

### INFECTION AND PATHOLOGICAL PROCESS

#### **Bacteria as potential pathogens:**

**Pathogen:** Disease causing microorganisms, such as bacteria, fungi, and viruses, found commonly around us. Most pathogens are parasites and the diseases they cause are an indirect result of their obtaining food from, or shelter in, the host. **OR**

Any disease producing agent especially a virus, bacterium or other microorganisms are called pathogens.

#### **Virulence factors**

Pathogenic bacteria produce a variety of virulence factors — e.g., adherence factors, so that the organisms can attach to intestinal cells; enzymes, including haemolysin, that facilitate cell invasion;

exotoxins; and several other factors that produce immunomodulation. The successful pathogen will possess a whole range of these factors, but some are critical; an example is *Vibrio cholera* with and without cholera toxin gene, the former producing cholera and the latter being avirulent. It is important to appreciate that the possession of a single virulence factor by an organism not normally considered to be pathogenic may not be significant. The assessment of virulence should therefore include detection systems for a whole range of virulence factors.

Virulence factors enable bacteria to survive in hostile environments. The approach to a better understanding of them should be to identify disease states where the organisms are involved through epidemiological studies, investigate the pathogenic mechanisms in detail, examine the host responses and then look at possible transmission routes, appropriate interventions and protection of the public.

#### **Hospital-acquired infection**

Many different types of heterotrophic bacteria occur in hospital distribution systems, and counts may increase because of stagnation caused by the many “dead ends” that result from previously modified systems. All wet areas in wards, such as sluices, showers and baths, become colonized with Gram- negative bacteria such as *Pseudomonas*, *Klebsiella*, *Citrobacter* and *Acinetobacter*. These areas also provide ecological niches for highly resistant organisms, which can be transmitted to patients and cause infection problems.

The heterotrophic bacteria in the water distribution systems have not caused infection in patients by ingestion. Patients are, however, encouraged to drink tap water, as the heterotrophic bacteria

## MEDICAL PATHOLOGY

present pose no risk unless the patient is significantly immunocompromised, in which case boiled water is recommended.

### **Campylobacter**

Campylobacter are the most common cause of human bacterial gastroenteritis in the United Kingdom, with *Campylobacter jejuni* being the predominantly isolated species. They are widespread in the environment and occur very commonly in the intestinal tracts of animals, including birds. Ninety-five per cent of ready-prepared chickens are contaminated with *Campylobacter*, and poultry meat is thought to be an important source of infection. Wild birds also have a high intestinal colonization rate.

Two hundred and eighty-one people out of a population of 1215 served by the supply developed gastroenteritis following an incident of influx of surface water into a holding tank for treated water. Fifteen of the cases were positive for *Campylobacter*, but it was not isolated from the water; indicator organisms were detected.

### **Escherichia coli**

Most *E. coli* are not pathogenic and are part of the normal human bowel flora. Some types possess virulence factors and cause gastroenteritis in humans by several different mechanisms. Seven such groups have been defined, of which three may be waterborne.

- Enteropathogenic *E. coli* have been associated with outbreaks in children in nurseries and hospital wards. These strains belong to particular “O” serotypes.
- Enterotoxigenic *E. coli* are a common cause of diarrhoea in travellers.

They are identified by the production of a heat-stable toxin and a heat-labile toxin.

- Verocytotoxigenic *E. coli* (VTEC) cause serious diarrhoeal disease, with bloody diarrhoea and painful abdominal cramps. In 10–15% of cases, haemolytic uraemic syndrome develops as a complication, which can result in kidney failure or even death. The most frequent serotype isolated is O157, but other serotypes, such as O139, have been reported. The organism is common in cattle and sheep and other farm animals, in which it behaves as a commensal organism and does not cause any recognized disease. The infectious dose for VTEC is very low, about 10–100 organisms, which explains their potential to cause waterborne outbreaks when animal faeces-contaminated material gains access to water supplies past treatment or where treatment is inadequate.

## MEDICAL PATHOLOGY

### **Salmonella**

The salmonellas cause two distinct types of disease. One group of two species, *Salmonella typhi* and *Salmonella paratyphi* is the cause of the enteric fevers, typhoid and paratyphoid. The other group, consisting of over 2000 serotypes of what is now considered to be one species, *Salmonella enteric*, causes gastroenteritis. These serovars were previously considered to be separate species and were named after the city or animal from which the organism was initially isolated. Transmission of salmonellas is by the faecal oral route and often involves food and sometimes water. The enteric fever salmonellas are associated

Only with humans and human disease and remain important causes of waterborne disease worldwide, but nowadays very rarely in developed countries. The gastroenteritis salmonellas are widespread in animals and are often found in poultry, eggs and meat products. Food is the major vehicle of infection, but transmission via water does occur, even though the bacteria survive for only a few hours or days in surface water. Normal water treatment

Processes are adequate to remove the organism from drinking-water. The organisms are susceptible to chlorine disinfection. The infectious dose for humans for the enteric fever salmonellas is about  $10^2$ – $10^3$  organisms, whereas the infectious dose for humans for the gastroenteritis salmonellas is about  $10^6$ – $10^8$  organisms, mainly because of their susceptibility to gastric acid.

The enteric fevers are systemic infections presenting with high fever (40– 41 °C), headache, malaise and rigors. Diarrhoea does not usually occur, and patients often experience constipation in early enteric fever.

### **Shigella**

Species of *Shigella* are the causative organisms of dysentery and are almost entirely human pathogens; no other animal species play a role in maintenance or spread of infection in the community. Occasionally, higher primates become infected by human-to-animal transmission. *Shigellas* are transmitted by the faecal–oral route and sometimes, because the infectious dose is low, around  $10^2$  organisms, by person-to-person spread. Patients excrete large numbers of organisms, between  $10^5$  and  $10^8$  per gram of faeces. Point source outbreaks associated with infected food handlers are reported from time to time. Occasionally, waterborne outbreaks occur, although the organism does not survive for more than a few hours or days in surface water, and

## MEDICAL PATHOLOGY

normal water treatment processes are adequate to remove it from drinking-water. The organism was isolated from tap water as well as patients.

### **Vibrio**

The *Vibrio* genus is composed of over 30 species, of which the most important is *V. cholera*, the cause of epidemic cholera, a predominantly waterborne infection. The species *V. cholera* is subdivided into 140 O-serovars, of which the toxin-producing strains are O1 and O139. The epidemiological picture of cholera has changed and now has a wide distribution.

The O1 strain continues to occur in about 19.7% of patients. Cholera is a disease of humans, and approximately 5% of patients become carriers. The organism survives well in the environment, and viable but non-culturable organisms have been described. There is quite clearly potential for further epidemic spread. Other *Vibrio* species, particularly *Vibrio parahaemolyticus*, have been associated with diarrhoea, often through the consumption of raw, contaminated seafood. *Vibrios* are removed from raw waters by chlorination and normal water treatment processes.

### Mechanisms of Bacterial Pathogenicity

A **pathogen** is a microorganism that is able to cause disease in a plant, animal or insect. **Pathogenicity** is the ability to produce disease in a host organism. Microbes express their pathogenicity by means of their **virulence**, a term which refers to the degree of pathogenicity of the microbe. Hence, the **determinants of virulence** of a pathogen are any of its genetic or biochemical or structural features that enable it to produce disease in a host.

The relationship between a host and a pathogen is dynamic, since each modifies the activities and functions of the other. The outcome of such a relationship depends on the virulence of the pathogen and the relative degree of resistance or susceptibility of the host, due mainly to the effectiveness of the host defense mechanisms.



*Staphylococcus aureus*, the most prevalent pathogen of human cause septicemia and toxic shock.

#### The Underlying Mechanisms of Bacterial Pathogenicity

Two broad qualities of pathogenic bacteria underlie the means by which they cause disease:

**1. Invasiveness** is the ability to invade tissues. It encompasses mechanisms for **colonization** (adherence and initial multiplication), **production of extracellular substances which facilitate invasion (invasins)** and **ability to bypass or overcome host defense mechanisms**.

**2. Toxigenesis** is the ability to produce toxins. Bacteria may produce two types of toxins called **exotoxins** and **endotoxins**. **Exotoxins** are released from bacterial cells and may act at tissue sites removed from the site of bacterial growth. **Endotoxins** are cell-associated substance. (In a classic sense, the term **endotoxin** refers to the lipopolysaccharide component of the outer membrane of Gram-negative bacteria). However, endotoxins may be released from growing bacterial cells and cells that are lysed as a result of effective host defense (e.g. lysozyme) or the activities of certain antibiotics (e.g. penicillins and cephalosporins). Hence, bacterial toxins, both soluble and cell-associated, may be transported by blood and lymph and cause cytotoxic effects at tissue sites remote from the original point of invasion or growth. Some bacterial toxins may also act at the site of colonization and play a role in invasion.

## MEDICAL PATHOLOGY

### **Chlamydia Infection**

Chlamydia is a common sexually transmitted infection (STI) caused by bacteria. People who have chlamydia often do not have outward symptoms in the early stages. That might make you think you shouldn't worry. However, chlamydia can cause health problems in the later stages, including preventing women from getting pregnant or even endangering their pregnancies.

If you have unprotected sex with someone whose STI status you're not certain of, get tested for chlamydia and other STIs. You should get tested every time you might have been exposed. The treatment for chlamydia is oral antibiotics given either in multiple doses or just one dose. Waiting too long to treat it can cause serious complications. Make sure you talk to a doctor as soon as you think you might have been exposed.

### **Causes of Chlamydia Infection**

Sex without a condom and unprotected oral sex are the main ways a chlamydia infection can spread. You don't have to have penetration to get it. Touching genitals together may also transmit the bacteria. It can also be contracted during anal sex.

Newborn babies can acquire chlamydia from their infected mother during birth. Most prenatal testing includes a chlamydia test, but it doesn't hurt to double-check with your OB-GYN during your first prenatal checkup.

Someone can get a chlamydia infection in the eye through oral or genital contact with the eyes, but this isn't common.

### **Risk Factors of Chlamydia Infection**

Men and women can get the infection, but women are more likely to be diagnosed. Infection rates are highest among younger women partly because their immature cervical cells are vulnerable to infection, but older age isn't a protection.

Other risk factors include having an STI in the past or currently having an infection because that could lower your resistance

### **Signs and Symptoms of Chlamydia**

Many people don't notice the symptoms of chlamydia. If symptoms do appear, it's usually one to three weeks after you have been infected. Some of the most common symptoms include:

- burning sensation during urination
- discharge from the penis or vagina (yellow or green)
- pain in the lower abdomen

## MEDICAL PATHOLOGY

- pain in the testicles
- painful sexual intercourse in women (dyspareunia)

In some women, the infection can spread to the fallopian tubes, which may cause a condition called pelvic inflammatory disease (PID). PID is a medical emergency. The symptoms of PID are fever, severe pelvic pain, nausea, and abnormal bleeding between periods.

It's also possible to get a chlamydia infection in the anus. In this case, the main symptoms are often discharge, pain, and bleeding from this area.

If you have oral sex with someone who has the infection, you may get it in your throat. You may notice a sore throat, a cough, or fever, but it's possible to carry the bacteria in your throat and not know it.

### **Diagnosing Chlamydia**

The most effective diagnostic test for chlamydia is to swab the vagina in women and to test the urine in men. If there is a chance the infection is in your anus or throat, these areas may be swabbed as well.

### **Treating Chlamydia**

The good news is that chlamydia is easy to treat. Since it's bacterial in nature, it's treated with antibiotics. Azithromycin is an antibiotic usually prescribed in a single, large dose, but the dose may also be spread out over 5 days. Doxycycline is an antibiotic that must be taken twice per day for about one week.

### **Mycoplasma**

Mycoplasma pneumonia (MP) is a contagious respiratory infection. The disease spreads easily through contact with respiratory fluids, and it causes regular epidemics. The most common sign of infection is a dry cough. Untreated or severe cases can have symptoms affecting the heart and nervous system.

Diagnosis is difficult in the early stages of MP because there are few unusual symptoms. As the disease progresses, imaging and laboratory tests may be able to detect it. Doctors use antibiotics to treat MP. If antibiotics aren't effective at treating MP, you may need intravenous medications.

### **Causes**

A bacterium called *Mycoplasma pneumonia* causes MP. This is the most recognized of all human pathogens. There are over 200 different known species. Most patients with respiratory

## MEDICAL PATHOLOGY

infection due to *Mycoplasma pneumoniae* don't develop pneumonia. Once inside the body, the bacterium may attach itself to your lung tissue and multiply until a full infection develops.

### **Risk for Developing Mycoplasma Pneumonia**

In many healthy adults, the immune system is capable of fighting off MP before it can grow into an infection. Those who are most at risk include:

- older adults
- people who have diseases that compromise their immune system, such as HIV
- people who have lung disease
- people who have sickle cell disease
- children younger than age 5

### **Symptoms of Mycoplasma Pneumonia**

The symptoms of MP are the same as a common upper respiratory tract infection.

Common symptoms of MP include:

- persistent fever
- dry cough
- malaise
- fever

In rare cases, the infection may become dangerous and cause damage to the heart or central nervous system. Examples of these disorders include:

- arthritis, which is a disorder in which the joints become inflamed
- pericarditis, which is inflammation of the pericardium that surrounds the heart
- Guillain-Barré syndrome, which is a neurological disorder that can lead to paralysis and death
- encephalitis, which is an inflammation of the brain

### **Diagnosis**

The disease generally develops silently for the first one to three weeks after exposure. Diagnosis is difficult in the early stages because the body doesn't instantly reveal an infection. Sometimes manifestations of infection may occur outside of your lung. If this happens, signs of infection may include the breakup of red blood cells, a skin rash, and joint involvement. The symptoms and signs can indicate infection of the gastrointestinal tract, central nervous system, and heart disease.

### **Treatment Options for Mycoplasma Pneumonia**

#### **Antibiotics**

The first line of treatment for MP is antibiotics. Children get different antibiotics than adults to avoid any potentially dangerous side effects.

Macrolides, the first choice of antibiotics for children, include:

- erythromycin
- clarithromycin
- roxithromycin
- azithromycin

Antibiotics prescribed for adults include:

- doxycycline
- tetracycline
- quinolones

#### **Prevention of Mycoplasma Pneumonia**

MP peaks in the fall and winter months. The risk of contracting MP is greatest during these times. This is especially true in schools, day care centers, and dorms. Close places make it easy for the infection to transmit from person-to-person.