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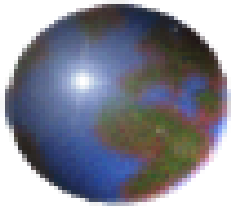

ACUTE INFECTIOUS GE

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Digestive Diseases Research Institute,

Infectious Diseases Dept.,

TUMS

World Digestive Health Day (WDHD) 2011

Iranian Miniature

Enteric infections: prevention and management

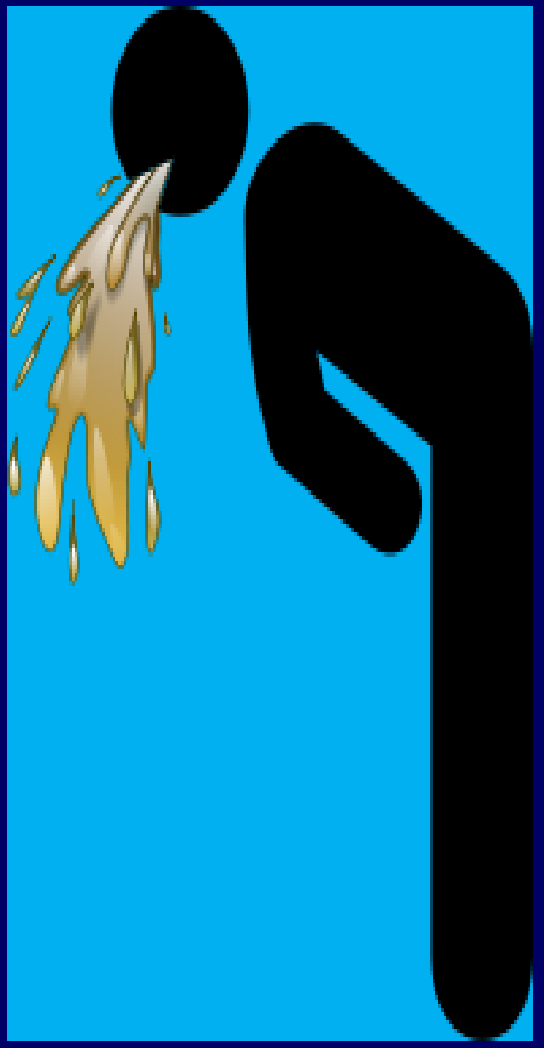
Definitions & Etymologies

Definition of Diarrhea

- Etymology: from the ancient Greek word διαρροή = leakage; lit. "to run through")
- Diarrhea: is loosely defined as passage of abnormally liquid or unformed stools at an increased frequency. For adults on a typical Western diet, stool weight >200 g/d can generally be considered diarrheal.

Definition of Vomiting

- Etymology: from L. vomitare "to vomit often," frequentative of vomere "spew forth, discharge,“. Avestan vam- "to spit;"
- Vomiting (known medically as emesis and informally as throwing up and by a number of other terms) is the forceful expulsion of the contents of one's stomach through the mouth and sometimes the nose.

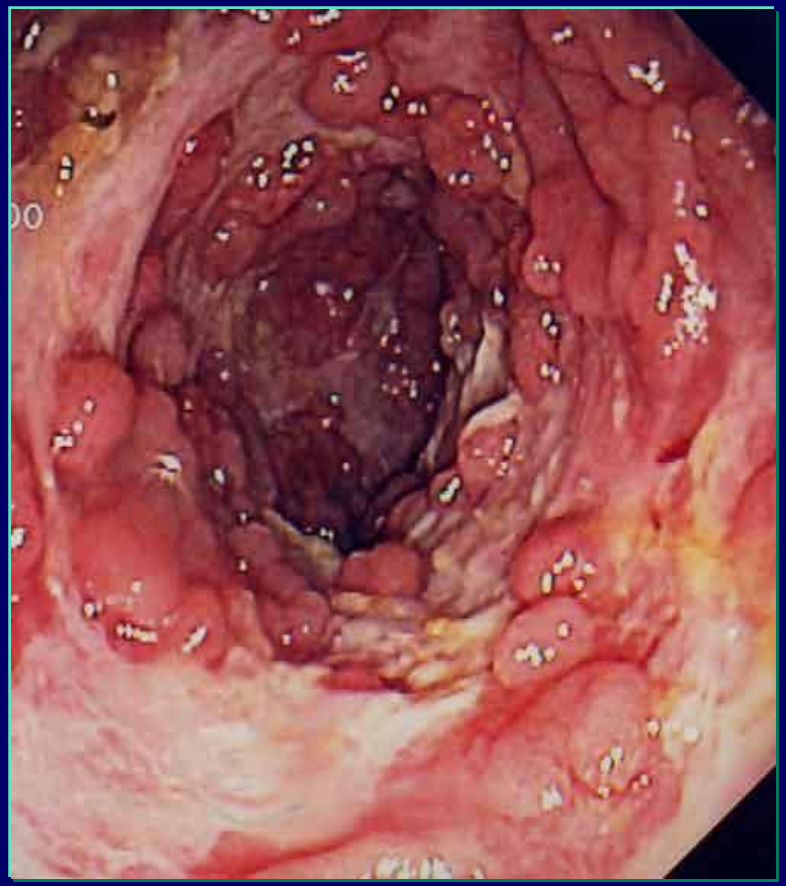


Definition of Gastritis

- Etymology: 1806, Medical L., from gastro- + -itis. Coined by French pathologist François-Boissier de la Croix de Sauvages (1706-1767).
- Gastritis is an inflammation of the lining of the stomach

Definition of Enteritis

- Enteritis, from Greek words enteron (Small Intestine) and suffix -itis (Inflammation)
- Enteritis refers to the inflammation of the small intestine.

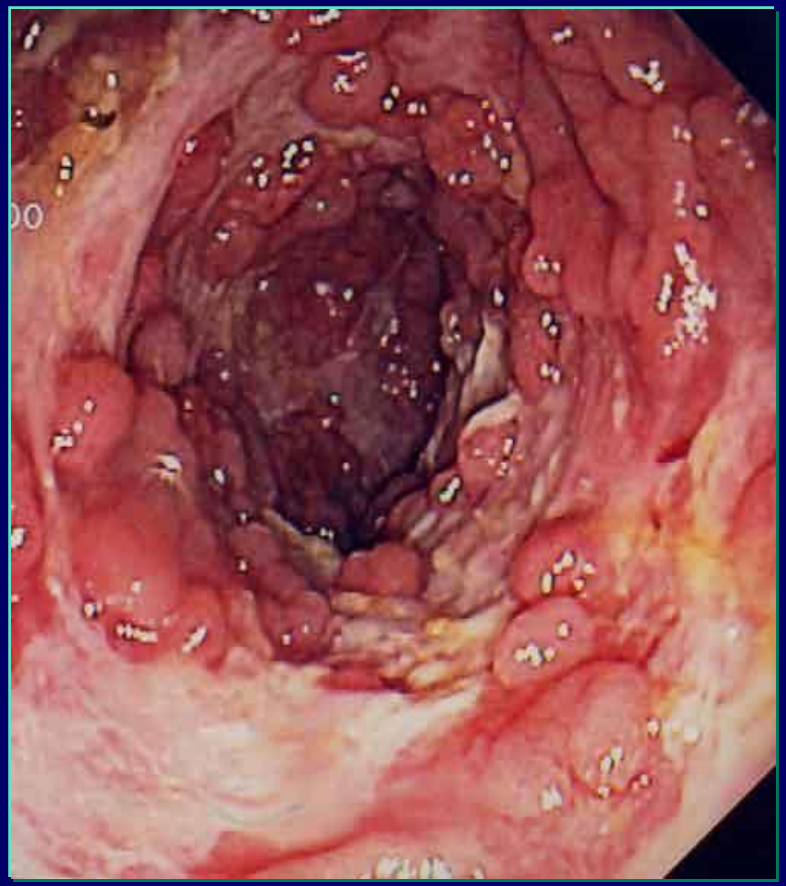


Definition of Colitis

- Colon: "large intestine," late 14c., from Gk. kolon (with a short initial -o-) "large intestine, food, meat," of unknown origin
- Colitis (pl. colitides) refers to an inflammation of the colon and is often used to describe an inflammation of the large intestine (colon, caecum and rectum).

Definition of Gastroenteritis

- Gastroenteritis (also known as gastric flu, stomach flu, and stomach virus, although unrelated to influenza) is marked by severe inflammation of the gastrointestinal tract involving both the stomach and small intestine resulting in acute diarrhea and vomiting.



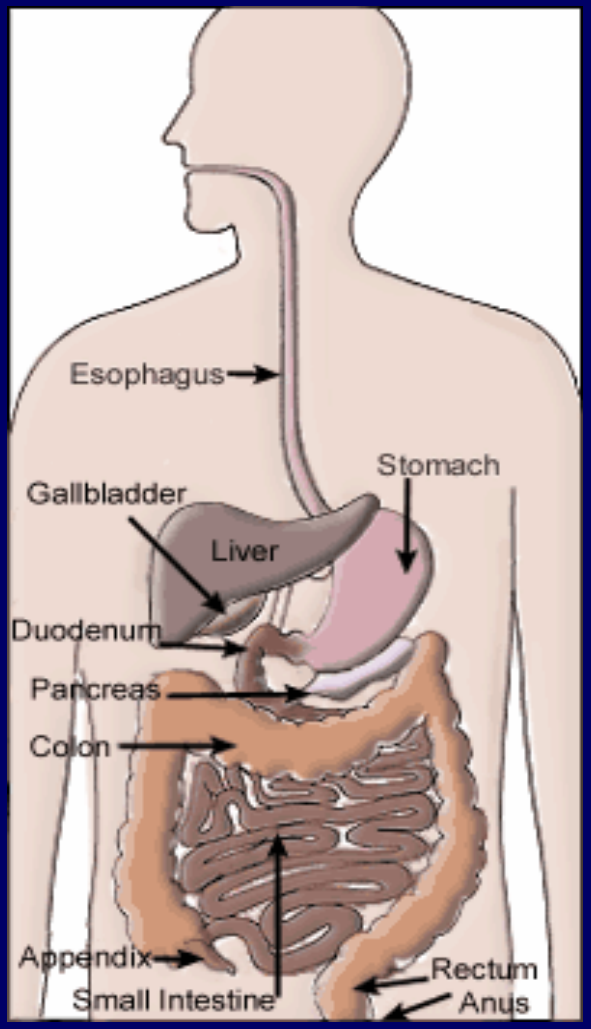
Epidemiology

In 24 hours……

- 200 million people on earth have gastroenteritis
- Diarrheal water = amount water over Victoria Falls in 1 min
- This does NOT include animals!

Health impact of diarrhea

- Each year there are approximately 4 billion cases of diarrhea worldwide
- Almost 3 million people worldwide die
- Diarrheal illness is the #2 killer in the world
- Diarrhea occurs world-wide and causes 4% of all deaths and 5% of health loss to disability



The World Health Report 2000,WHO, Geneva

Health impact of diarrhea (Cont'd)

- Annually from water-borne diarrheal illnesses
- 1.9 million of the 3 million annual deaths are children.
- It kills 5,000 children every day(one child every eight seconds!)

The World Health Report 2000,WHO, Geneva

Health impact of diarrhea (Cont'd)

- Nearly one in five child deaths – about 1.5 million each year – is due to diarrhea. Today, only 39 per cent of children with diarrhea in developing countries receive the recommended treatment

UNICEF/WHO (2009)

Health impact of diarrhea (Cont'd)

- Enteric infections, however, are not only occurring only in developing countries
- In the United States it is estimated that children less than 5 years old will have 2.2 episodes of diarrhea per year, in those above the age of 16 years this rate is still 1.7.

UNICEF/WHO (2009)

Health impact of diarrhea (Cont'd)

- Lastly, travelers originating in industrialized countries must expect an incidence rate of travelers' diarrhea exceeding 20%, sometimes even exceeding 50%, during a two weeks' stay in a developing country

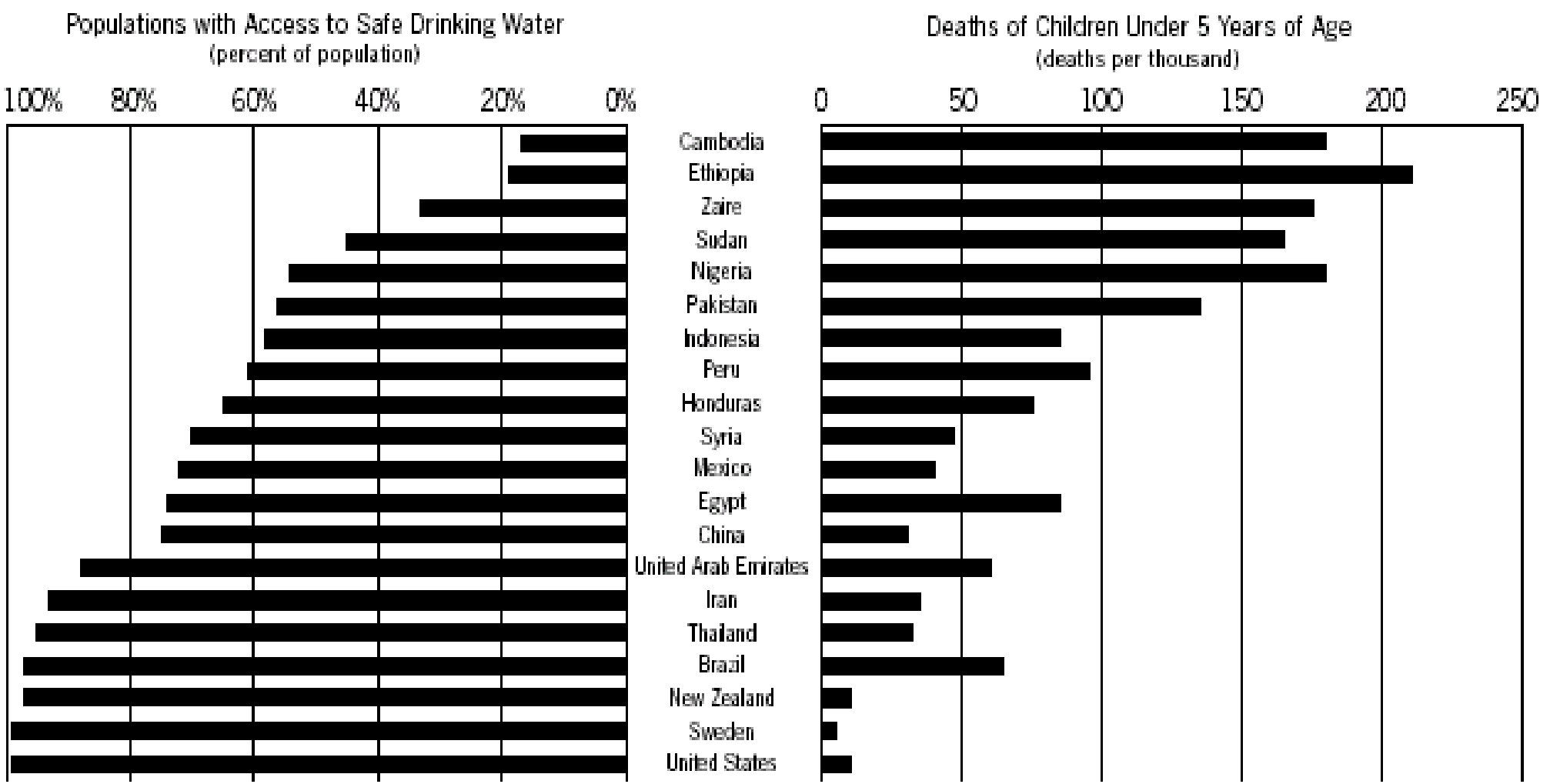
UNICEF/WHO (2009)

Health impact of diarrhea (Cont'd)

- Special attention will be given to at risk travelers.
- Obviously the strategies will vary in different parts of the world.

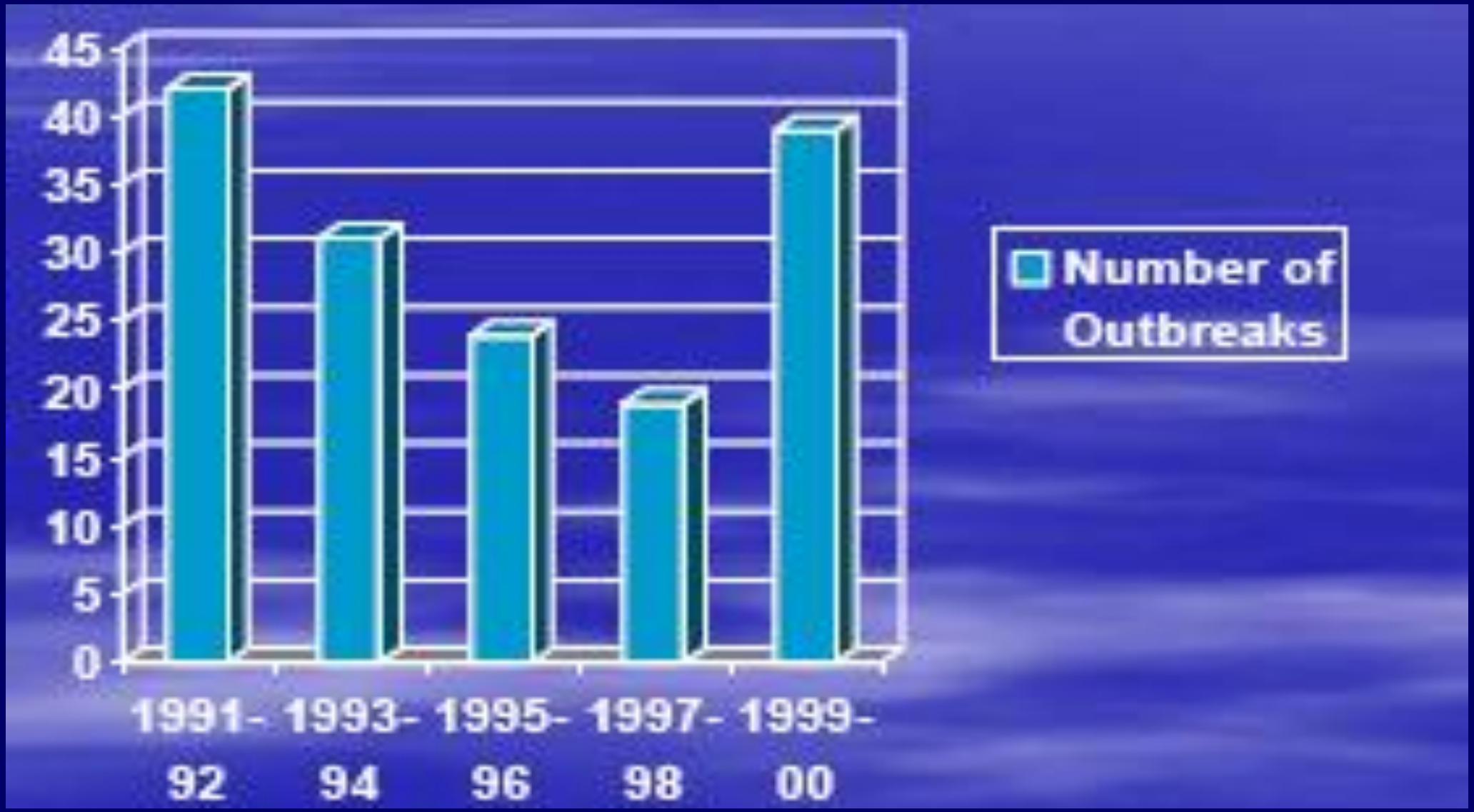
(UNICEF/WHO, 2009)

Water Quality & Child Survival



Sources: United Nations Children's Fund, *The State of the World's Children 1993*; Worldwatch Institute, *Worldwatch Paper 64: Investing in Children*, June 1985

Number of drinking water outbreaks

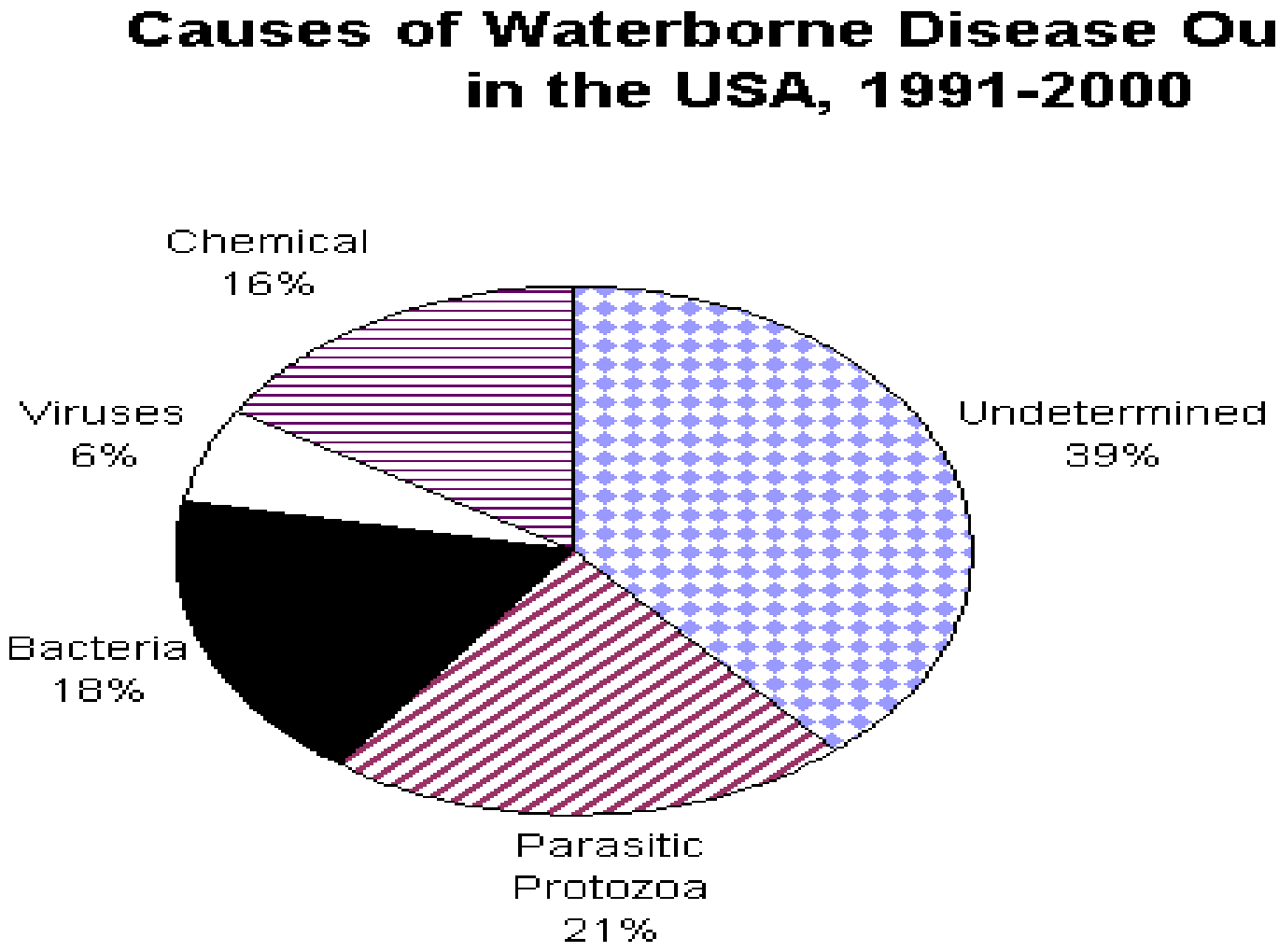


Cholera

- **According to the World Health Organization (WHO) in 2001, 58 countries reported 184,311 cases of cholera that resulted in 2,728 deaths.**
- **WHO estimates that only 5-10% of cases are reported.**

Dark areas showing locations of major outbreaks of cholera in 2001 (from World Health Organization).

Water borne outbreaks



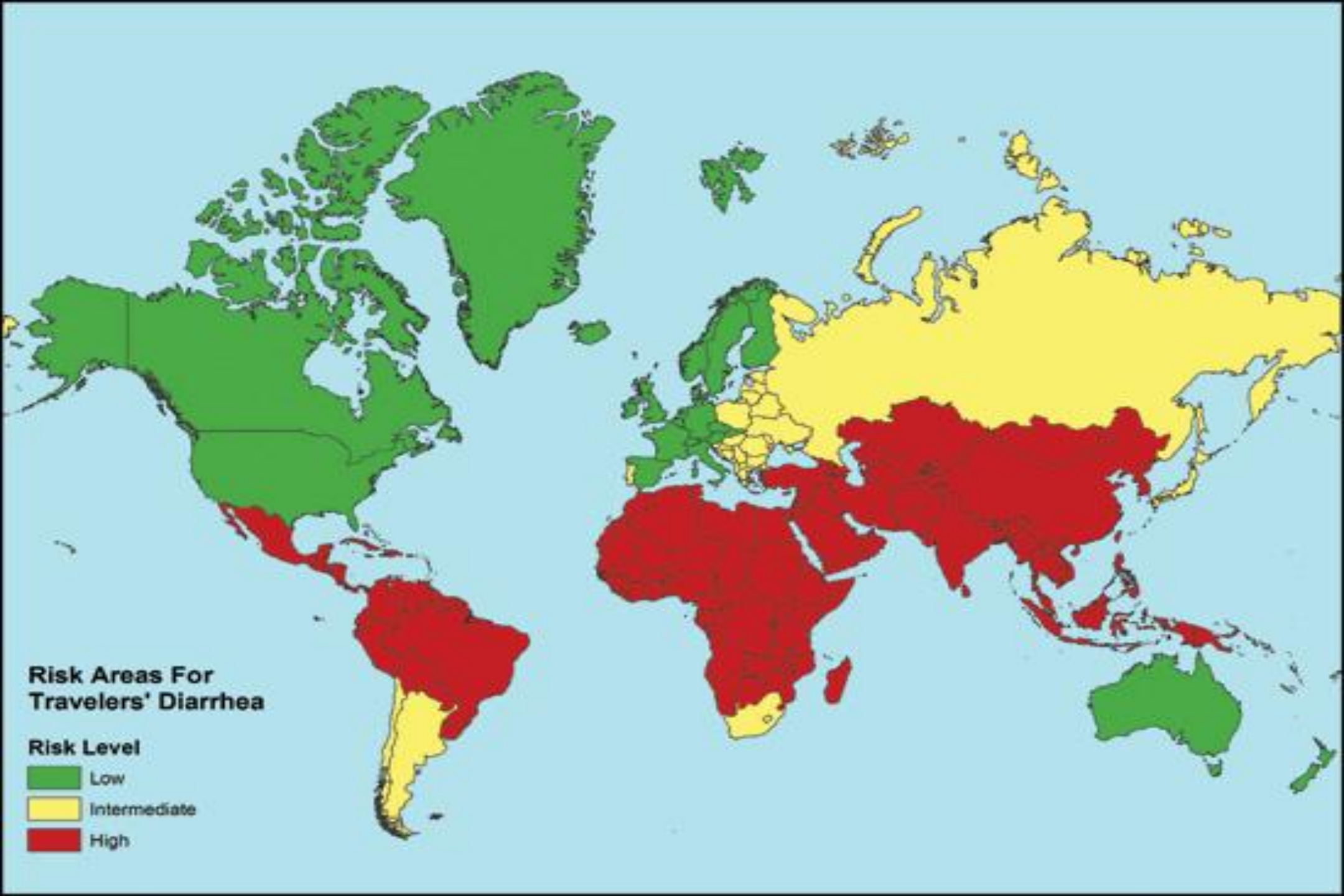
Etiological Agent	Community Water Systems[2]		Noncommunity Water Systems[3]		Individual Water Systems[4]		All Systems	
	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
Giardia	11	2,073	5	167	6	16	22	2,256
Cryptosporidium[7]	7	407,642	2	578	2	39	11	408,259
Campylobacter	1	172	3	66	1	102	5	340
Salmonellae, nontyphoid	2	749	0	0	1	84	3	833
E. coli	3	208	3	39	3	12	9	259
E. coli O157:H7/C. jeuni	0	0	1	781	0	0	1	781
Shigella	1	83	5	484	2	38	8	605
Plesiomonas shigelloides	0	0	1	60	0	0	1	60
Non-01 V. cholerae	1	11	0	0	0	0	1	11
Hepatitis A virus	0	0	1	46	1	10	2	56
Norwalk-like viruses	1	594	4	1806	0	0	3	2400
Small, round-structured virus	1	148	1	70	0	0	2	218
Chemical	18	522	0	0	7	9	25	531

Modern/Recent Outbreaks

- Campylobacter
  - 1978, Bennington, VT
  - 2000 sick out of 10,000
- Giardia (amoeba)
  - cysts
  - hikers
- Cryptosporidium (sporozoan protozoa)
  - oocysts
  - Milwaukee, WI, 1993 – 400,000 sick, 100 deaths
- Sydney, Australia, 1999 – threatened Olympics
  - Giardia and Cryptosporidium

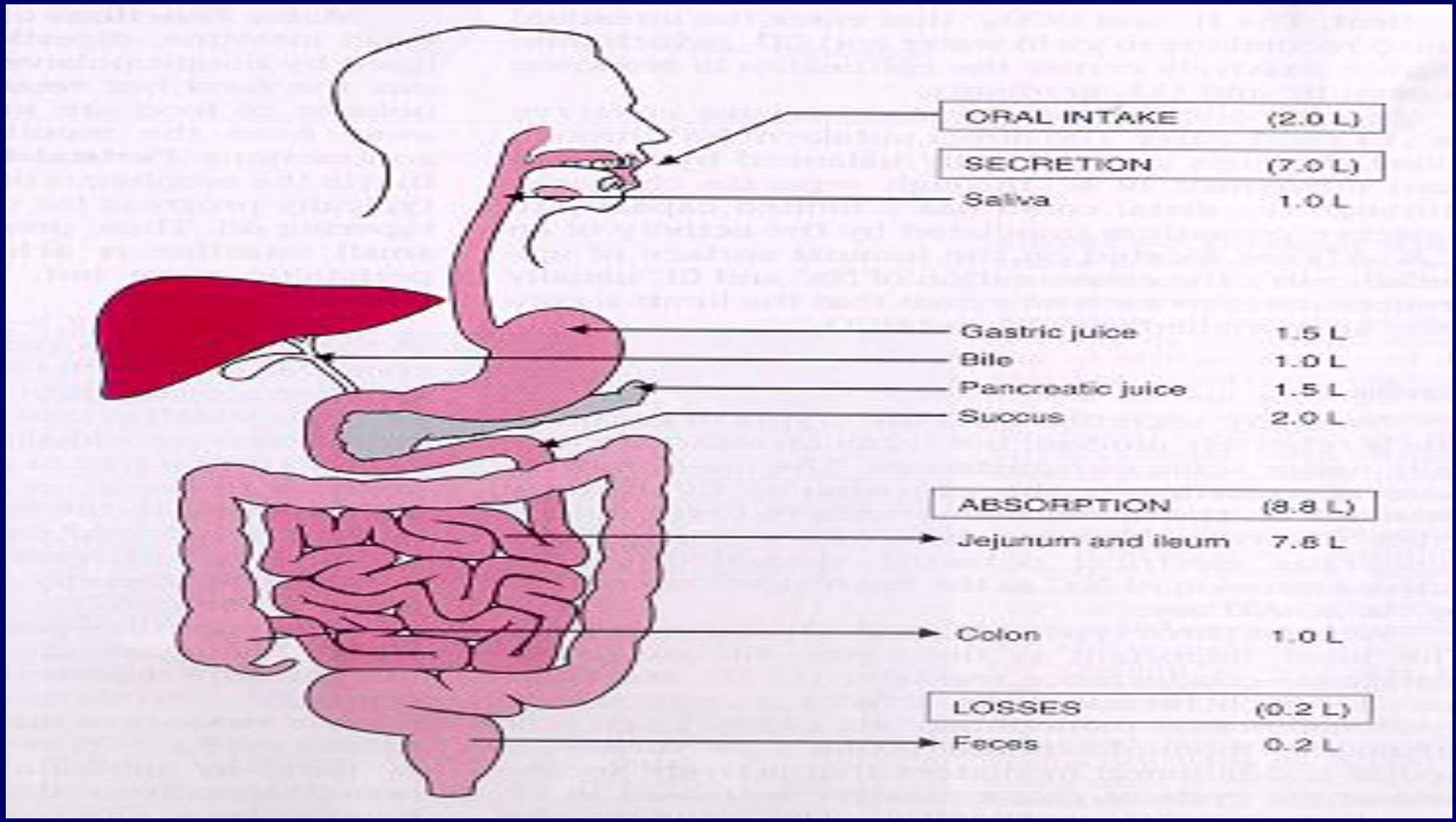
TRAVELER'S DIARRHEA

- Whenever a person travels from one country to another—particularly if the change involves a marked difference in:
  - Climate
  - Social conditions
  - Sanitation standards and facilities
- Diarrhea is likely to develop within 2–10 days


Risk Areas For
Travelers' Diarrhea
Risk Level
Low
Intermediate
High

WATER SUPPLY, GLOBAL COVERAGE, 2000

Fluid Absorption in the Gut

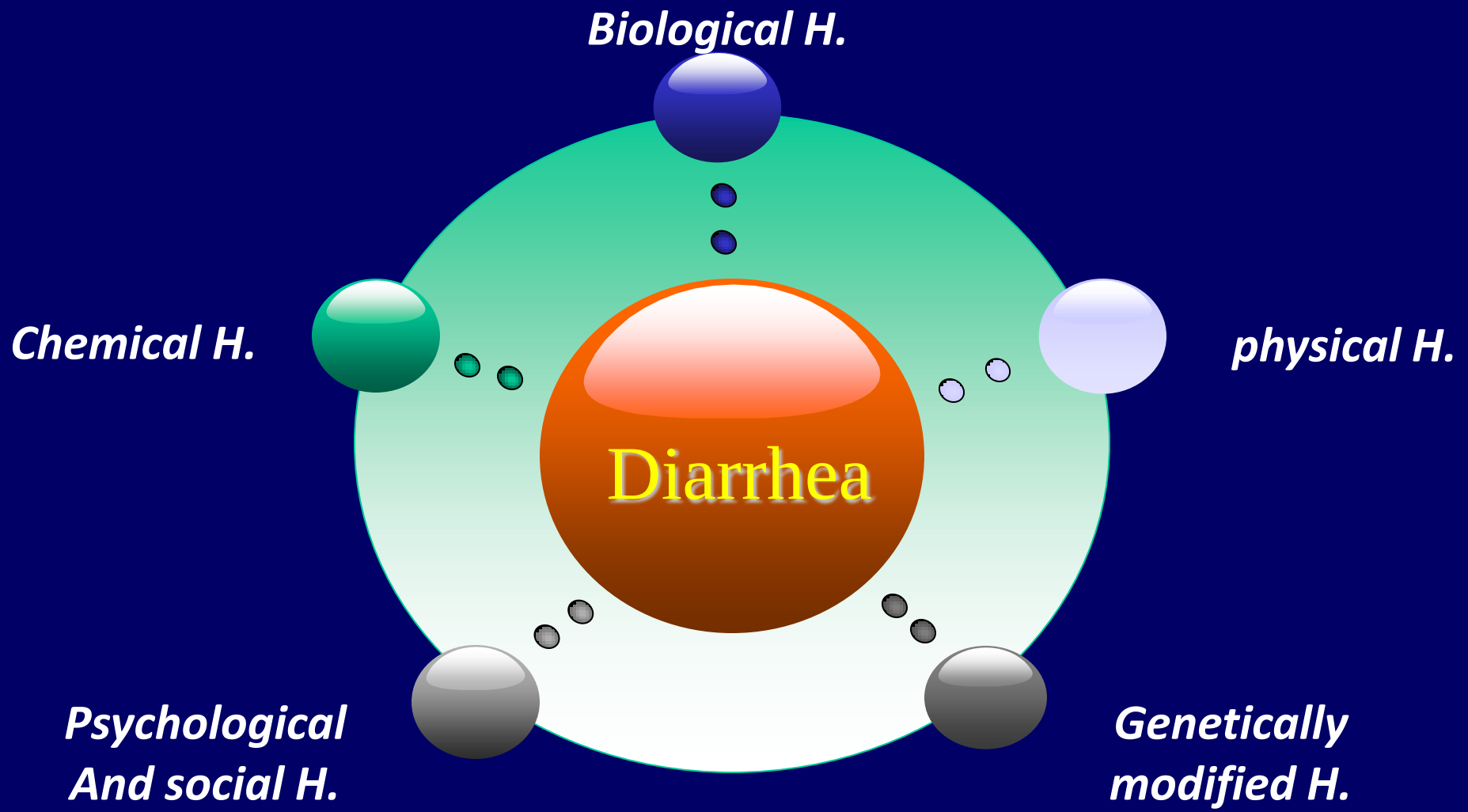


Causes of diarrhea: as an overview

1. Physical hazards: Irradiation, ionizing particles,…
2. Chemical Hazards: Heavy metals, nitrates, F, Se,…
3. Biological Hazards: bacteria, viruses, parasites,…
4. Psychological and social hazards: leading to IBS, IBD, DM…
5. Genetically modified hazards: Genetic engineering,…

Causes of diarrhea: an overview

(Cont'd)



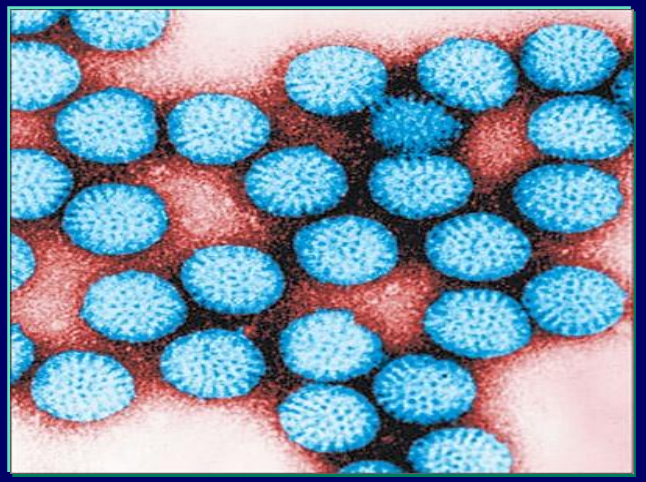
Which one is our country priority?

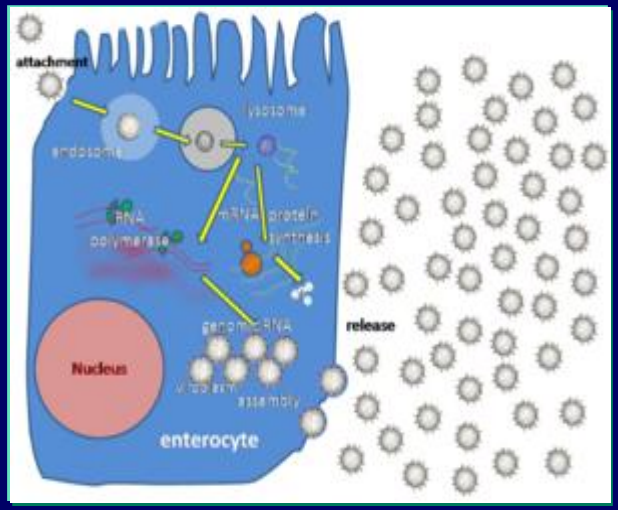
Common Causes Of Diarrhea- Viruses

- Rotavirus: stomach flu!
- Norvo virus and Norwalk-like viruses
- Adenoviruses
- Caliciviruses
- Astroviruses

Viral GE: Rotavirus (Cont'd)

- Rotavirus (Rota is Latin for wheel):
  - A dsRNA virus, cause about one- third of all diarrhea- related hospitalizations world wide, with about 800,000 deaths each year
  - Of 5 recognized species of Rota virus (A, B, C, D, and E), group A accounts for most (90%) outbreaks





Viral GE: Rotavirus (Cont'd)

- IP: 2 days
- Host: 6- 24 mo (decrease progressively towards 45 years of age)
- Transmission:
  - Mainly fecal- oral route, (explaining in part its high frequency in children care centers)
  - possibly by the respiratory route

Viral GE: Rotavirus (Cont'd)

- Clinical manifestation:

  low grade fever, vomiting and diarrheas lasting for 4 to 8 days
- Complications: rare reports of complications (Viremia, Encephalitis, Meningitis)

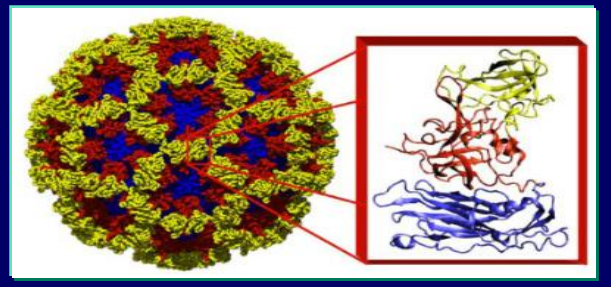
Viral GE: Rotavirus (Cont'd)

- Diagnosis:
  - EIA of stool
  - EM
  - Polyacrylamide Gel Electrophoresis
  - RT-PCR

Viral GE: Rotavirus (Cont'd)

- Treatment: conservative measures
- Prevention:
  - Sanitary measures ineffective in control of rotavirus, as the incidence of rotavirus infection in countries with high and low health standards is similar
  - Personal health
  - Vaccine

Viral GE: Noroviruses and other calciviruses



- Caliciviruses (Calix is Latin for “Cup” or “goblet”)
  - Cause more than one-third of non- bacterial GE outbreaks in the US
  - Norovirus(previously Norwalk agent, after an outbreak in Norwalk, Ohio) is a genera of calcivirus family (stomach flu)

Viral GE: Viral GE: Noroviruses and other calciviruses (Cont'd)

- IP: 2 days
- Host: all age groups
- Transmission:
  - Generally by fecal- oral route
  - Can also spread by respiratory route (aerosols)
  - Highly stable in the environment
  - Category B bioterrorism agents

Viral GE: Noroviruses and other calciviruses (Cont'd)

- Clinical Manifestations:
  - Inflammation of stomach, small and even large intestine, hence the term "winter vomiting"
  - Vomiting and diarrhea, or both
  - Usually last for 2-3 days

Viral GE: Viral GE: Noroviruses and other calciviruses (Cont'd)

- Diagnosis:
  - RT-PCR
  - ELISA
- Treatment:
  - Conservative management
- Prevention:
  - Hand washing
  - Personal health

Viral GE: Viral GE: Astroviruses and other agents of viral GE

- Astrovirus:
  - Mostly in young children
  - Usually no symptoms in adults
  - Secondary cases are less common
- Adenovirus (Group F)
- Coronaviruses, Echoviruses, Coxsacki A and B, Non- group F Adenoviruses, Picobirnaviruses, Picotrinaviruses, Pestiviruses, and Toroviruses

Common Causes Of Diarrhea- Bacteria

- Vibrio cholera
- Shigella
- Escherichia coli
- Salmonella
- Campylobacter jejuni
- Yersinia enterocolitica
- Staphylococcus
- Vibrio parahemolyticus
- Clostridium difficile

Common Causes Of Diarrhea- Parasites

- Entameba histolytica
- Giardia lamblia
- Cryptosporidium
- Isospora

Common Causes Of Diarrhea-Others

- Metabolic disease
  - Hyperthyroidism
  - Diabetes mellitus
  - Pancreatic insufficiency
- Food allergy
  - Lactose intolerance
- Antibiotics
- Irritable bowel syndrome

Travelers' diarrhea etiology

- Bacteria :80% of cases of TD (ETEC, Shigella species, and Campylobacter jejuni being the most common pathogen
- Less common causative agents include Aeromonas, Salmonella, noncholera vibrios, Entamoeba histolytica, and Giardia lamblia.
- Contributory causes may at times include unusual food and drink, change in living habits, occasional viral infections (adenoviruses or rotaviruses), and change in bowel flora

Mechanisms of Diarrhea

1) Osmotic load within the intestine resulting in retention of water within the lumen
2) Excessive secretion of electrolytes and water into the intestinal lumen
3) Exudation of fluid and protein from the intestinal mucosa
4) Altered intestinal motility resulting in rapid transit through the colon

Mechanisms of Diarrhea

- **Secretory:** water secretion exceeds water absorption – e.g. toxins
- **Osmotic:** excessive solute in the gut lumen – water won't be absorbed – e.g. lactose intolerance
- **Infectious/Inflammatory:** epithelial destruction, loss of absorptive capacity – viral infection

Chronic diarrhea

- **Osmotic:** e.g.. Liquid formula
  contaminated, infusion rate, feeding tube, tonicity

- **Secretory:** Tumor/hormonal secretion(Gastrinoma, VIPoma,
  Carcinoid syn) or enterotoxin irritation.
- **Exudative:** R/T, C/T, IBD…
- **Motility:** surgical procedure(rapid emptying) or
  bacterial overgrowth

Types Of Diarrhea(Time of the onset)

- Acute: if <2 weeks
- Persistent: if 2 to 4 weeks
- Chronic: if >4 weeks in duration

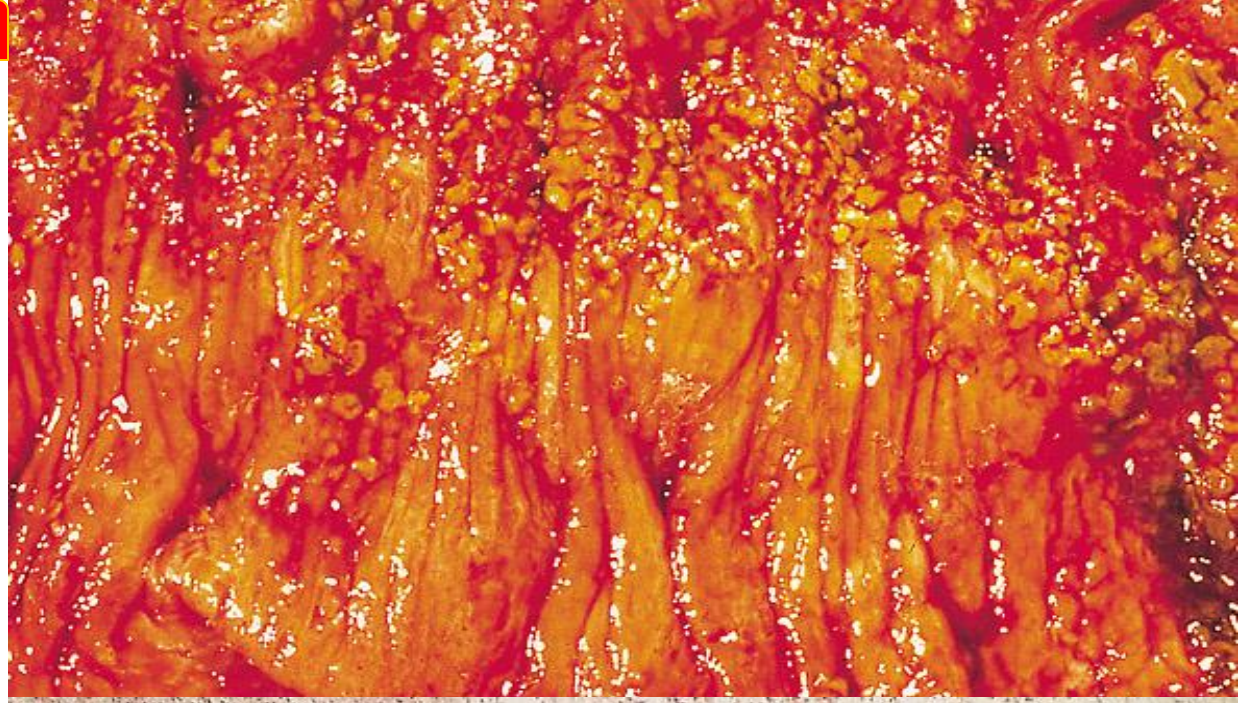
Types Of Diarrhea (Severity of Diarrhea)

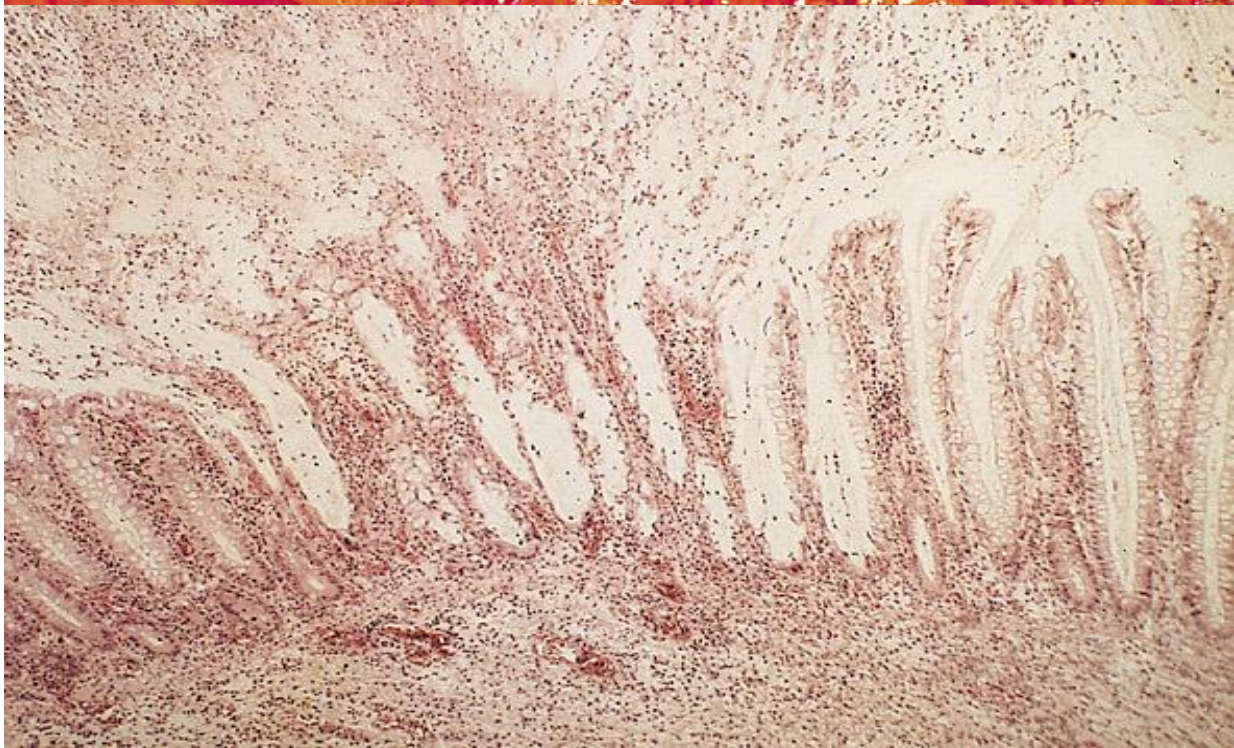
- Mild: ≤3 unformed stool/day, minimal associated symptomatology
- Moderate: ≥4 unformed stools and/or systemic symptoms
- Severe: ≥6 unformed stools/day and/or Temp ≥101°F and/or systemic symptoms

The Sanford guide to antimicrobial therapy, 2010

Severe Diarrhea

ally, profuse diarrhea; however, in
ome cases there is little or no
arrhea because of involvement of
e cecum and right colon or
ecause of ileus
ally severe abdominal pain
fever and appearance of toxic
ffects
me depletion
ked leukocytosis
toneal signs
l leukocytes
iographic findings can include
aralytic ileus, dilated colon (and
ven toxic megacolon),
humbprinting" on abdominal plain
ms, and diffusely thickened or
dematous colonic mucosa
oscopy may demonstrate adherent
ellow plaques that vary in diameter
nd in some cases, may coalesce to
over large areas of the mucosa*





Types Of Diarrhea(Type of stool)

- Watery Diarrhea
- Dysentery

Types Of Diarrhea(Volume and frequency of stool)

- Small bowel pattern diarrhea
- Large bowel pattern diarrhea

Clinical Features: Cholera

- Rice-watery stool
- Marked dehydration
- Projectile vomiting
- No fever or abdominal pain
- Muscle cramps
- Hypovolemic shock
- Scanty urine

Diagnosis

Diagnosis

- The causes of diarrhea are myriad
- In clinical practice, it is helpful to distinguish acute from chronic diarrhea, as the evaluation and treatment are entirely different
- Syndromic approach both in "Diagnosis" and "Treatment " of acute diarrheas

Evaluation

- Over 90% of patients with acute diarrhea, the illness is mild and self-limited and responds within 5 days to simple rehydration therapy or antidiarrheal agents
- Patients with signs of inflammatory diarrhea manifested by any of the following require prompt medical attention: high fever (> 38.5 °C), bloody diarrhea, abdominal pain, or diarrhea not subsiding after 4–5 days. Similarly, patients with symptoms of dehydration must be evaluated (excessive thirst, dry mouth, decreased urination, weakness, lethargy)

Evaluation (Cont'd)

- Physical examination should note the patient's general appearance, mental status, volume status, and the presence of abdominal tenderness or peritonitis
- Peritoneal findings may be present in C difficile and enterohemorrhagic E coli. Hospitalization is required in patients with severe dehydration, toxicity, or marked abdominal pain. Stool specimens should be sent in all cases for examination for fecal leukocytes and bacterial cultures

Evaluation (Cont'd)

- The rate of positive bacterial cultures in patients with dysentery is 60–75%. A wet mount examination of the stool for amebiasis should also be performed in patients with dysentery who have a history of recent travel to endemic areas or those who are homosexuals. In patients with a history of antibiotic exposure, a stool sample should be sent for C difficile toxin. If E coli O157:H7 is suspected, the laboratory must be alerted to do specific serotyping. In patients with diarrhea that persists for more than 10 days, three stool examinations for ova and parasites also should be performed. Rectal swabs may be sent for Chlamydia, Neisseria gonorrhoeae, and herpes simplex virus in sexually active patients with severe proctitis

Evaluation (Cont'd)

- Usually no need to perform:
- S/E, S/C
- Blood test
- Imaging
- Toxin assay

Treatment

Treatment and care

Key measures to treat diarrhea include:

- Giving more fluids than usual, including oral rehydration salts solution, to prevent dehydration.
- Continue feeding.
- Consulting a health worker if there are signs of dehydration or other problems

The World Health Report 2000,WHO, Geneva

Treatment and care (Care)

Mild Diarrhea

- Fluids only (ORT preferably)
- Lactose free diet
- Avoid caffeine

NEJM: 350: 38, 2004)

Treatment and care (Care)

Moderate Diarrhea

- Fluids (ORT preferably)
- Anti motility agents :
  - Loperamide(Imodium) 4 mg po, then 2 mg after each loose stool to max. of 16 mg per day
  - Bismuth subsalicylate 2tab(262mg) po qid
  - Avoid in suspected HUS

NEJM: 350: 38, 2004)

Treatment and care (Care)

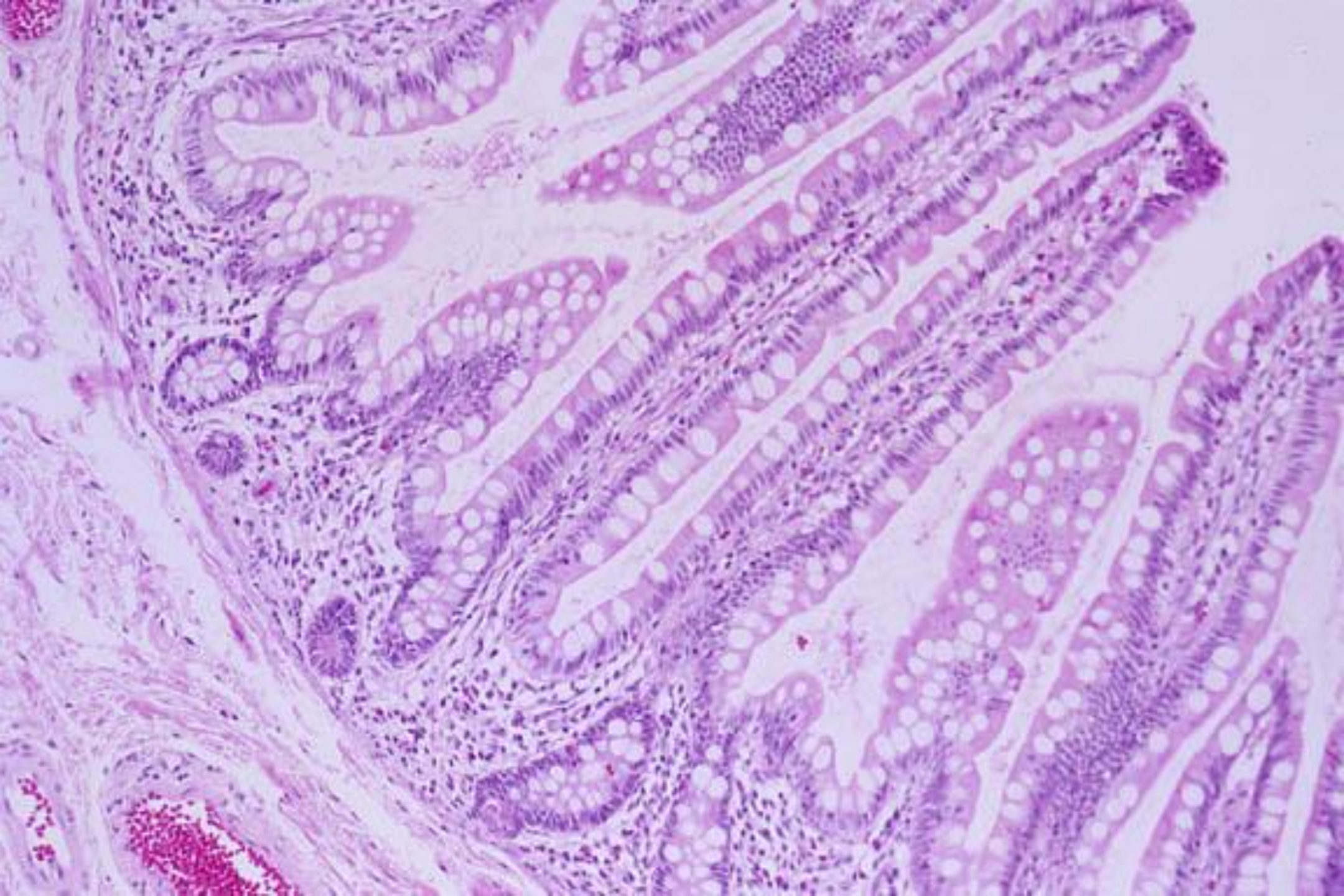
Severe Diarrhea

- FQ (Ciprofloxacin 500mg po q12h or Levofloxacin 500mg q24h) 3-5 days
- Alternative: TMP/SMZ- DS po BID 3-5 days
- If recent ABx Rx (C.difficil toxin colitis possible) add Metronidazole 500mg po tid 10-14 days, or Vancomycin 125 mg po qid 10-14 days

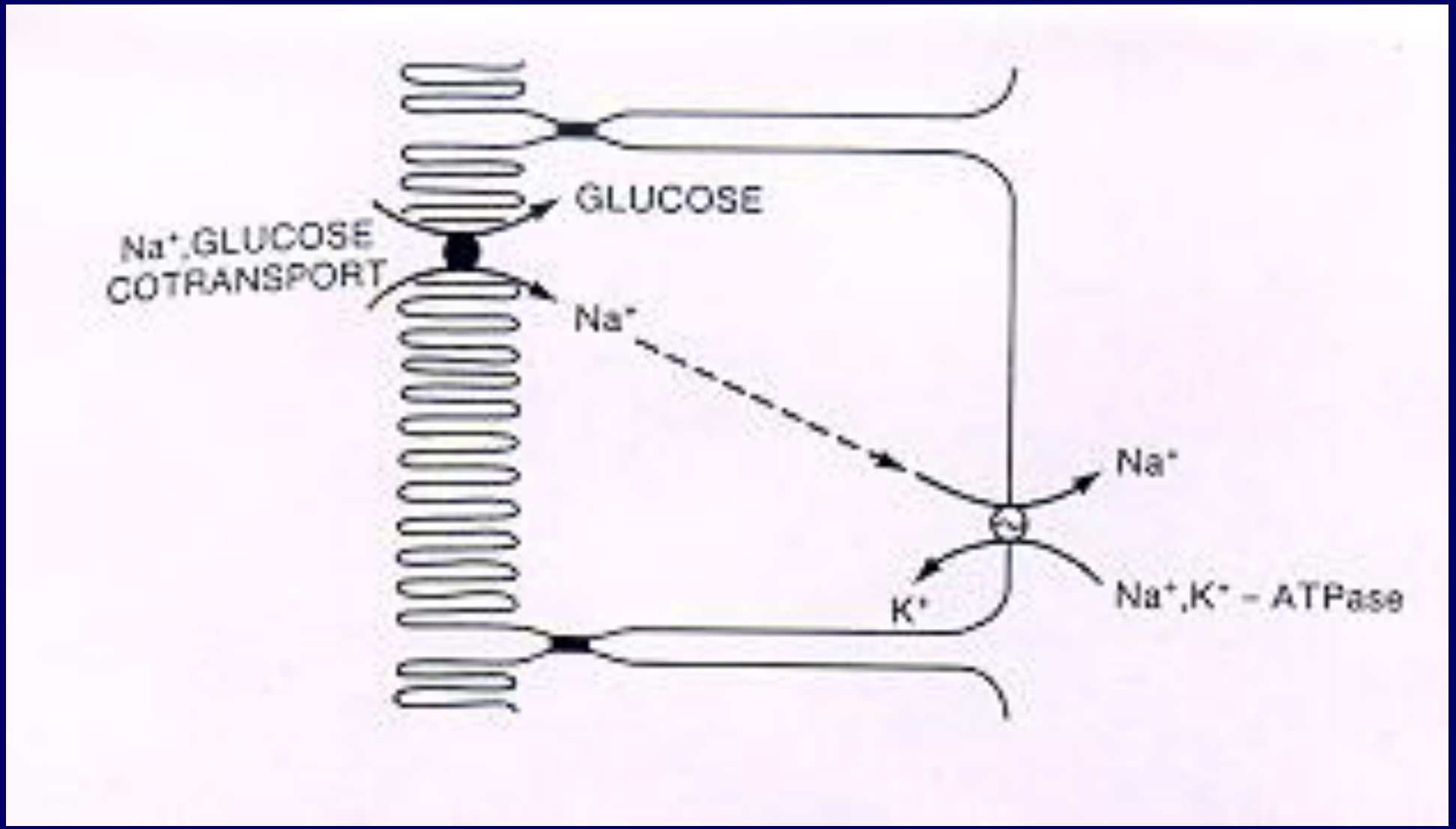
NEJM: 350: 38, 2004)

Rehydration Therapy (RT)

- Oral electrolyte Therapy (ORT): ORS is readily available.
- An easy alternative mixture is:
  - 1 tsp salt (3.5 g)
  - 1 tsp baking soda (2.5 g $NaHCO_3$)
  - 8 tsp sugar (40 g)
  - 8 oz orange juice (1.5 g KCl)
- Diluted to 1 Lit water:50–200 mL/kg/24 h depending on the hydration status
- Intravenous Therapy (IVT): lactated Ringer's solution preferred acutely in patients with severe dehydration



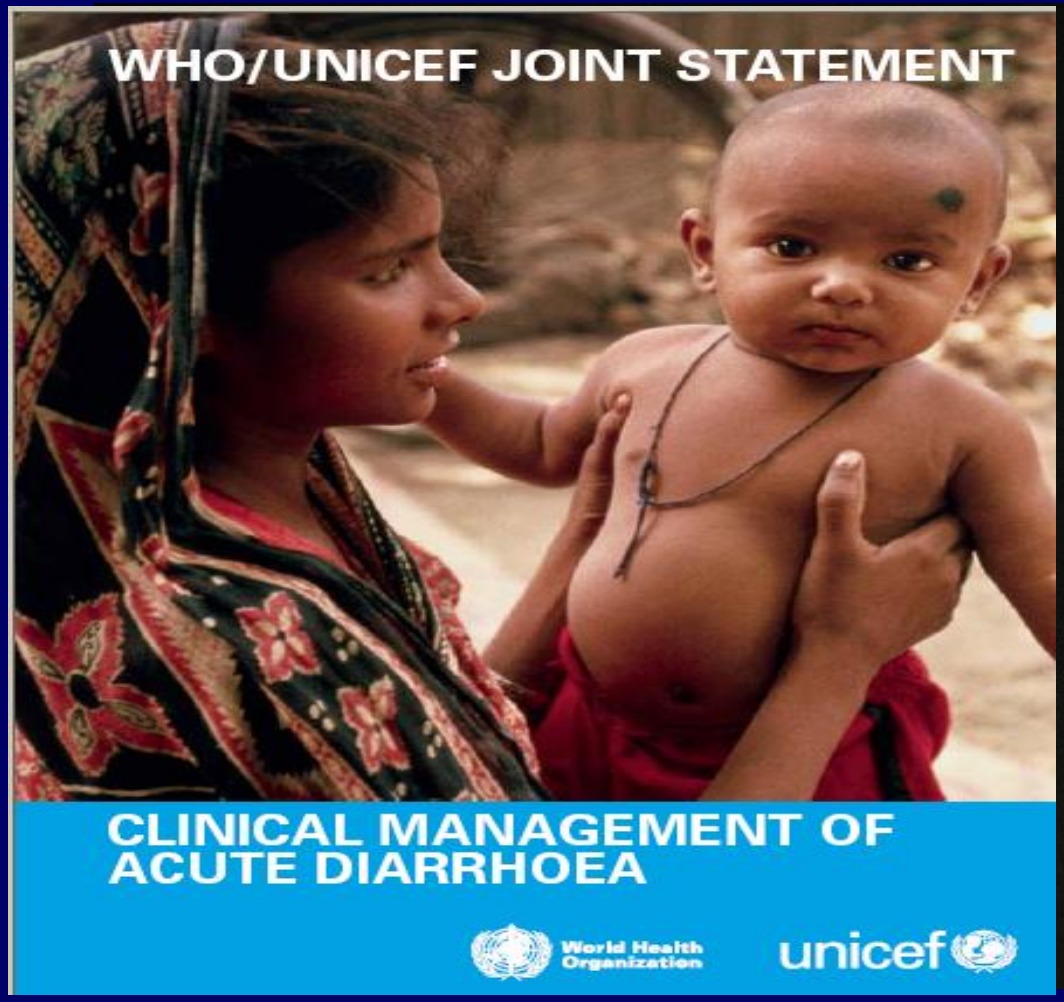
Ion Transport and Electrolyte Balance

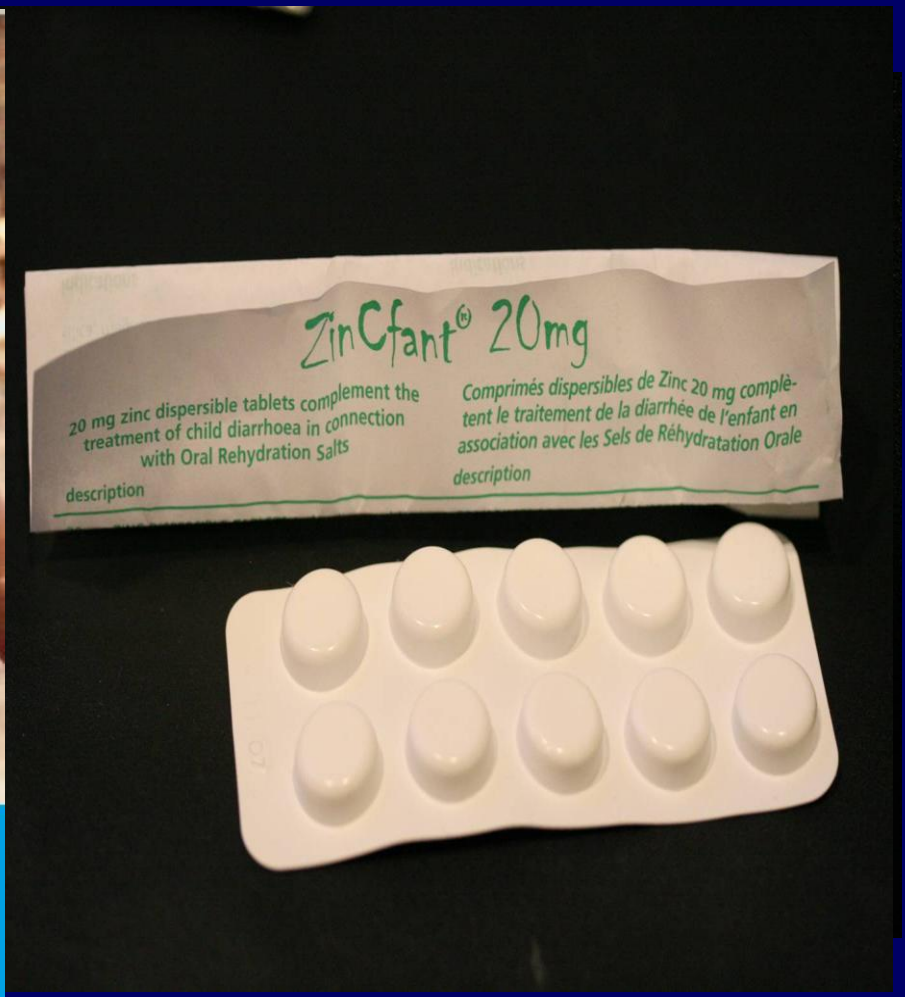


Nutrition and zinc supplement

- The overwhelming majority of adults have mild diarrhea that will not lead to dehydration provided the patient takes adequate oral fluids containing carbohydrates and electrolytes.
- Zn supplement reduces duration of diarrhea episode by up to 25%
- Provide children with 20 mg per day of zinc supplementation for 10-14 days (10 mg per day for infants under six months old)
- Frequent feedings of fruit drinks, tea, "flat" carbonated beverages, and soft, easily digested foods (eg, soups, crackers) are encouraged

Zinc and Low-osmolarity ORS: effective, safe and available





Antidiarrheal Agents

- Loperamide: is the preferred drug in a dosage of 4 mg initially, followed by 2 mg after each loose stool (maximum:16 mg/24 h
- Bismuth subsalicylate (Pepto-Bismol): two tablets or 30 mL four times daily, reduces symptoms in patients with traveler's diarrhea by virtue of its anti-inflammatory and antibacterial properties
- Anticholinergic agents: are contraindicated in acute diarrhea

Medically Important Diarrhea

- Inflammatory, bloody diarrhea
- Severe volume depletion
- High fever
- Sever abdominal pain
- Duration > 3 days
- Community outbreak
- Impaired host

Antibiotic Therapy

- Fluoroquinolones: (eg, ciprofloxacin, 500 mg twice daily) for 5–7 days.
- Alternative agents:TMP/SMZ(160/800 mg twice daily), or Erythromycin(250–500 mg four times daily)

Antibiotic Therapy (Cont'd)

- Specific antimicrobial treatment- Antibiotics are not generally recommended in patients with:
  - Viral GE
  - Nontyphoid Salmonella,
  - Campylobacter
  - Yersinia infection(except in severe or prolonged disease because they have not been shown to hasten recovery or reduce the period of fecal bacterial excretion)
-

Antibiotic Therapy (Cont'd)

- The infectious diarrheas for which treatment is clearly recommended are:
  - Shigellosis
  - Cholera
  - Extraintestinal salmonellosis
  - Traveler's diarrhea
  - C difficile infection
  - Giardiasis
  - Amebiasis
  - STIs (gonorrhea, syphilis, chlamydiosis, and herpes simplex infection)

Antibiotic Associated Colitis(AAC)

Treatment

➢ *WBC< 15000, no increase in serum Cr.:*

- Choice: Metronidazole: 500 mg po tid or 250 mg po qid 10-14 dyas
- Alternatives:
  - Vancomycin: 125 mg po qid 10-14 days
  - Teicoplanin: 400 mg po bid 10 days

CID 43:421, 2006

Antibiotic Associated Colitis(AAC)

Treatment

- *Sicker, WBC> 15000, ≥50% increase in baseline Cr.:*
- Choice: Vancomycin: 125 mg po qid 10-14 days
- Alternatives:
- Metronidazole: 500 mg po tid or 250 mg po qid 10 days

CID 43:421, 2006

CHRONIC DIARRHEA

- The causes of chronic diarrhea may be grouped into six major pathophysiologic categories

Prevention

Control & Prevention

- Global
- Governments
- Communities
- Individuals

Control & Prevention

- Global
- Governments
- Communities: as a educational, treatment and care and/or research institute
- Individuals

Control & Prevention

- Global
- Governments
- Communities: as a research institute
- Individuals: as a physician

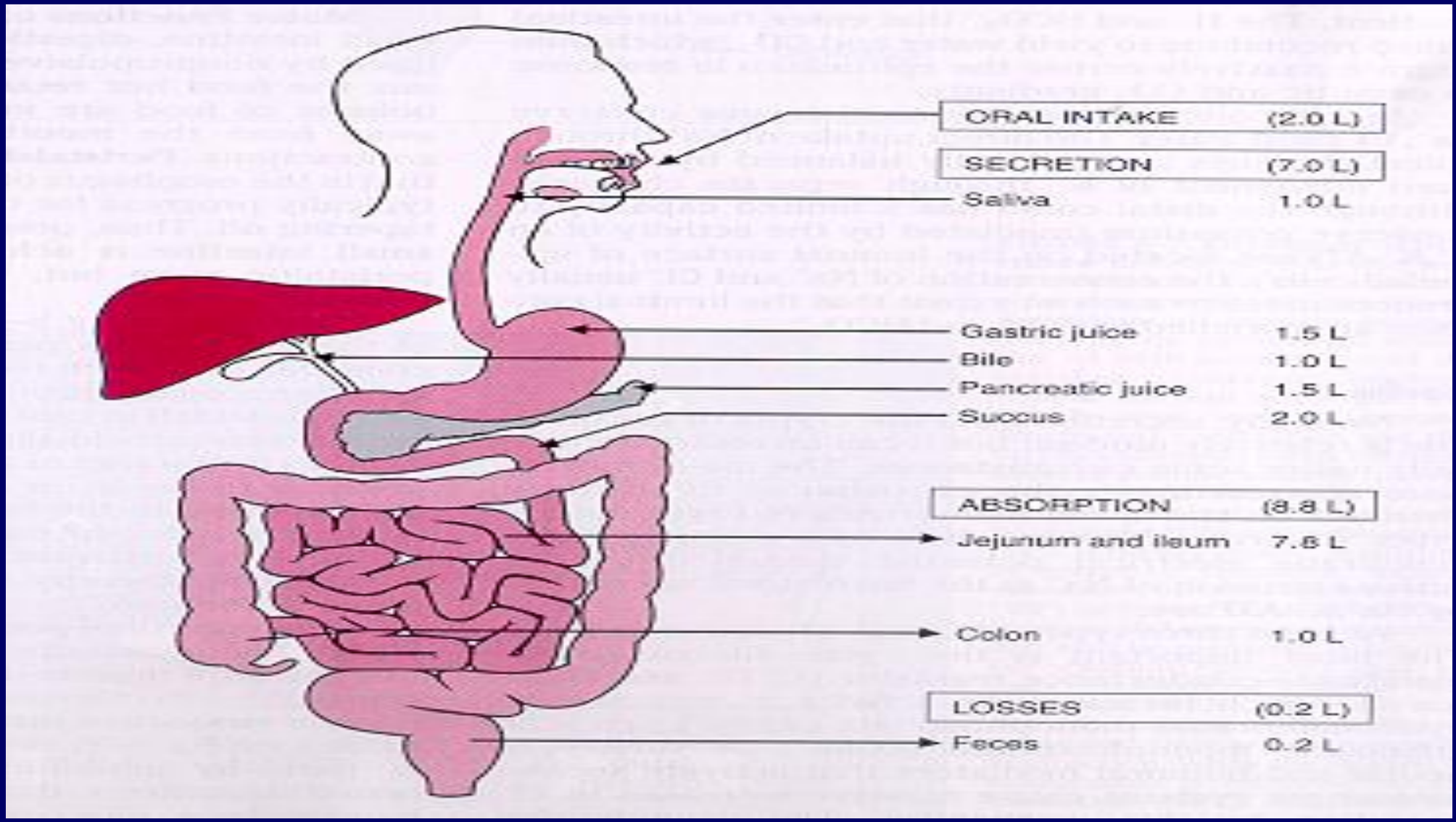
Prevention and control Strategies

Key measures to reduce the number of cases of diarrhea include:

- Clean water
- Clean food :good personal and food hygiene
- Clean environment
- Improvement of the infrastructures
- Vaccines

(UNICEF/WHO, 2009)

Food & Fluid and the Gut



Prevention and control Strategies

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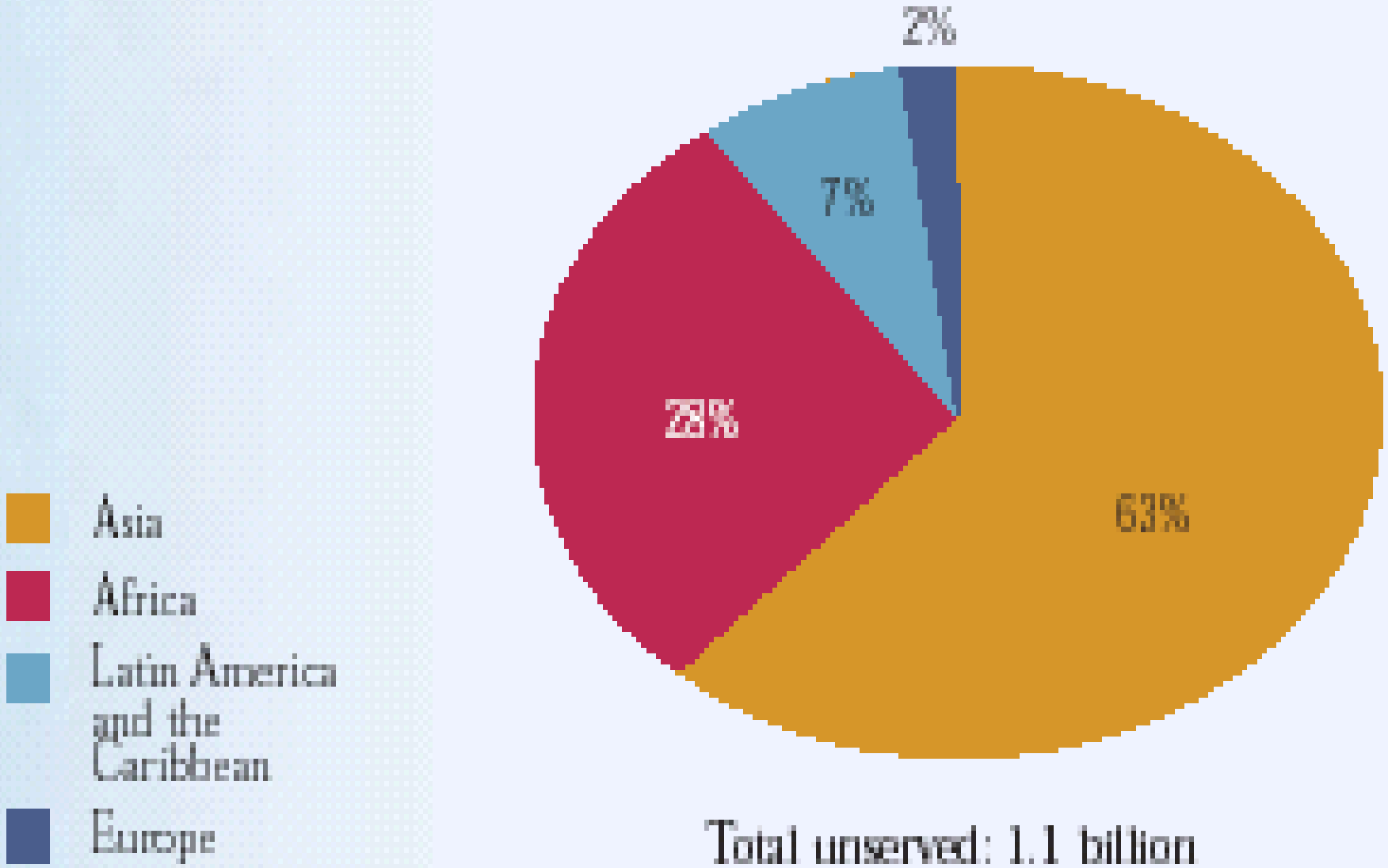
(UNICEF/WHO, 2009)

Healthy Drinking Water

- Water is basic to life and health.
- Over 1 billion people worldwide have no access to safe drinking water.

Center for Disease Control (CDC)

DISTRIBUTION OF THE GLOBAL POPULATION NOT SERVED WITH IMPROVED WATER SUPPLY, BY REGION



Total unserved: 1.1 billion

WATER SUPPLY, GLOBAL COVERAGE, 2000

Water-related diseases can be classified into 4 major categories (from WHO):

- ***1: Water-borne diseases:***
  infections spread through contaminated drinking water
  2: Water-washed diseases:
  diseases due to the lack of proper sanitation and hygiene
  3: Water-based diseases:
  infections transmitted through an aquatic invertebrate organism
  4: Water-related vector-borne diseases
  diseases transmitted by insects that depend on water for their propagation

WBDs: Diarrheal Diseases

- Cholera
- Shigellosis
- Typhoid fever
- Viral Gastroenteritis: Rora virus, Noro virus, Adenovirus, Hepatitis A, Hepatitis E
- Giardiasis
- Cryptosporidiosis
- Campylobacteriosis
- Cyclosporiasis

WBDs (Cont'd)

In addition, water-borne disease can be caused by the pollution of water with chemicals that have an adverse effect on health:

- Arsenic
- Flouride
- Nitrates from fertilizers
- Carcinogenic pesticides (DDT)
- Lead (from pipes)
- Heavy Metals

Other WBDs

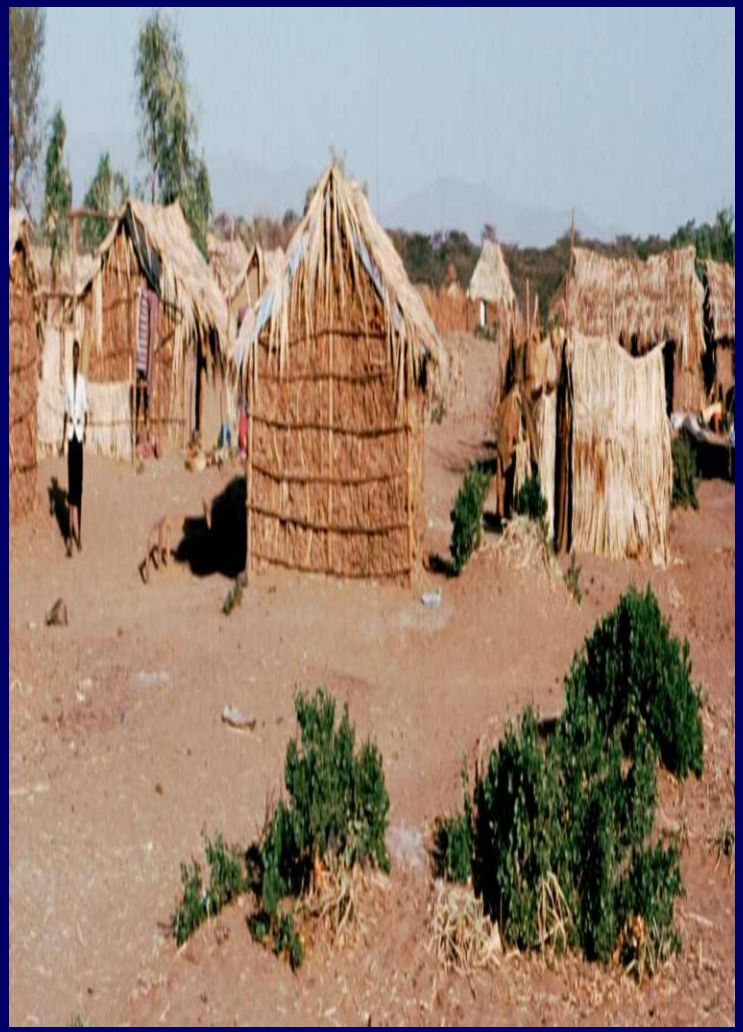
- Bathing
- Swimming
- Other recreational activities that have water contact
- Agriculture
- Aquaculture

Water-washed Diseases

Diseases caused by poor personal hygiene and skin and eye contact with contaminated water

These include :

- scabies
- trachoma
- typhus
- other flea, lice, and tick-borne diseases

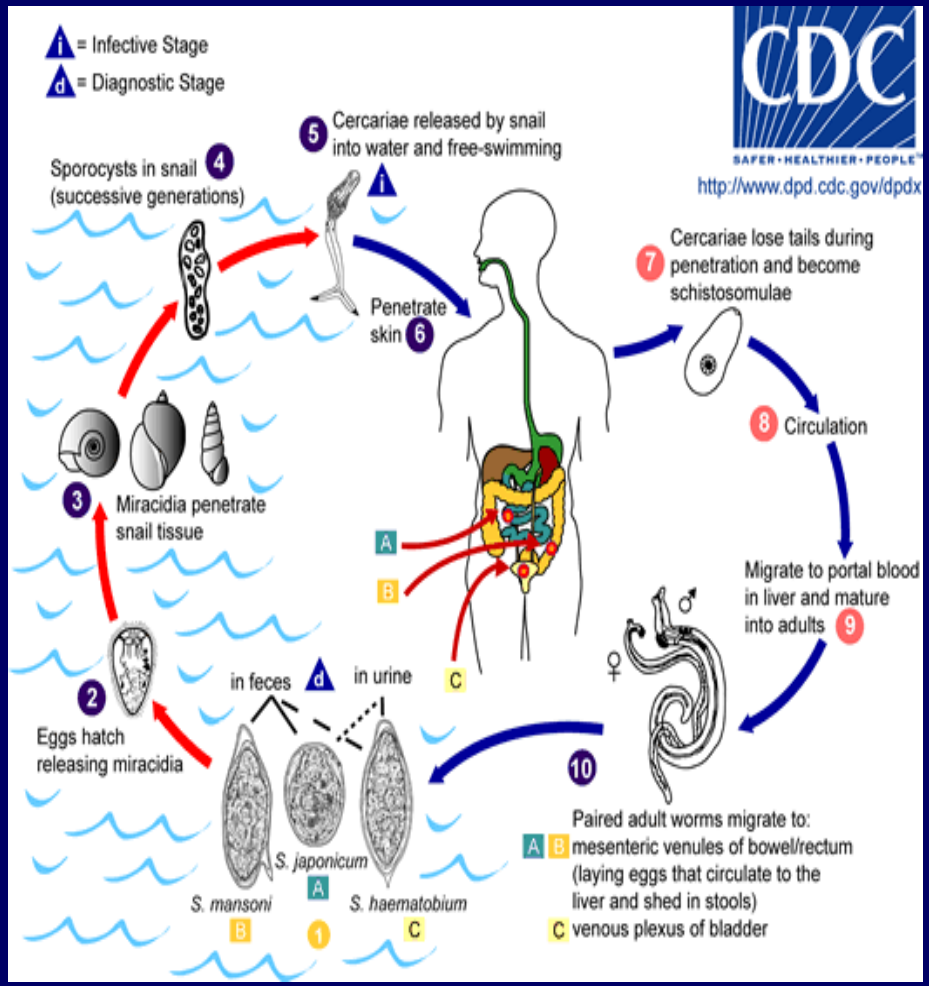


Water-based Diseases

Diseases caused by parasites found in intermediate organisms living in contaminated water

Includes:

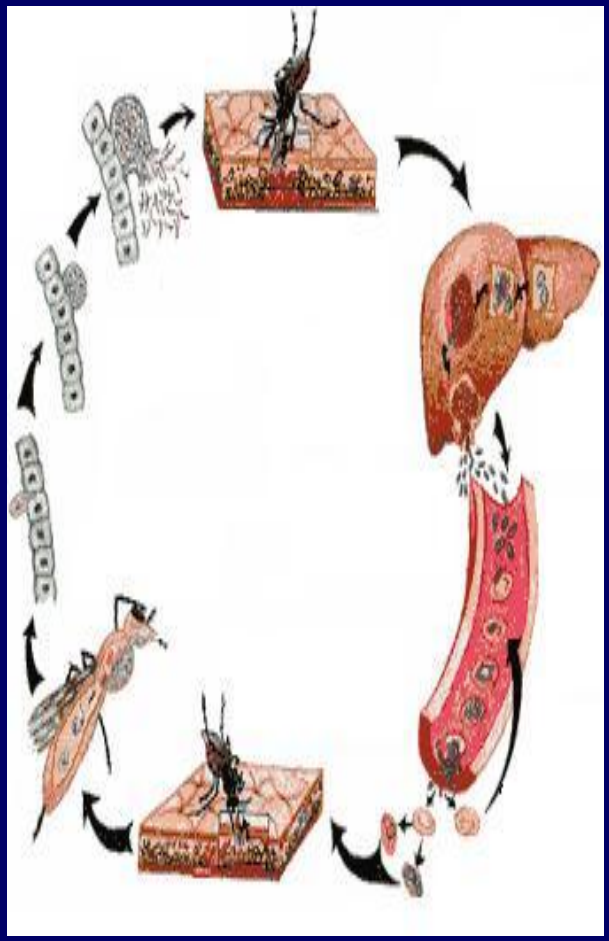
- ❑ Schistosomiasis
- ❑ Dracunculiasis



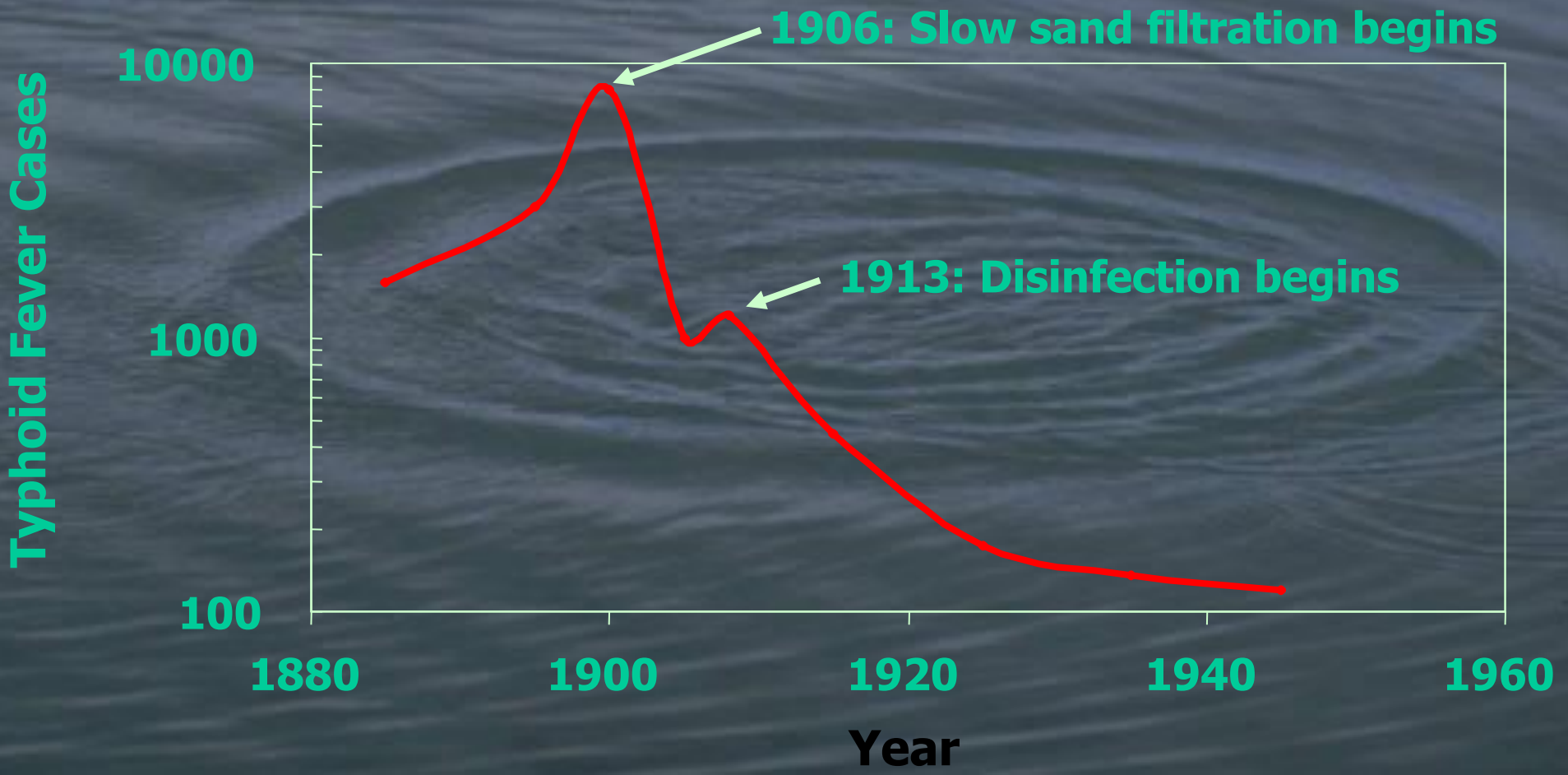
Water-related Diseases

Water-related diseases are caused by insect vectors, especially mosquitoes, that breed or feed near contaminated water.

Including : Dengue, Filariasis, Malaria, Onchocerciasis, Trypanosomiasis and Yellow fever



Impact of water filtration and chlorination on typhoid fever death rate in Albany, New York (Logsdon and Lippy, 1982)



Water Supply Highlights

(from *The Global Water Supply and Sanitation Assessment 2000)*

- **The percentage of people served with some form of improved water supply rose from 79% (4.1 billion people) in 1990 to 82% (4.9 billion) in 2000. Between 1990 and 2000, approximately 816 million additional people gained access to water supplies - an improvement of 3%.**
- **Two of every five Africans lack access to an improved water supply. Throughout Africa, rural water services lag far behind urban services.**
- **During the 1990s, rural water supply percentage coverage increased while urban coverage decreased - although the number of people who lack access to water supplies remained about the same.**
- **In Africa, Asia, Latin America and the Caribbean, nearly 1 billion people in rural areas have no access to improved water supplies.**
- **To achieve the 2015 targets in Africa, Asia, Latin America and the Caribbean, water supplies will have to reach an additional 1.5 billion people.**

Distribution of global population not served with improved water supply and sanitation (from the World Health Organization & United Nations Children's Fund, Global Water Supply and Sanitation Assessment 2000 Report). Coverage in North America is 100%.

Region	Percentage of Population Lacking Improved Water Supply	Percentage of Population Lacking Improved Sanitation	2000 Population (in millions)
Asia	19	52	3,683
Africa	38	40	784
Latin America and Caribbean	15	22	519
Oceania	12	7	30
Europe	4	8	729

Update on Progress towards meeting MDG #7, target for safe drinking water and sanitation

	Latin America & Caribbean	Southeast Asia	Sub-Saharan Africa	
Halve rural population without improved drinking water	Progress, but lagging	Progress, but lagging	Progress, but lagging	
Halve urban population without improved drinking water	Met	High access, but no change	No change	
Halve rural population without sanitation	Progress, but lagging	Progress, but lagging	No change	

WATER SUPPLY, GLOBAL COVERAGE, 2000

Clean water

Prevention and control Strategies

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- Clean environment
- Improvement of the infrastructures
- Vaccines

(UNICEF/WHO, 2009)

Clean food

- Improved hygienic food package in recent years
- Still Brucellosis is common!
- Still Cholera epidemics is present!

Health education

- Wash hands with soap and water before handling food
- When traveling to countries where sanitation and hygiene are poor, avoid water or food that may be contaminated.
- *Boil it, peel it, cook it, or forget it!!*

Health education (Cont'd)

Hygiene education issues include:

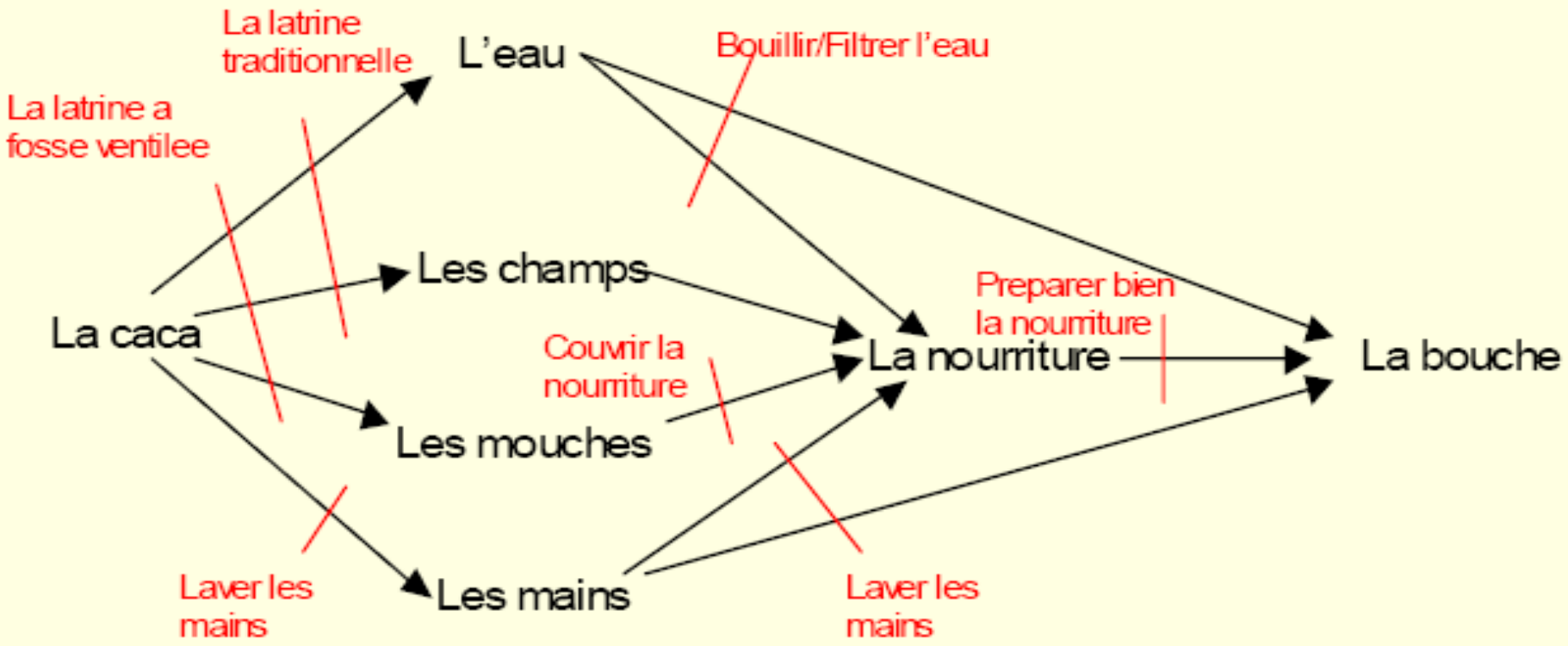
- Good nutrition
- Improvements in habitation and general sanitation
- Higher education training in water-related issues

Health education (Cont'd)

- Avoid contacting soil that may be contaminated with human feces.
- Do not defecate outdoors
- Dispose of diapers properly

Prevention of Disease Transmission (in French)

(from Lauren Fry, "Spring Improvement as a Tool for Prevention of Water-Related Illness in Four Villages of the Center Providence of Cameroon," M.S. Report, Civil & Environmental Engineering, Michigan Technological University, 2004.)



Role of mass media

- Impacts at all levels
- Very powerful, when others fail !

Prevention and control Strategies

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(UNICEF/WHO, 2009)

Systemic Surveillance

- Public health infrastructure
- Standardized surveillance of water-borne disease outbreaks
- Guidelines must be established for investigating and reporting water-borne diseases

Prevention and control Strategies

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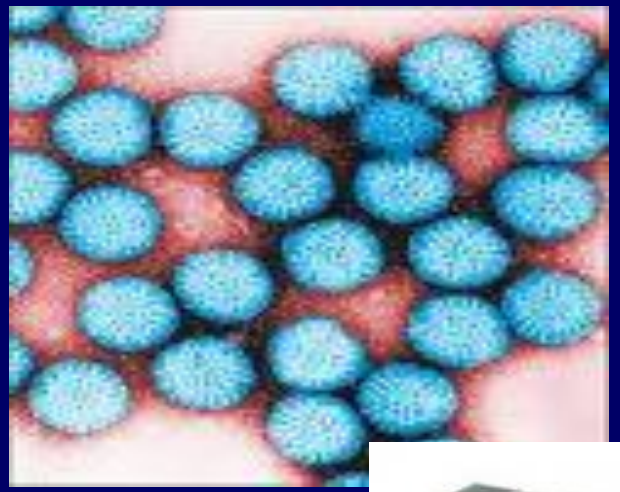
(UNICEF/WHO, 2009)

Vaccines for diarrhea

- Rota virus
- Cholera
- Typhoid fever



Antibiotic Associated Colitis(AAC)

Prevention

- *Robotics(lactobacillus and sacharomyces) inconsistent in prevention of C. difficile*

NEJM 395:1932, 2008

Thanks for your kind attention!
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