Cephalosporins Overview

Cephalosporins are beta-lactam antibiotics that are derived from Acremonium fungus. Like other beta-lactams, these antibiotics work by inhibiting bacterial cell wall synthesis. However, they are not as susceptible to penicillinases. There are traditionally five generations of cephalosporins classified based on their antimicrobial characteristics. Each new generation provides a more extended spectrum and has greater gram-negative bactericidal properties than the previous generation.

PLAY PICMONIC

Mechanism of Action

Beta Lactam Drug

(B lac) Black Beta-fish

This is a class of antibiotics that contain a beta-lactam group in their molecular structures. These antibiotics include penicillins, cephalosporins, monobactams, and carbapenems. Beta-lactam antibiotics work by inhibiting cell wall biosynthesis. Cephalosporins are often preferred for their broader spectrum of activity and better resistance profiles compared to other beta-lactams.

Inhibits Cell Wall Synthesis

Breaking Wall

Beta-lactam antibiotics all work by inhibiting bacterial cell wall biosynthesis, which eventually leads to bacterial cell death. They target penicillin-binding proteins (PBPs), those enzymes that are responsible for cross-linking peptidoglycan chains in the cell wall. Inhibition prevents proper cell wall formation, resulting in cell lysis due to osmotic pressure.

Bactericidal

Bacteria-sliders

Unlike bacteriostatic agents, which simply stop bacteria from reproducing, bactericidal agents actually cause bacterial cell death because bacteria are unable to synthesize their cell wall, and they are lysed by osmotic pressure.

CLINICAL USE

Meningitis

Men-in-tights

Some third- and fourth-generation cephalosporins, such as ceftriaxone and cefepime, can be used to treat meningitis due to their ability to cross the blood-brain barrier (BBB). They have broad-spectrum activity against common pathogens which can cause meningitis. Ceftriaxone (third generation) is often the first-line agent for community-acquired meningitis.

MRSA

MR. Saw

The fifth-generation cephalosporin ceftaroline is used to treat infections caused by methicillin-resistant Staphylococcus aureus (MRSA). Ceftaroline is able to bind altered proteins on MRSA. A protein is altered in MRSA, which is why other beta-lactam drugs are ineffective against it.

Side Effects

Hypersensitivity Reactions

Hiker-sensitive-crying

Some individuals with penicillin hypersensitivity demonstrate cross-reactivity with cephalosporins due to the fact that these antibiotics are structurally related. Therefore, people with a history of penicillin allergy are typically not given cephalosporins. These hypersensitivity reactions are characterized by an overreaction of the body's immune response to the antibiotic. Common symptoms include rashes, hives, itchy eyes, and swollen tongue or face. Some individuals can have an anaphylactic reaction. The risk is more significant with first-generation cephalosporins, while newer generations pose less risk.

Vitamin K Deficiency

Viking (K) King

Prolonged antibiotic use can deplete the normal gut flora, which synthesizes vitamin K, an essential component for normal blood clotting. Chronic antibiotic use, especially cephalosporins, can lead to vitamin K deficiency with subsequent clotting deficiencies. Additionally, some cephalosporins (e.g., cefotetan) inhibit vitamin K epoxide reductase, increasing the risk of impaired clotting.

Disulfiram Like Reaction with Alcohol

Dyed-shirt-surfer with Alcohol-bottles

Patients who consume alcohol within 72 hours after taking certain cephalosporins, such as cefotetan or cefoperazone, may develop a disulfiram-like reaction. This reaction is characterized by flushing, tachycardia, nausea, thirst, chest pain, vertigo, and hypotension. It occurs due to the inhibition of aldehyde dehydrogenase, leading to the accumulation of acetaldehyde during alcohol metabolism.

Increased Nephrotoxicity of Aminoglycosides

Up-arrow Kidney with Toxic-green-glow of A-mean-ol'-glider

Cephalosporins and aminoglycosides demonstrate a synergistic nephrotoxic interaction when used in combination, necessitating close monitoring of renal function.

RESISTANCE

Extended Spectrum Beta Lactamase

Extended Rainbow (B lac) Black Beta-fish

Cephalosporins are more resistant to narrow-spectrum beta-lactamases, but some are still susceptible to being destroyed by extended-spectrum beta-lactamases (ESBLs) or AmpC beta-lactamases (cephalosporinases).