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Unit-II

Escherichia coli

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INTRODUCTION

- E. coli is the most common and important member of the genus Escherichia.
- This organism is associated with a variety of diseases, including gastroenteritis and extraintestinal infections such as UTIs, meningitis, and sepsis.
- A multitude of strains are capable of causing disease.
- (e.g., E. coli O157 is the most common cause of hemorrhagic colitis and hemolytic uremic syndrome).

PATHOGENESIS & IMMUNITY

- *E. coli* possesses a broad range of virulence factors.
- In addition to the general factors possessed by all members of the family Enterobacteriaceae.
- Escherichia strains possess specialized virulence factors that can be placed into two general categories:

    1. Adhesins
    2. Exotoxins

EPIDEMOLOGY

- Large numbers of *E. coli* are present in the GI tract.
- Most E. coli that cause GI and extraintestinal disease because they have acquired specific virulence factors encoded on plasmids or in bacteriophage DNA.
- The effectiveness of E. coli as a pathogen is illustrated by the fact that the bacteria are

  (1) the most common gram-negative rods isolated from patients with sepsis.

  (2) a prominent cause of gastroenteritis.
- Most infections are endogenous.

CLINICAL DISEASES

A. GASTROENTERITIS

- The strains of E. coli that cause gastroenteritis are subdivided into a number of groups.
- Five of these groups are:
    1. Enterotoxigenic,
    2. Enteropathogenic,
    3. Enteroaggregative,
    4. Shiga toxin–producing,
    5. Entero invasive
- The first three groups primarily cause a secretory diarrhea involving the small intestine, and the last two groups primarily involve the large intestine.

1. ENTEROTOXIGENIC

- Enterotoxigenic E. coli (ETEC) is one of the most common causes of bacterial diarrheal disease in developing countries (estimated 840 million cases annually) and in an estimated 30% of travelers to these countries with diarrheal disease.
- Because the inoculum for disease is high, infections are primarily acquired through consumption of fecally contaminated food or water.
- Secretory diarrhea caused by ETEC develops after a 1- to 2-day incubation period and persists for an average of 3 to 5 days.
- The symptoms watery, non bloody diarrhea and abdominal cramps; less commonly nausea and vomiting, mortality rate is high in malnourished individuals, particularly children and the elderly.
- Disease requires bacterial attachment to the small bowel epithelium by bacterial surface proteins and heat-stable and heat-labile enterotoxins.
- The genes for the colonization factors and enterotoxins are encoded on a transmissible plasmid.

2. ENTEROPATHOGENIC

- Two groups of E. coli responsible for enteric disease (Enteropathogenic E. coli [EPEC] and some Shiga toxin–producing E. coli [STEC]) possess a cluster of virulence genes located on a chromosomal pathogenicity island called the locus of enterocyte effacement (LEE).
- Bacteria in the heterogeneous EPEC group were the first E. coli strains associated with outbreaks of diarrheal disease reported in the 1940s and 1950s.
- They were originally characterized by the specific serotypes responsible for each outbreak but are now defined by (1) presence of LEE and (2) absence of Shiga toxin.
- EPEC are further subdivided into typical and atypical strains based on the presence or absence of the E. coli adherence factor (EAF) plasmid.
- Disease is transmitted by fecal-oral exposure to contaminated surfaces or food products.
- Humans are the only source of typical strains, whereas both humans and a variety of animal hosts are reservoirs of atypical strains.
- Infection is initiated by bacterial attachment to epithelial cells of the small intestine, with subsequent effacement.

3. ENTEROAGGREGATIVE

- Enteroaggregative E. coli (EAEC) are a heterogeneous collection of strains characterized by their autoagglutination in a “stacked-brick” arrangement over the epithelium of the small intestine and, in some cases, the colon.
- The prevalence of disease caused by EAEC is unclear because a single molecular marker for these bacteria has not been discovered.
- Genes encoding adhesins, toxins including Shiga toxin, and other virulence proteins are highly variable among EAEC.
- Outbreaks of gastroenteritis caused by EAEC have also been reported in the United States, Europe, and Japan and are likely an important cause of childhood diarrhea in developed countries.
- These are one of the few bacteria associated with chronic diarrhea and growth retardation in children.
- Characteristically, following adherence to the epithelium, cytokine release is stimulated, which results in neutrophil recruitment and progression to an inflammatory diarrhea.
- Disease is characterized by a watery secretory diarrhea, often with inflammatory cells and accompanied by fever, nausea, vomiting, and abdominal pain.
- This process can be either acute or progress to a persistent diarrhea patients.

4. SHIGA TOXIN PRODUCING

- All members of this group are defined by the presence of Shiga toxin 1 (Stx1) or 2 (Stx2). Some but not all EHEC strains are LEE positive and form A/E cytopathology, resembling EPEC strains.
- Classification of STEC is further complicated because the most common serotype associated with human disease is O157:H7, and initial efforts to diagnose disease were to determine if the suspected pathogen was this serotype.
- It is now appreciated that although O157:H7 is the most common serotype associated with severe human disease, it represents less than 50% of the responsible serotypes.
- Thus diagnosis of STEC disease is now based on detection of the Shiga toxins rather than serotyping suspected STEC disease is most common in the warm months, and the highest incidence is in children younger than 5 years.
- Most infections are attributed to the consumption of undercooked ground beef or other meat products, water, unpasteurized milk or fruit juices (e.g., cider made from apples contaminated with feces from cattle), uncooked vegetables such as spinach, and fruits. Ingestion of fewer than 100 bacteria can produce disease, and person-to person spread occurs

5. ENTERO INVASIVE

- Enteroinvasive E. coli (EIEC) strains are rare in both developed and developing countries.
- Pathogenic strains are primarily associated with a few restricted O serotypes: O124, O143, and O164.
- The strains are closely related by phenotypic and pathogenic properties to Shigella.
- The bacteria are able to invade and destroy the colonic epithelium, producing a disease characterized initially by watery diarrhea.
- A minority of patients progress to the dysenteric form of disease, consisting of fever, abdominal cramps, and blood and leukocytes in stool specimens.
- A series of genes on a plasmid mediate bacterial invasion (pInv genes) into the colonic epithelium.
- The bacteria then lyse the phagocytic vacuole and replicate in the cell cytoplasm.
- Movement within the cytoplasm and into adjacent epithelial cells is regulated by formation of actin tails (similar to that observed with Listeria).
- This process of epithelial cell destruction with inflammatory infiltration can progress to colonic ulceration.

B. EXTRAINTESTINAL INFECTION

1. URINARY TRACT INFECTION

- Most gram-negative rods that produce UTIs originate in the colon, contaminate the urethra, ascend into the bladder, and may migrate to the kidney or prostate.
- Although most strains of E. coli can produce UTIs, disease is more common with certain specific serogroups.
- These bacteria are particularly virulent because of their ability to produce adhesins (primarily P pili, AAF/I, AAF/III, and Dr) that bind to cells lining the bladder and upper urinary tract (preventing elimination of the bacteria in voided urine) and hemolysin HlyA that lyses erythrocytes and other cell types (leading to cytokine release and stimulation of an inflammatory response).

2. NEONATAL MENINGITIS

- E. coli and group B streptococci cause the majority of CNS infections in infants younger than 1 month.
- Approximately 75% of the E. coli strains possess the K1 capsular antigen.
- This serogroup is also commonly present in the GI tracts of pregnant women and newborn infants.
- However, the reason this serogroup has a predilection for crossing the bloodbrain barrier and causing meningitis in newborns is not understood.

3. SEPTICEMIA

- Typically, septicemia caused by gram-negative rods, such as E. coli, most commonly originates from infections in the urinary or GI tract (e.g., intestinal leakage leading to an intraabdominal infection).
- The mortality associated with E. coli septicemia is high for patients in whom immunity is compromised or the primary infection is in the abdomen or CNS.

LABORATORY DIAGNOSIS

1. CULTURE

- Members of the family Enterobacteriaceae grow readily on culture media.
- Specimens of normally sterile material, such as spinal fluid and tissue collected at surgery, can be inoculated onto nonselective blood agar media.
- Selective media (e.g., MacConkey agar, eosin-methylene blue [EMB] agar) are used for the culture of specimens normally contaminated with other organisms (e.g., sputum, feces).
- Use of these selective differential agars enables the separation of lactose fermenting Enterobacteriaceae from nonfermenting strains, thereby providing information that can be used to guide empirical antimicrobial therapy.
- In contrast with most E. coli, many strains of STEC, particularly O157:H7, do not ferment sorbitol.
- Thus sorbitol-containing MacConkey agar (S-MAC) has been used to screen stool specimens for sorbitol-negative (colorless), gram-negative bacteria that are then confirmed by sero grouping and biochemical tests to be E. coli O157.
- The limitation to this approach is that some strains of O157 and many other STEC serotypes ferment sorbitol and would be missed by this screening approach.
- The preferred method to detect STEC is to test stool specimens directly for the presence of Shiga toxin by use of commercial immunoassays or molecular tests for the Shiga toxin (Stx1 and Stx2) genes.
- These tests are rapid and sensitive.

2. BIOCHEMICAL IDENTIFICATION

- There are many diverse species in the family Enterobacteriaceae.
- Biochemical test systems have become increasingly sophisticated, and the most common members of the family can be identified accurately in less than 24 hours with one of the many commercially available identification systems.
- Sequencing of species-specific genes (e.g., 16S rRNA gene) or detection of characteristic protein profiles by mass spectrometry is used to identify the less common species.

3. SEROLOGY TEST

- Serologic testing is very useful for determining the clinical significance of an isolate (e.g., serotyping specific pathogenic strains such as E. coli O157 or Y. enterocolitica O8) and for classifying isolates for epidemiologic purposes.
- The usefulness of this procedure is limited, however, by cross reactions with antigenically related Enterobacteriaceae and with organisms from other bacterial families.

PREVENTION, TREATMENT & CONTROL

- Antibiotic therapy for infections with Enterobacteriaceae must be guided by in vitro susceptibility test results and clinical experience.
- Some organisms, such as E. coli and P. mirabilis, are susceptible to many antibiotics, but others can be highly resistant.
- Production of enzymes that inactivate all the penicillins and cephalosporins (e.g., extended-spectrum β-lactamases [ESBLs]) is now widespread in E. coli.
- In general, antibiotic resistance is more common in hospital-acquired infections than in community-acquired infections.
- Antibiotic therapy is not recommended for some infections.
- For example, symptomatic relief but not antibiotic treatment is usually recommended for patients with Shiga toxin–producing E. coli and Salmonella gastroenteritis, because antibiotics can prolong the fecal carriage of these organisms or increase the risk of secondary complications (e.g., HUS with STEC infections in children).
- Vaccination is recommended for travelers to endemic areas of the world (e.g., Africa, Asia, Latin America).
- The Vi capsular vaccine can be administered in a single dose, but the attenuated live vaccine must be administered in four doses over a 1-week period.

REFERENCES

- https://www.cdc.gov/dpdx/diagnosticprocedures/stool/specimenproc.html

- https://www.healthline.com/health/stool-ova-parasites-test#risks

THANK YOU