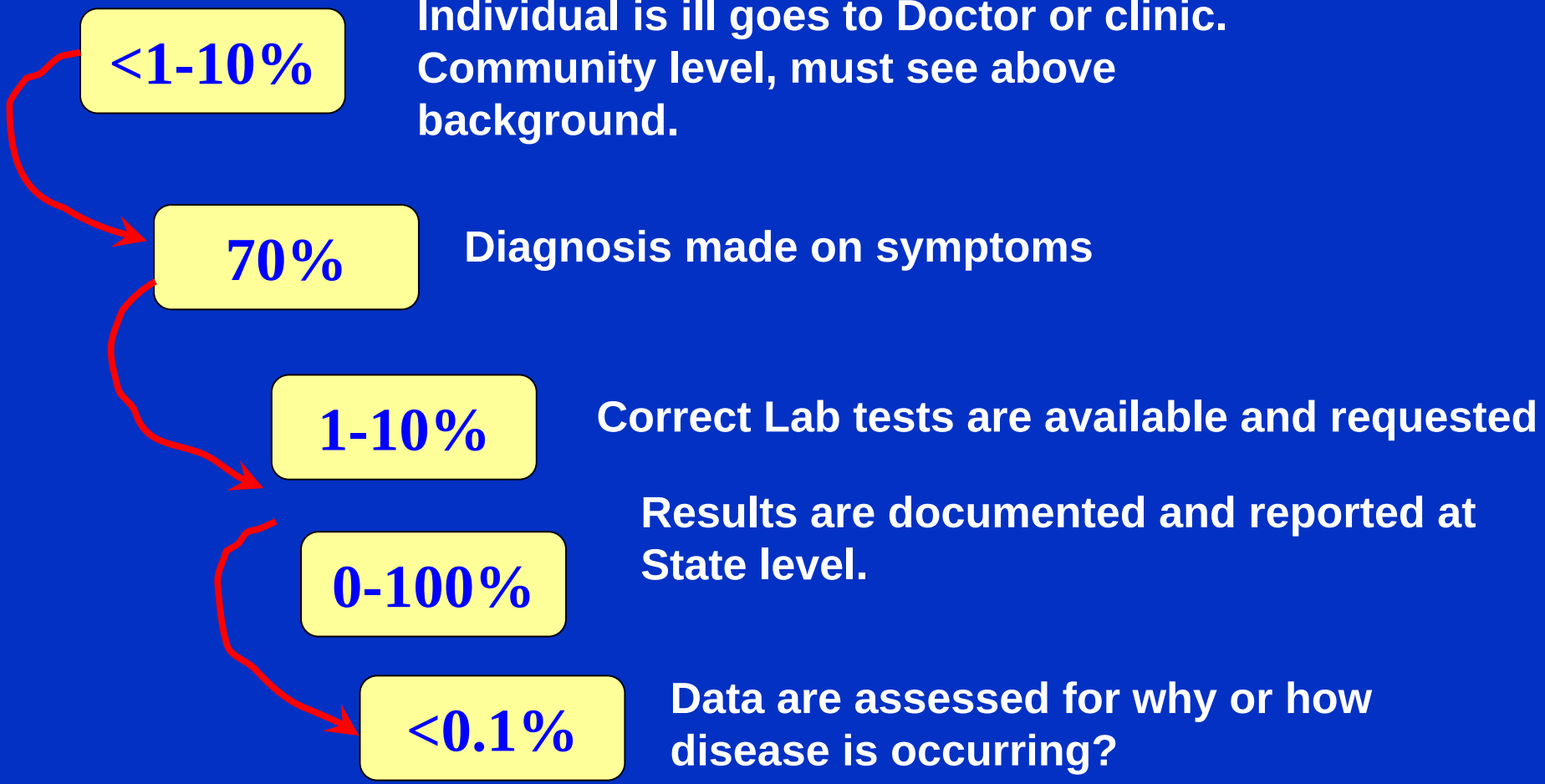
- **The usual statistics cited are that among those infected and not treated with antibiotics, 5% develop clinical disease within the first two years of infection, and another 5% develop clinical disease at some point in their remaining lifetimes subsequent to the first two years**



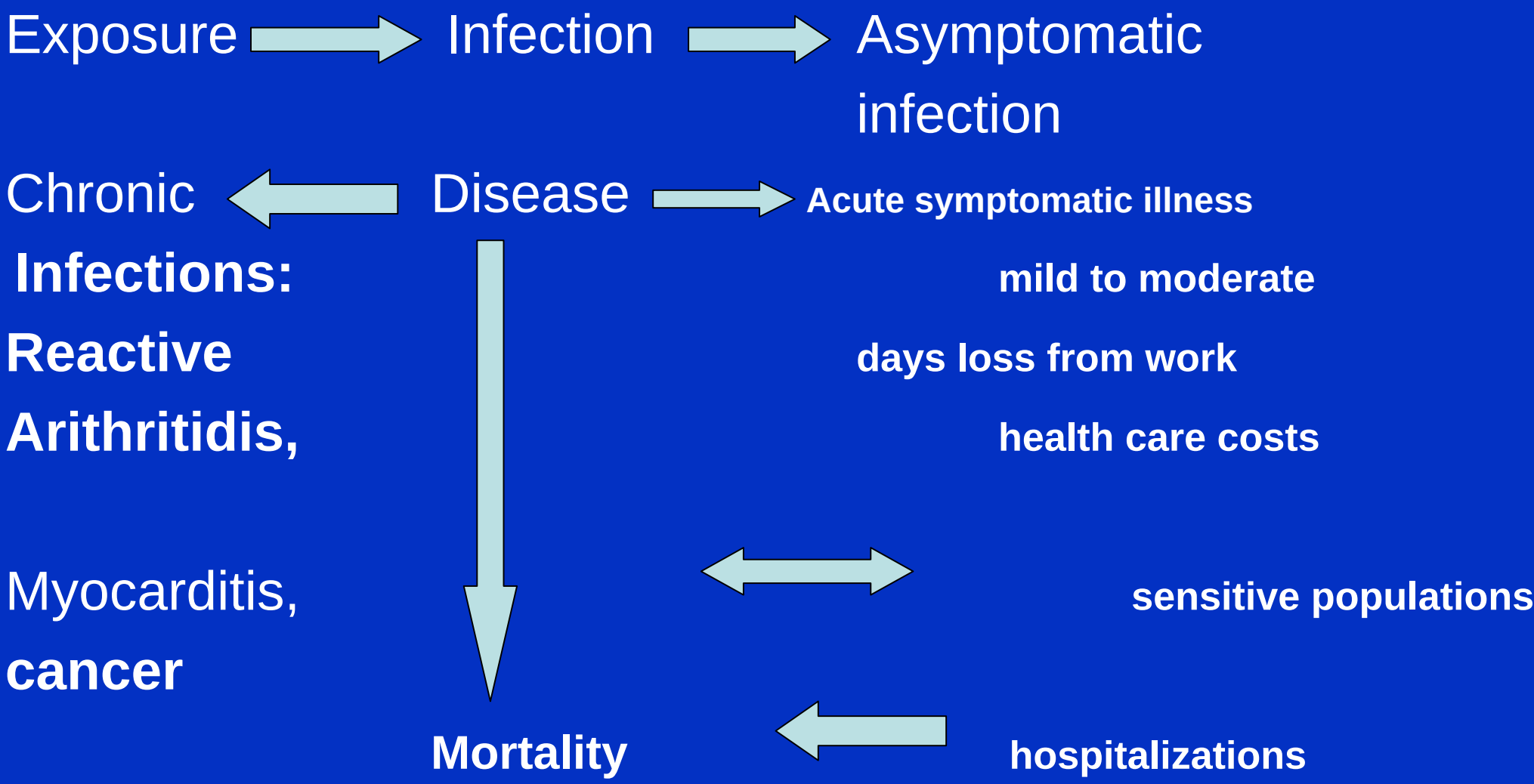
REPORTED CHOLERA BY 1995-2005

WATERBORNE DISEASE OUTBREAKS

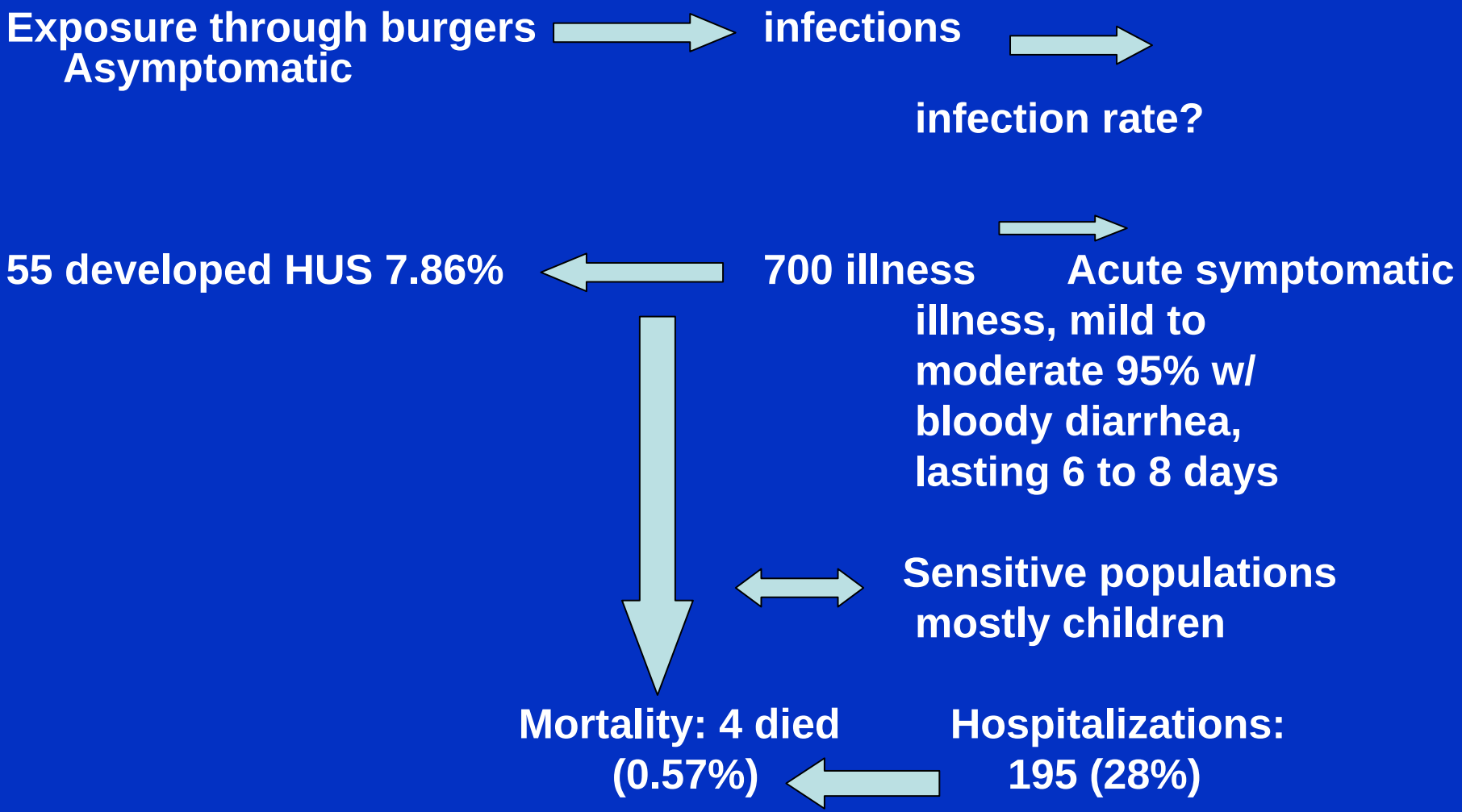
Disease & Documentation

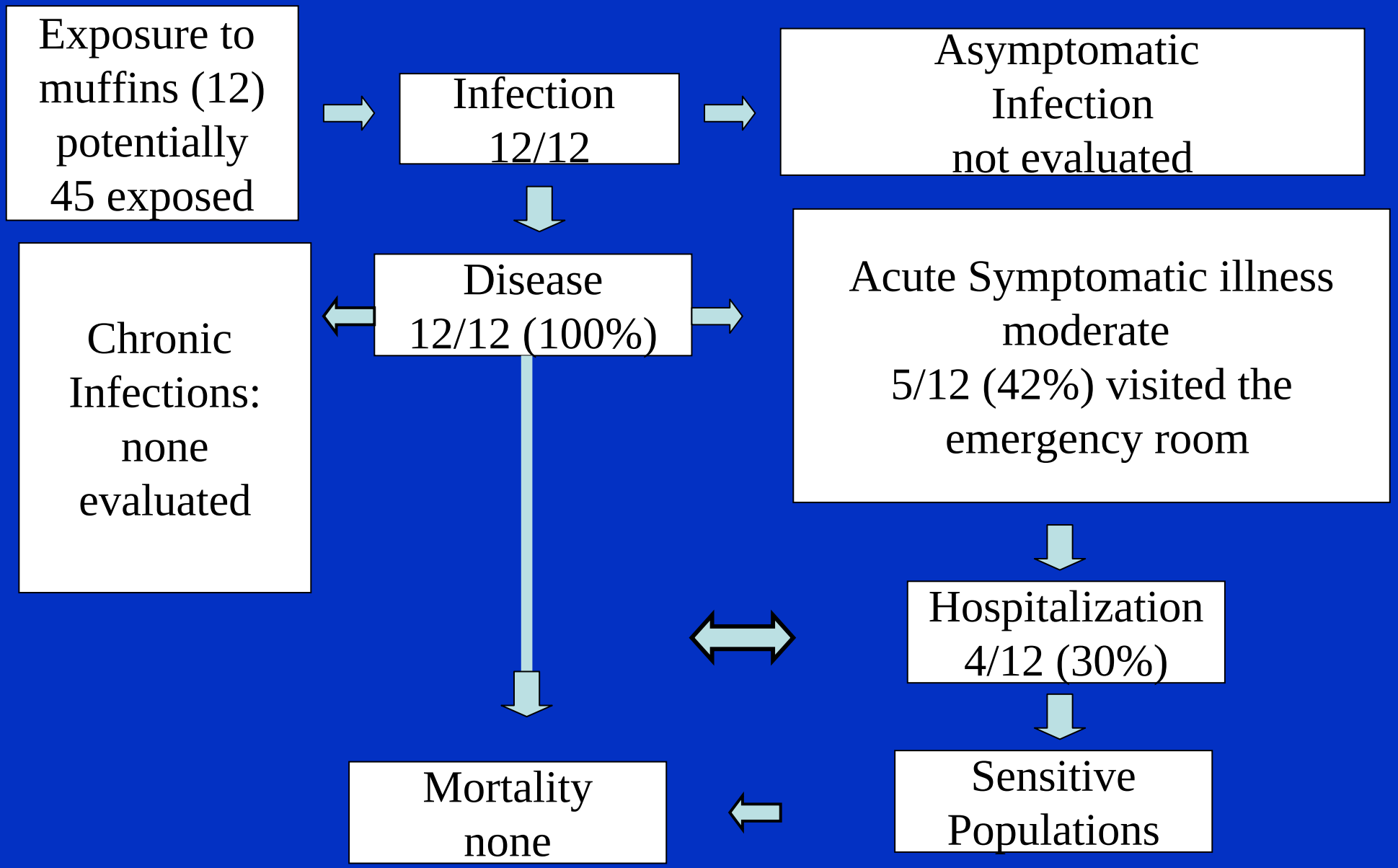


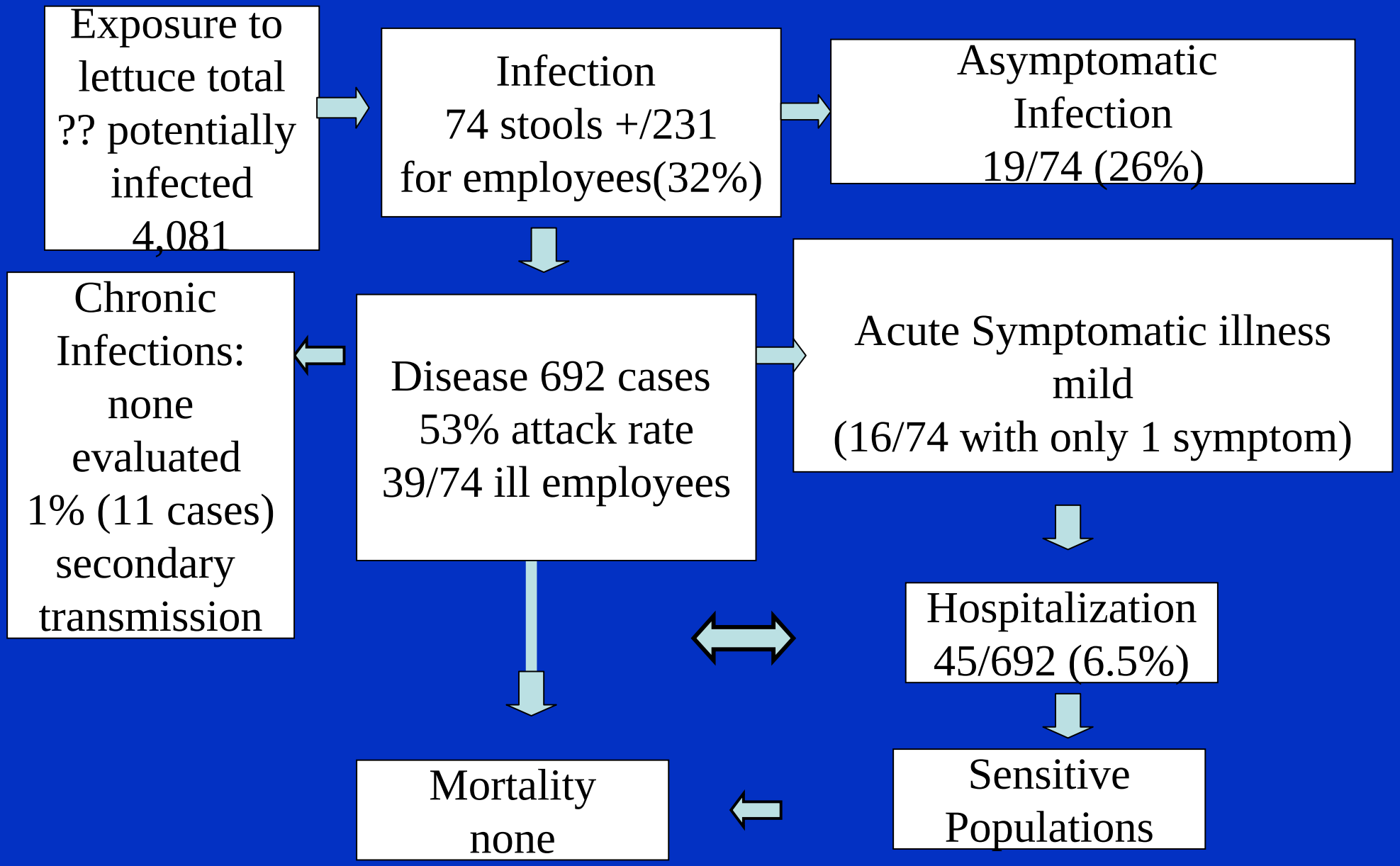
Outcomes of infection process for quantification



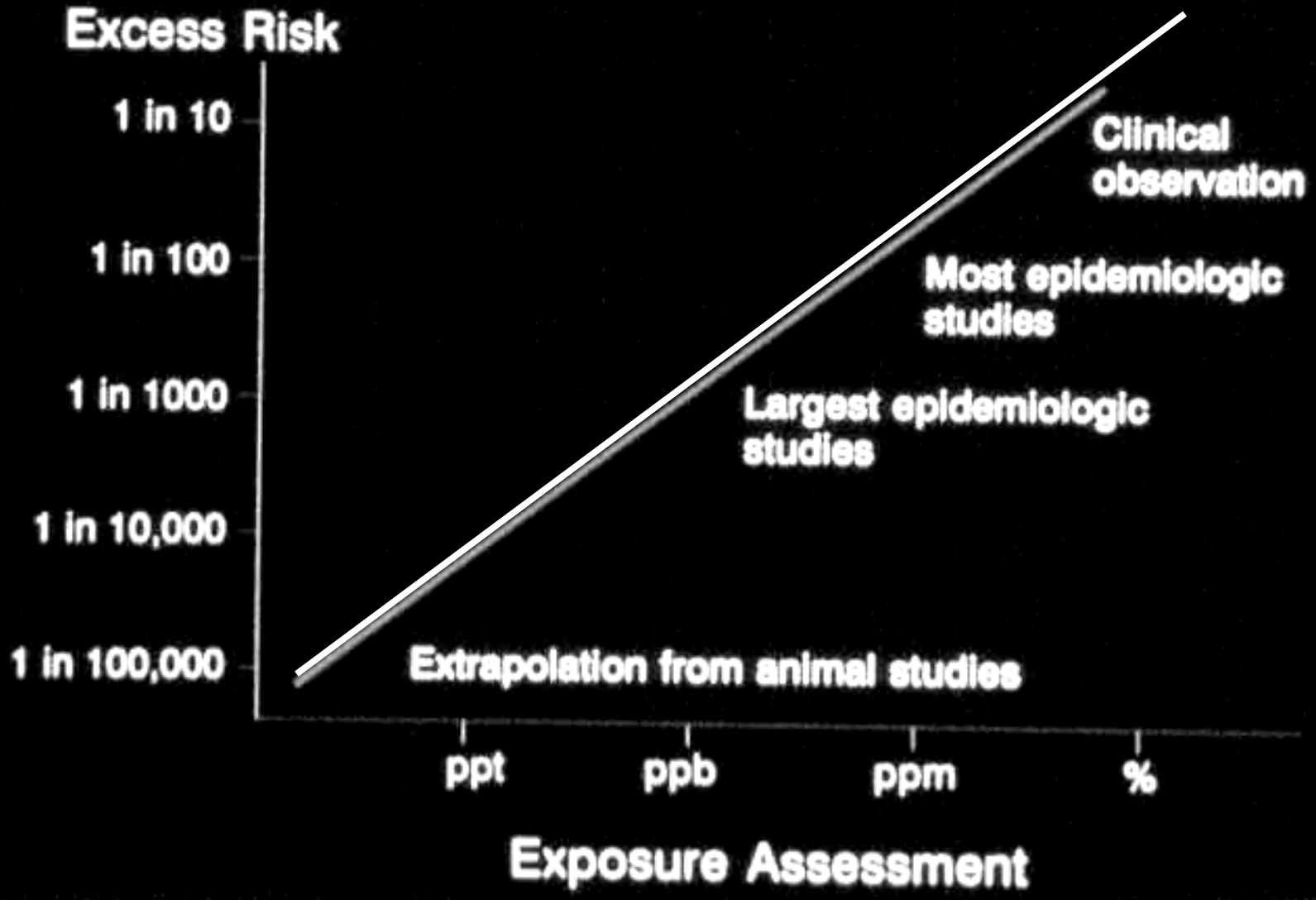
Health outcomes associated with E. coli 015H7 infections during a foodborne outbreak




Exposure to muffins (12) potentially 45 exposed
Infection 12/12
Asymptomatic Infection not evaluated
Chronic Infections: none evaluated
Disease 12/12 (100%)
Acute Symptomatic illness moderate 5/12 (42%) visited the emergency room
Hospitalization 4/12 (30%)
Sensitive Populations
Mortality none


Exposure to lettuce total ?? potentially infected 4,081
Infection 74 stools +/231 for employees(32%)
Asymptomatic Infection 19/74 (26%)
Chronic Infections: none evaluated 1% (11 cases) secondary transmission
Disease 692 cases 53% attack rate 39/74 ill employees
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



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**