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**G020: Preventing the transmission of faecal-oral diseases**

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Preventing the transmission of faecal-oral diseases

Poor hygiene practices, lack of adequate sanitation and unsafe or limited water supplies can contribute to the spread of preventable diseases such as cholera or typhoid. Understanding how pathogens (organisms that cause disease) are transmitted allows engineers and public health workers to intervene in appropriate ways to break the transmission cycle, saving lives and reducing unnecessary suffering. This guide examines these crucial issues.

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Infectious dose, ID50, is defined as the number of pathogens ingested per person needed to infect 50% of the population.
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Introduction

Infectious faecal-oral diseases are spread when a susceptible person (or in some cases, an animal) ingests a pathogen that gives them the disease. The pathogen multiples inside them and is subsequently found in their faeces.

Excreta-related water-borne diseases can be transmitted by any route which allows faecal matter to enter the mouth; the faecal-oral route. In 1958, Wagner and Lanoix identified the major means of transmission and produced what is now known as the ‘f’ diagram’.

Figure 1. An example of a transmission route is through contaminated drinking water
Table 1. Visual components and attributes

<table>
<thead>
<tr>
<th>Disease</th>
<th>Pathogen</th>
<th>Infectious dose</th>
<th>Annual burden</th>
<th>Asymptomatic carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholera (severe diarrhoea and vomiting)</td>
<td><em>Vibrio cholera</em></td>
<td>$10^3$ to $10^8$</td>
<td>3 – 5 million cases, 120,000 deaths</td>
<td>1 in 30 – 50 infected people develops illness</td>
</tr>
<tr>
<td>Giardiasis (diarrhoea and stomach cramps)</td>
<td><em>Giardia intestinalis</em> (or <em>G.lamblia</em>)</td>
<td>10 to 100</td>
<td>200 million cases, death rare</td>
<td>1 in 2 – 4 infected people develops illness</td>
</tr>
<tr>
<td>Typhoid (fever)</td>
<td><em>Salmonella typhi</em> and <em>S paratyphi</em></td>
<td>$10^3$ to $10^9$</td>
<td>6 - 33 million cases, 216,000 deaths</td>
<td>Asymptomatic carriers: Very common</td>
</tr>
<tr>
<td>Hepatitis A and E (liver inflammation, jaundice)</td>
<td><em>Hepatitis A and E viruses</em></td>
<td>low</td>
<td>1.4 million cases, mortality rate &gt; 1%</td>
<td>1 in 2 - 13 infected people develops illness</td>
</tr>
<tr>
<td>Bacillary dysentery (bloody diarrhoea)</td>
<td><em>Shigella dysenteriae</em></td>
<td>10 to 100</td>
<td>120 million cases, 1.1 million deaths</td>
<td>Asymptomatic carriers: Common</td>
</tr>
</tbody>
</table>

Types of faecal-oral disease

The diseases spread by faecal-oral routes can be categorized as:

- Water-borne diseases, where pathogens are ingested via contaminated drinking water or food. This is addressed by improving water quality.

- Water-washed or water-scarce diseases, where the disease is spread due to poor hygiene practices, such as a lack of hand washing after defecation and before preparing and eating food. This is addressed by improving water quantity.

- Excreta-related diseases, where poor sanitation contributes to its spread.
Susceptible people
Healthy people usually require a high infectious dose before they contract the disease. If people are already ill (e.g. suffer from HIV/AIDS), if they are malnourished, elderly or very young, then they are more susceptible to the disease and will succumb to a lower than average dose.

Some people can contract the disease but not show any adverse symptoms (asymptomatic). They become carriers of the disease and can still spread it.

Epidemics
These diseases are of particular concern in emergency situations where lack of safe water and adequate excreta disposal, coupled with more susceptible people often living in crowded conditions, make the rapid spread of the disease possible.

Breaking the transmission
The spread of the disease can be halted by curing everybody carrying the disease, so it is no longer in their faeces, but this leaves them vulnerable to new sources of infection.

Vaccination has been very successful in reducing the spread of polio by reducing the number of susceptible people in the population. Once about 80% of the population are immune, the cycle of transmission is effectively broken, but vaccines are not available for every faecal-oral disease.

Generally a more sustainable solution is to break the transmission routes. This can be carried out at several stages, taking a multiple barrier approach. So, if one barrier does not stop the transmission, another may. Safe water, adequate excreta disposal or handwashing may each only reduce the disease by about 30%. Together, the impact is much higher, but wider environmental sanitation measures and improved general health (nutrition, for example) also contribute to the reduction of disease.

A complex pattern
The ‘f’ diagram is complex, featuring many possible transmission routes and barriers. Its role as a way of directly promoting good hygiene practices to the public is not always advisable, as it can be confusing. It is better to concentrate on one or two clear messages rather than trying to address every possible transmission route at the same time. These messages should be based on an assessment of the higher risk practices current in the local population and which of these can be identified and changed easily.

Print out a poster!
A poster of the ‘f’ diagram pictured overleaf is available from:

http://wedc.lboro.ac.uk/resources/booklets/f-diagram.pdf
The ‘f’ diagram

Barriers can stop the transmission of disease; these can be primary (preventing the initial contact with the faeces) or secondary (preventing it being ingested by a new person). They can be controlled by water, sanitation and hygiene interventions.

- **WATER**
  - Treat, transport and store the water safely
  - Protect the water source
  - Separate faeces from water sources

- **SANITATION**
  - Wash hands after defecation
  - Wash hands before eating or preparing food
  - Separate faeces from the environment
  - Cover food

- **HYGIENE**
  - Wash hands before eating or preparing food
  - Control flies
  - Drainage

**Primary barrier**
- field
- faeces
- flies
- fluids

**Secondary barrier**
- faces
- food
- fingers
- floods

---

Wash hands:
- before eating or preparing food
- after defecation
- before eating or preparing food

Cover food:
- before eating or preparing food

Peel and wash food:
- before eating or preparing food

**Control flies**:
- before eating or preparing food

**Protect the water source**:
- before eating or preparing food

**Separate faeces from the environment**:
- before eating or preparing food

**Drainage**:
- before eating or preparing food

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WASH HANDS before eating or preparing food
Summary
The ‘f’ diagram is a useful and easy to remember diagnostic tool for engineers and public health workers trying to prevent the spread of widespread, but preventable, diseases transmitted via the faecal-oral route.

Decisions about the extent to which water supply staff and community members should be involved should be made locally.

About the diagram
The movement of pathogens (disease-causing organisms) from the faeces of a sick person to where they are ingested by somebody else can take many pathways, some direct and some indirect.

This diagram illustrates the main pathways. They are easily memorized as they all begin with the letter ‘f’: fluids (drinking water), food, flies, fields (crops and soil), floors, fingers and floods (and surface water generally).

The diagram is a summary of pathways: other associated routes may be important. Drinking water may be contaminated by a dirty water container, for example, or food may be infected by dirty cooking utensils.

References and further information


About WEDC

The Water, Engineering and Development Centre is one of the world’s leading education and research institutes for developing knowledge and capacity in water and sanitation for sustainable development and emergency relief.

We are committed to the provision of effective, evidence-based and appropriate solutions for the improvement of basic infrastructure and essential services for people living in low- and middle-income countries. With over 45 years of experience, we offer expert advice and quality learning opportunities for sector professionals.

Founded in 1971, WEDC is based in the School of Civil and Building Engineering at Loughborough University, one of the top UK universities. Being a part of a leading university gives us a recognised platform of independence and quality.

What makes us stand out from the crowd is our outreach to practitioners. We use our knowledge base and our applied research work to develop the capacity of individuals and organizations throughout the world, promoting the integration of social, technical, economic, institutional and environmental activities as foundations for sustainable development.

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