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THE IMPORTANCE OF INFECTIOUS DISEASES OF BACTERIAL ETIOLOGY

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Annotation (in English): Bacterial infectious diseases remain one of the most significant global health challenges due to their wide distribution, rapid transmission, and potential to cause severe complications. These infections are caused by pathogenic bacteria that enter the human body through various routes such as air, water, food, physical contact, and damaged tissues. Bacterial pathogens can affect different organ systems and lead to illnesses such as pneumonia, meningitis, tuberculosis, and tonsillitis. Early diagnosis, appropriate antibiotic therapy, and preventive measures play a crucial role in reducing morbidity and mortality rates. This article discusses the general characteristics of bacteria, major bacterial diseases, their clinical manifestations, diagnostic approaches, and modern treatment strategies. The importance of hygiene, vaccination, and antimicrobial stewardship inpreventing bacterial infections is also highlighted.

Keywords: Bacteria, Infection, Etiology. Epidemiology. Antibiotic resistance,

Pathogenesis, Prevention

Enter

Among infectious diseases, infections of bacterial etiology are the oldest.and is one of the most widespread groups. Throughout human history, many epidemics of diseases such as plague, cholera, diphtheria, and typhus have claimed the lives of millions of people. Despite the development of medicine, bacterial infections still remain a serious threat to global health. The reason is that bacteria are very adaptable, multiply rapidly, and can form antibiotic-resistant forms.

In modern times, the increasing level of resistance of bacteria to antibiotics makes it difficult to combat them. In addition, population migration, global trade, and lack of compliance with sanitary and hygienic requirements contribute to the spread of bacterial infections. Therefore, the etiology, pathogenesis, and preventive measures of these diseases are one of the main areas of study in medicine.

General description of infectious diseases of bacterial etiology

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Bacteria are prokaryotic microorganisms, usually single-celled. They are widespread in the external environment, found in soil, water, and in the body of animals and humans. Some are harmless, even beneficial (intestinal microflora), while others are pathogenic, causing disease. i.e.

Pathogenesis (disease-causing mechanism): general mechanisms and classification

The pathogenesis of bacterial diseases consists of several stages: irritant (entry), colonization, adhesion, invasion, toxin production, host (criteria) immune response, and the final outcome (recovery/relapse).

1) Introduction and exposition (entry)

Bacteria enter the body through various routes: respiratory (aerosol), fecal-oral, parenteral (through wounds), transdermal (through skin lesions), vector-borne (mosquito, night mosquito), or vertical (mother-to-child). Each route determines the type of infection and the clinical picture.

2) Adhesion and colonization Bacteria attach to epithelial cells via fimbriae, adhesins, and other surface structures. For example, uropathogenic E. coli. adheres to the urinary tract via fimbriae (P-fimbriae); while Streptococcus pyogenes M-protein and S. aureus adhesins allow them to adhere to skin and mucous membranes.

3) Invasion and local proliferation

In drug-resistant infections, bacteria enter cells or multiply in tissues, followed by local inflammation and tissue damage. Some bacteria use enzymes (hyaluronidase, collagenase) or toxins to break down tissue, allowing for systemic spread.

4) Toxins and toxic products

Exotoxins (e.g., diphtheria toxin, botulinum toxin) destroy specific cellular targets and cause extremely severe clinical signs.Endotoxin (LPS) originates from gram-negative bacteria and causes a systemic inflammatory response; high exotoxins can lead to sepsis and septic shock.

5) Host immunological response

The innate immune response (phagocytosis, complement, macrophages) and the adaptive response (T and B cells) attempt to control pathogens. However, some bacteria have mechanisms to evade the immune system (biofilm formation, antigenic changes, absorption of antimicrobial agents), resulting in chronic infections and recurrent episodes.

Clinical manifestations and main nosologies (division into types).Bacterial infections are clinically very diverse, and their presentation depends on the pathogen, the site of infection, and the patient's immune status.

1) Respiratory tract infections

Pneumonia: S. pneumoniae, H. influenzae, atypical (Mycoplasma), gram-negative agents (Klebsiella, Pseudomonas). Clinical: fever, cough, shortness of breath; diagnosis requires X-ray, sputum culture.Bronchitis, sinusitis, otitis media are associated with many bacterial agents 2) Central nervous system (CNS) infections

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Bacterial meningitis: N. meningitidis, S. pneumoniae, H. influenzae type b (historical). Symptoms: headache, fever, stiff neck, photophobia: lumbar puncture and CSF analysis are essential in diagnosis.

3) Gastrointestinal infections

Agents such as Shigella, Salmonella, Vibrio, Campylobacter cause diarrhea and require testing; some toxins (Staphylococcus aureus enterotoxin) cause food poisoning.

4) Skin and soft tissue infections

Cellulitis, abscess, necrotizing fasciitis, S. aureus, and group A streptococci are common; necrotic cases can rapidly progress and may require surgical intervention.

5) Genitourinary tract infections

Urinary tract infections: E. coli is the main agent; can progress to pyelonephritis and sepsis.

6) Nosocomial (hospital-acquired) infections

Pseudomonas, Acinetobacter, MRSA, ESBL-producing Enterobacterales are high risk in hospitals, often resistant to antibiotics.

Features of bacterial diseases

Bacteria are microscopic, single-celled organisms that come in a variety of shapes and structures. Once pathogenic bacteria enter the body, they grow, multiply, and secrete various toxins. This process leads to the development of infection and symptoms of disease. Diseases are often manifested by fever, inflammation, pain, pus, and intoxication.

Bacterial diseases and examples

The most common bacterial infections include:Tonsillitis (angina) is an inflammation of the tonsils, caused by streptococcal bacteria. Pneumonia is an inflammation of the lungs caused by pneumococcus and staphylococcus bacteria.Dysentery - caused by Escherichia coli (shigella), is characterized by bloody diarrhea.Salmonellosis is transmitted through food and water, and is manifested by nausea and vomiting.

Tuberculosis (TB) is caused by the bacterium Mycobacterium tuberculosis and is characterized by a persistent cough, weight loss, and sweating.

Meningococcal infection affects the meninges, causing severe illness and rashes.

Ways of transmission

Bacteria enter the body in various ways:

Airborne (pneumonia, meningitis).

Through food and water (dysentery, salmonellosis).

Contact route (skin infections, staphylococcus).

Through injuries.

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The structure of bacteria

Bacteria have the following basic structures:

cell wall (gram-positive or gram-negative),

cytoplasm,

DNA (chromosome),

ribosomes,

plasmids,

spirilla (spiral) and vibrios (vibrating).

Classification of bacteria

Bacteria are classified: the diseases they cause are often as follows:

Respiratory tract infections - pneumonia, bronchitis, meningitis.

Intestinal infections: dysentery, salmonellosis, cholera.

Skin and soft tissue infections - furuncle, carbuncle, abscess.

Systemic infections: sepsis, typhus, brucellosis.

Specific diseases are tuberculosis, leprosy, and diphtheria.

Pathogenesis of bacterial diseases

Pathogenesis is the mechanism of disease development and explains how bacteria affect the body after entering it. The infection process occurs in several stages: entry of the bacteria into the body, multiplication in cells or tissues, production of toxins, and activation of the immune system.

If the immune response is insufficient, the infection spreads and the disease becomes severe.

Entry gates of infection

Bacteria enter the body in the following ways:

airborne (meningococcus, pneumococcus),

through food and water (salmonella, shigella),

contact route (staphylococcus),

through injuries,

through insects (plague, plague).

Bacterial toxins

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Pathogenic bacteria produce two main types of toxins: exotoxins (released outside the cell and delivered to specialized organs) Diagnostic methods.Diagnosis based on clinical signs alone is not entirely reliable. Microbiological tests, positive, serological tests, and molecular diagnostics (PCR) help to accurately identify bacterial diseases. To identify bacterial infections:

Bacteriological examinations

plant (positive),

colony rearing,

determination of antibiotic sensitivity.

Microscopy

Staining with Gram stains.

Serological methods

ELISA, RNA, PCR tests.

Clinical analyses

Blood, urine, and stool tests.

Treatment principles

Antibiotics

The mainstay of treatment for bacterial infections is antibiotics.

The most commonly used groups are:

penicillins

cephalosporins

tetracyclines,

macrolides,

fluoroquinolones.

Antibiotic resistance

The biggest problem of our time. Due to the irregular use of antibiotics, bacteria become resistant to them. Bacteria become resistant to antibiotics over time. This occurs as a result of taking the wrong and excessive amount of antibiotics, not completing the course of treatment, or choosing the wrong drug. Resistant bacteria increase nosocomial infections (hospital-acquired diseases) and make treatment more difficult.

Symptomatic treatment

fever reduction,

prevent dehydration, relieve pain.

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Prevention

Personal hygiene

Wash your hands, drink clean water.

Vaccination

BCG (tuberculosis),

DTP (diphtheria),

Meningococcal vaccines.

Sanitary measures

Proper storage of food products, disinfection of drinking water.

Isolation of patients

Prevents the spread of disease. Diagnostics - laboratory and instrumental

Accurate and rapid diagnosis increases the effectiveness of treatment:

1) Clinical assessment

History (exposure, travel, vaccination), symptoms, severity assessment (SOFA, sepsis criteria)

2) Laboratory

Microscopy: Gram-positive/Gram-negative classification by Gram-staining.

Bacteriological culture: identification of the specific agent and determination of antibiotic sensitivity (antibioticogram).

Molecular tests (PCR): high sensitivity and rapid accuracy (for conditions such as meningitis, TB, gonorrhea).

Serological tests: for certain pathogens (Brucella, Leptospira).

Biomarkers: CRP, procalcitonin help in detecting bacterial infection and monitoring treatment.

3) Instrumental tests

X-ray (pneumonia), CT (abscess or necrosis), ultrasound (internal abscess or IV courses), and lumbar puncture (CSF analysis in meningitis).

Treatment principles

Treatment is fundamentally divided into two main areas: etiotropic (directed to the microorganism) and pathogenetic/supportive (supporting organ function).

1) Antibacterial therapy (etiotropic)

Empirical therapy: begins with broad-spectrum or targeted drugs depending on the clinical situation and then is modified according to the antibiogram.

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Specific agents: beta-lactams (penicillins, cephalosporins), aminoglycosides, macrolides, fluoroquinolones, carbapenems, etc. Choice: depends on pathogen, local AMR profile, patient allergies, and pharmacological properties.

Due to antimicrobial resistance, some infections may not respond to previous therapies; in this case, combination therapy or new drugs are required. WHO and other analyses indicate that the antibiotic pipeline (new antibacterial agents) is lacking.

2) Supportive and surgical intervention

Intensive care in sepsis: fluids, vasopressors, respiratory support.

Surgical approach is necessary for drainage of abscesses or debridement of necrotic tissue.

3) Antitoxins and immunomodulators

There are therapeutic antitoxins against exotoxins such as diphtheria antitoxin, botulism antitoxin. IVIG is used in some clinical situations.

Prevention and public health measures

1) Vaccination

Vaccines against bacteria such as pneumococcus, meningococcus, and H. influenzae type b significantly reduce morbidity and severe complications. Vaccination is a key preventive measure in public health.

2) Infection control and sanitation

Hygiene, clean drinking water and sanitation, food safety - reduce fecal-oral infections. Infection control protocols within the hospital (isolation, hand hygiene, sterilization) reduce nosocomial infections

Bacteria and their resistance are exchanged between humans, animals and the environment. The One Health strategy takes this connection into account and promotes veterinary control, regulation of the use of agricultural antibiotics, and environmental monitoring

Antibiotic resistance (AMR) - key risks and conclusions

1) Current situation

Sources such as the WHO and the Lancet confirm that AMR is a significant threat to global health: millions of deaths could be attributed to AMR by 2021-2023, and resistance is growing in many regions. Reports from 2025 indicate that around 1/6 of some common infections are found to be resistant to antibiotics.

2) Reasons

Inappropriate and overuse of antibiotics (in medicine and agriculture).The limitation of diagnostic capabilities is a poor empirical choice.Rapid spread through global travel and migration.Economic barriers to the development and market application of new antibiotics.

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3) Impact

Longer treatment times, more complex and expensive therapies, increased hospital admissions, increased mortality, and an economic burden on the healthcare system.

4) Countermeasures

AMS programs, increasing diagnostic capabilities, new antibiotics and alternative strategies (bacteriophages, antitoxins, immunotherapy), and strengthening global surveillance systems are important areas.

Socioeconomic importance of bacterial infections

Its widespread distribution among the population reduces working capacity.

Treatment costs will increase.

Epidemics cause great damage to the economy.

Antibiotic resistance is being assessed as a global threat.

Infectious bacterial diseases lead to reduced workforce productivity due to illness, increased healthcare costs, and economic losses.

Antibiotic resistance, on the other hand, is a growing global health threat and requires the development of new drugs.

Summary

Infectious diseases of bacterial etiology remain an urgent problem in modern medicine. Their prevalence is high, complications can be severe, and treatment can be difficult. Therefore, measures such as early diagnosis, adherence to hygiene rules, vaccination, and rational use of antibiotics play a crucial role in disease prevention. Maintaining public health, preventing epidemics, and strengthening infection control are the main directions of effective control of bacterial diseases.

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