Public Health and Epidemiology

Communicable diseases: Infections through the Gastro-intestinal tract

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INFECTIVE AGENTS

- A number of important pathogens gain entry through the gastro-intestinal tract.
- Some of these cause **diarrheal diseases** (e.g. *Salmonella* and *Shigella* spp.) whilst others **pass through the intestinal tract** to cause disease in other organs (e.g. poliomyelitis, viral hepatitis).
- The pathogens include viruses, bacteria, protozoa and helminths.

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Viral infections
Gastro-enteritis/meningitis (coxsackie, echo, reo, rotaviruses)
Poliomyelitis (poliovirus)
Viral hepatitis* (hepatitis A and E viruses)

Bacterial infections
Enteric fevers (*Salmonella typhi, S. paratyphi*)
Gastro-enteritis (*Escherichia coli, Campylobacter* spp.)
Bacillary dysentary (*Shigella* spp.)
Cholera (*Vibrio cholera*)
Brucellosis (*Brucella* spp.)
Food poisoning (*Salmonella typhimurium, Staphylococcus aureus, Clostridium welchii*)

Protozoal infections
Amoebiasis (*Entamoeba histolytica*)
Giardiasis (*Giardia lamblia*)
Balantidiasis (*Balantidium coli*)
Toxoplasmosis (*Toxoplasma gondii*)
Cryptosporidiosis (*Cryptosporidium*)

Helminthic infections
Nematodes (roundworms)
Ascariasis (*Ascaris lumbricoides*)
Toxocariasis (*Toxocara canis, T. cati*)
Trichuriasis (*Trichuris trichiura*)
Enterobiasis (*Enterobius vermicularis*)
Dracontiasis/guinea worm (*Dracunculus medinensis*)
Trichinosis (*Trichinella spiralis*)
Angiostrongyliasis (*Angiostrongylus cantonensis*)
Gnathostomiasis (*Gnathostoma* spp.)

Cestodes (tapeworms)
Taeniasis (*Taeniae* spp.)
Diphyllobothriasis (*Diphyllobothrium latum*)
Hymenolepiasis (*Hymenolepis* spp.)
Hydatid disease (*Echinococcus* spp.)

Trematodes (flukes)
Paragonimiasis (*Paragonimus* spp.)
Clonorchiasis (*Clonorchis sinensis*)
Opisthorchiasis (*Opisthorchis* spp.)
Fascioliasis (*Fasciola hepatica*)
Fasciolopsiasis (*Fasciolopsis buski*)
Heterophyiasis (*Heterophyes heterophyes*)
Metagonimiasis (*Metagonimus yokogawi*)

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TRANSMISSION

- Viruses, bacteria and cysts of protozoa are directly infectious to man as they are passed in the faeces, but in the case of helminths, the **egg** may become infectious only after maturation in the soil (e.g. *Ascaris*) or after passing through an intermediate host (e.g. *Taenia saginata*).

- The most important pattern of transmission is the passage of infective material from human faeces into the mouth of a new host and this is known as 'faeco-oral' transmission.

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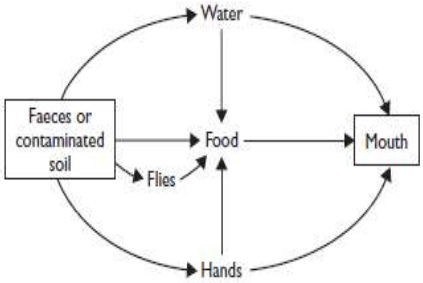
The faeco-oral route

- The direct ingestion of gross amounts of faeces is uncommon, except in young children and mentally disturbed persons. Faeco-oral transmission occurs mostly through inapparent faecal contamination of food, water and hands – the three main items that regularly make contact with the mouth.
- It should be noted that minute quantities of faeces can carry the infective dose of various pathogens. Thus, dangerously polluted water may appear sparkling clear, contaminated food may be free of objectionable odour or taste, and apparently clean hands may carry and transmit disease.



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Control of the infections acquired through the gastro-intestinal tract

- The most effective method of controlling these diseases can best be determined from a knowledge of the epidemiology of the infection with particular reference to the local community. Control can operate on each of the three components of infection:

1-The infective agent:

- sanitary disposal of faeces;
- elimination of human and animal reservoirs.

2-The route of transmission:

- provision of safe water supply;
- protection of food from contamination;
- control of flies;
- improvement of personal hygiene.

3-The host:

- specific immunization;
- chemoprophylaxis;
- specific treatment.

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Diarrhea Definition

- Clinical syndrome in which there is frequent passage of unusually loose or watery bowel movements, usually three or more in a 24 hour period, sometimes accompanied by vomiting and fever, abdominal pain or cramps, fecal urgency, tenesmus, or the passage of bloody or mucoid stools.

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Factors that increase the risk of diarrhea include:

1. Failing to breastfeed exclusively for the first 6 months of life: the risk of developing severe diarrhea is many times greater in non-breast-fed infants than in breast-fed infants; the risk of death from diarrhea is also substantially greater.

2. Failing to continue breastfeeding until at least one year of age: prolonged breastfeeding reduces the incidence or severity of certain types of diseases causing diarrhea, such as shigellosis and cholera.

3. Using infant feeding bottles: these easily become contaminated with faecal bacteria and are difficult to clean. When milk is added to an unclean bottle it becomes contaminated and if it is not consumed immediately, further bacterial growth occurs.

4. Allowing an infant or child to crawl or play in an area where human or animal faeces are present.

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5. Storing cooked food at room temperature: when food is cooked and then saved to be used later, it may easily be contaminated, for example, by contact with contaminated surfaces or containers. If food is kept for several hours at room temperature, bacteria in it can multiply many times.

6. Drinking water that is contaminated with faecal bacteria: water may be contaminated at its source or during storage in the home. Contamination in the home may occur when a storage container is not covered, or when a contaminated hand comes into contact with water while collecting it from a container.

7. Failing to wash hands before handling food, after defecation, or after handling faeces.

8. Failing to dispose of faeces (including infant faeces) hygienically. It is often believed that infant faeces are harmless, whereas they may actually contain large numbers of infectious viruses or bacteria such as rotaviruses or *E. coli*.

9. Animal faeces can transmit enteric infections such as salmonella to humans.

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Host factors (Host factors also increase susceptibility to diarrhea and are associated with increased incidence, severity or duration of diarrhea).

1. Under nutrition: the frequency, severity, duration and risk of death from diarrhea are increased in undernourished children, especially those with severe under nutrition.

2. Immunodeficiency or immunosuppression: this may be a temporary effect of certain viral infections (for example, measles), or it may be prolonged, as in persons with the acquired immunodeficiency syndrome (AIDS). When immunosuppression is severe, diarrhea can be caused by unusual pathogens and may also be prolonged.

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DIARRHEAL DISEASES

- Diarrheal diseases, as a group, remain a major cause of death in developing countries, especially in preschool children.

➢**The main agents are:**

- Enteroviruses, e.g. rotavirus;
- *Escherichia coli*
- *Campylobacter spp.;*
- *Shigella;*
- *Vibrio cholerae;*
- *Salmonella;*
- *Entamoeba histolytica;*
- *Giardia lamblia;*
- *Cryptosporidium.*

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Rotavirus

- Rotavirus is the most common cause of severe, life threatening **diarrhea** in **children under 2 years** of age worldwide.

- There are four serotypes of human rotavirus; infection with one serotype causes a high level of immunity to that serotype, and partial protection against the other serotypes.

- Nearly all children are infected at least once before the age of 2 years, and repeat infections are common. For the most part, only the first rotavirus infection causes significant illness.

- Rotavirus is usually spread from person to person and possibly also through respiratory secretions as well as faeces.

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Enterotoxigenic *E. coli* (ETEC)

- ETEC is an important cause of acute **watery diarrhea** in adults and children in developing countries.
- ETEC does not invade the bowel mucosa and the diarrhea it causes is **toxin mediated**; there are two ETEC toxins – heat-labile (LT) and heat-stable (ST).
- Some strains produce only one type of toxin, some both. The LT toxin is closely related to the cholera toxin.
- ETEC is usually spread via contaminated food and water.

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Shigella

- Shigella is the most common cause of **dysentery**, present in about 60% of all episodes, and in nearly all severe episodes; **watery diarrhea** may also occur.
- There are four serogroups.
- Tissue destruction and possibly watery diarrhea are caused in part by the extremely potent **Shiga toxin**, produced in relatively large amounts by *S. dysenteriae* Type 1.
- Shigella is spread mostly by person-to-person transmission.

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Camphylobacter jejuni

- In developing countries, *C. jejuni* causes disease **mostly in infants**.
- *C. jejuni* also infects **animals**, especially chickens and dogs, and is spread by contact with their faeces or consumption of contaminated food, milk, or water. *C. jejuni* can cause both **watery diarrhea** (two-thirds of cases) or **dysentery** (one third of cases).
- Fever may be present.
- Disease is not usually severe and lasts 2–5 days.

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Cryptosporidium

- This is a coccidian **parasite** that causes disease in **infants**, **immunodeficient patients** and a variety of domestic animals.
- In developing countries infection is frequent and most episodes of illness occur in the first year of life. Thereafter, infections are usually asymptomatic.
- Diarrhea is usually neither severe nor prolonged, except in immunodeficient patients, such as those with severe malnutrition or AIDS.
- In such individuals, Cryptosporidium is an important cause of **persistent diarrhea with wasting**.

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Vibrio cholerae

- *V. cholerae* has two biotypes and two serotypes.
- *V. cholerae* is non-invasive, diarrhea being mediated by a **cholera toxin** which causes a profuse secretion of water and electrolytes in the small bowel.
- Diarrhea may be severe, leading to dehydration and collapse within a few hours if the lost fluids and salts are not replaced.

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Salmonella

- Most Salmonella infections can be traced to infected animals or contaminated animal products.
- Salmonellae are an unusual cause of diarrhea in most developing countries, but may be important in communities where commercially processed foods are widely used.
- Diarrhea is usually **watery**, but **dysentery may occur**.
- Antibiotics are not effective and may cause delayed clearance of Salmonellae from the intestinal tract.

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There are three types of diarrhea:

- Acute watery diarrhea;
- Dysentery; and
- Persistent diarrhea.

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Acute watery diarrhea

- Starts acutely, Lasts < 14 days and in most cases < 7 days
- Stools passed are frequent, loose or watery without visible blood

- The patient may vomit and have a fever
- Acute watery diarrhea causes dehydration

- When food intake is reduced it contributes to undernutrition
- When death occurs it is usually due to acute dehydration

- Most important causes of acute watery diarrhea in young children in developing countries are: (rotavirus, enterotoxigenic Escherichia coli, Shigella, C. jejuni and cryptosporidium)

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Dysentery

• Diarrhea with **visible blood** in the faeces

• Can cause anorexia and rapid weight loss, and the invasive bacteria can cause damage to the intestinal mucosa

• Other complications may occur, for example, haemolytic uraemic syndrome, which may cause renal failure.

• The most important cause of acute dysentery is **Shigella**; other causes are ***C. jejuni***, and infrequently enteroinvasive ***E. coli*** or **Salmonella**.

• **Entamoeba histolytica** can cause serious dysentery in young adults, but rarely in young children.

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Persistent diarrhea

• Begins acutely, but is of an unusually long duration (at least 14 days).

• May begin **either** as watery diarrhea or as dysentery.

• Marked weight loss is frequent.

• Diarrheal stool volume may also be great, with a risk of dehydration. There is **no single microbial cause** for persistent diarrhea.

• ***E. coli***, **cryptosporadium**, and **giardiasis** sometimes play a greater role than other agents.

• **Persistent diarrhea** should not be confused with **chronic diarrhea**, which refers to recurrent or long-lasting diarrhea due to **noninfectious causes**, such as sensitivity to gluten or inherited metabolic disorders.

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BACTERIAL FOOD POISONING

- Food poisoning in the tropics is commonly due to three species of bacteria: *Salmonella* spp. (the most important), *Staphylococcus aureus* and *Clostridium perfringens.*

- Food-borne bacterial gastro-enteritis may be of three types:
  - (i) infectious type (e.g. salmonella or *Vibrio parahaemolyticus*), when bacteria infected with food multiply in the individual;
  - (ii) toxin type (e.g. *Staphylococcus aureus*) when food is ingested that already contains a toxin; and
  - (iii) intermediate type (e.g. *Clostridium perfringens*, which releases a toxin in the bowel).

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Staphylococcus aureus

- causes food poisoning by ingestion of enterotoxin, which is preformed in foods
- Short incubation period (1–8 hours).
- prominent vomiting and watery, nonbloody diarrhea.

- The best way to avoid food poisoning by Staph is to prevent food from being held at an unsafe temperature (between 40°F and 140°F) for more than 2 hours.
  - "Keep hot foods hot (140°F or hotter) and cold foods cold (40°F or colder).
  - Store cooked food in wide, shallow containers and refrigerate within 2 hours (or 1 hour if it's hotter than 90° F outside)".

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- Enterotoxin acts as a **superantigen** within the gastrointestinal tract to stimulate the release of large amounts of interleukin-1 (IL-1) and interleukin-2 (IL-2) from macrophages and helper T cells, respectively.

- Released cytokines stimulate the enteric nervous system to activate the vomiting center in the brain.

- Enterotoxin is fairly heat-resistant and is therefore usually not inactivated by brief cooking. It is resistant to stomach acid and to enzymes in the stomach and jejunum.

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C. *perfringens*

- Spores are located in soil and can contaminate food.
- The heat-resistant spores survive cooking and germinate.
- The organisms grow to large numbers in reheated foods or when food cooled slowly. E.g. meat dishes.
- *C. perfringens* is a member of the normal flora in the colon but not in the small bowel, where the enterotoxin acts to cause diarrhea. The mode of action of the enterotoxin is the same as that of the enterotoxin of S. aureus; i.e., it acts as a **superantigen**.

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- 8 – 16 hour incubation period
- Watery diarrhea with cramps and little vomiting.
- It resolves in 24 hours.
- Symptomatic treatment is given; no antimicrobial drugs are administered.

- Prevention:
  - There are no specific preventive measures.
  - Food should be adequately cooked to kill the organism.
  - Cool food rapidly and refrigerate promptly or hold above 140°F to prevent surviving bacteria from growing. Reheat leftover foods to 165°F.

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Treatment

1. Watery diarrhea requires fluid and electrolyte replacement, irrespective of its etiology.
2. Feeding should be continued during all types of diarrhea to the greatest extent possible, and should be increased during convalescence so as to avoid any adverse effect on nutritional status.

3. Antimicrobials and antiparasitic agents should not be used routinely; most episodes, including severe diarrhea and diarrhea with fever do not benefit from treatment with antimicrobials or antiparasitic agents. (it is not possible to clinically distinguish episodes that might respond from those caused by agents unresponsive to antimicrobials, such as rotavirus. Selecting an effective antimicrobial requires knowledge of the causative organism and this information may not be available).

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➢**Antibiotic usage for selected infections:**

- **Shigella**: The most useful antibiotics are co-trimoxazole and nalidixic acid.
- ***Campylobacter jejuni***: Erythromycin or clarithromycin shortens the illness if given soon after the symptoms start. However, erythromycin is often ineffective if therapy is delayed until the diagnosis is confirmed by a laboratory.
- ***Vibrio cholerae***: Antibiotics can shorten the duration of the illness and thus simplify case management. Tetracycline (or doxycycline) is most widely used. When resistance occurs, other antibiotics (co-trimoxazole, erythromycin, or chloramphenicol) are usually effective.
- **Salmonella**: Antibiotics such as co-trimoxazole and ciprofloxacin **may shorten** the diarrheal illness but may also **cause delayed clearance** of Salmonellae from the intestinal tract.

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Prevention of food borne infection:

➢Practice Good Personal Hygiene

1. Wash hands with soap and warm running water before handling food, especially after using the toilet, changing a baby's soiled diaper, or touching animals.
2. If you are ill with diarrhea, prepare food only for yourself.
3. Properly bandage and glove cuts and burns on hands before handling food.

➢Cook Foods Adequately

1. Use a thermometer to make sure meat and poultry are cooked to safe temperatures.
2. Cook shellfish until the shell opens and the flesh is fully cooked.
3. Cook fish until flesh is opaque and flakes easily with a fork.
4. Heat hot dogs and lunch meats to steaming hot or 165°F before serving to those who are pregnant, immunocompromised, very young, or elderly.
5. Cook eggs until both the yolk and white are firm.

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➢Avoid Cross-contamination

1. Wash knives, cutting boards, and food preparation surfaces with hot water and soap after contact with raw poultry, meat, and seafood. potentially hazardous foods.
2. Wash hands with soap and warm running water after handling raw and potentially hazardous foods.
3. Keep cooked and ready-to-eat foods separate from raw meat, poultry, seafood, and their juices.
4. Clean food preparation surfaces with hot soapy water before and after food preparation.
5. Use paper towels or clean cloths to wash food preparation surfaces.

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➢Keep Foods at Safe Temperatures

1. Keep cold food at or below 40°F.
2. Do not prepare food too far in advance of serving without plans for proper cooling and reheating.
3. Keep hot food at or above 140°F.
4. Refrigerate food in shallow containers within 2 hours of preparation.
5. Use a thermometer to make sure the refrigerator temperature is between 35 and 40°F.
6. Thaw perishable foods in the refrigerator, microwave oven, or under cold running water.

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➢Avoid Foods & Water from Unsafe Sources

1. When drinking milk and fruit juices, make sure they are pasteurized.
2. Use water from a safe water supply for drinking and rinsing fresh produce.
3. Thoroughly rinse fresh fruits and vegetables under running water before eating.
4. Avoid serving soft unpasteurized cheeses, smoked seafood, or cold deli salads to those who are pregnant, immunocompromised, very young, or elderly.
5. Avoid serving hot dogs and lunch meats that have not been reheated to steaming hot or 165°F to those who are pregnant, immunocompromised, very young, or elderly.
6. Avoid eating raw or undercooked seafood.
7. Avoid eating foods containing raw eggs; substitute pasteurized eggs or egg products in uncooked foods containing eggs.
8. Use cheese and yogurt made from pasteurized milk.
9. Obtain shellfish from approved sources.

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