Antipseudomonal Penicillins

The antipseudomonals are antibiotic drugs that are effective against gram-negative rods including Pseudomonas species. They are divided into the carboxypenicillins, which include ticarcillin and carbenicillin, and the ureidopenicillins, which include piperacillin. Like penicillins, the antipseudomonals are bactericidal beta-lactam antibiotics, which work by inhibiting bacterial cell wall synthesis. The carboxypenicillins are inherently beta-lactamase resistant but piperacillin requires the addition of a beta-lactamase inhibitor such as tazobactam since it is beta-lactamase sensitive. These powerful antibiotics are all administered intravenously. Adverse events include hypersensitivity reactions due to the similar penicillin structure.

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Drugs

Ticarcillin
Tiger-villain
Ticarcillin is a carboxypenicillin and is beta-lactamase resistant. This is an injectable beta-lactam antibiotic that targets pseudomonal infections. Although it technically does not require a beta-lactamase inhibitor, it is commercially available in the USA only as ticarcillin-clavulanate (Timentin®).

Carbenicillin
Carpet-villain
Carbenicilllin is also a carboxypenicillin so it demonstrates higher beta-lactamase resistance than base penicillins such as ampicillin. This is an injectable beta-lactam antibiotic that targets pseudomonal infections but has limited coverage against gram-positive bacteria.

Piperacillin
Pipe-villain
Piperacillin is a ureidopenicillin so it does not have as much beta-lactamase resistance as the carboxypenicillins. For this reason, it must be combined with a beta-lactamase inhibitor such as tazobactam. This piperacillin-tazobactam combination is available in the USA as Zosyn®. It cannot be used orally and therefore is always given as an IV or IM injection.

Mechanism of Action

Same Mechanism as Penicillin
Mechanism-gear and Pencil-villain
As part of the penicillin family, antipseudomonals work like penicillins by binding to the penicillin-binding protein (PBP) to disrupt normal bacterial cell wall synthesis. They also block transpeptidase, a critical enzyme involved in the peptidoglycan cross linking in the bacterial cell wall, and activate autolytic enzymes to induce cell death. Please refer to picmonic card on "Penicillin" for more information.

Indications

Extended Spectrum
Rainbow
These antipseudomonals are referred to as “extended spectrum penicillins” because of their ability to cover extended spectrum beta-lactamase producing (ESBL) bacteria. ESBL organisms include mostly gram-negative bacteria such as Pseudomonas aeruginosa and Proteus mirabilis.

Pseudomonas and Gram-Negative Rods
Sumo-Mona and Graham-cracker Negative-devil Rod
As the name implies, these beta lactam antibiotics are especially effective against Pseudomonal infections and most gram negative rods as well like Proteus mirabilis.

Considerations

Combine with Beta Lactamase Inhibitor

Black-beta-fish-ace in Inhibiting-chains

Antipseudomonal penicillins are often combined with beta lactamase inhibitors to prevent the enzyme beta lactamase secreted by bacteria from degrading the antibiotic. Examples of beta lactamase inhibitors include clavulanic acid (combined with ticarcillin) and tazobactam (combined with piperacillin). Clavulanic acid shares a similar beta lactam ring structure and is called a suicide inhibitor because it covalently binds to the active site of beta lactamase, thus inactivating it.

Clavulanic Acid

Cleaver Acidic-lemon

Clavulanic acid or its basic form clavulanate is often combined with ticarcillin.

Tazobactam

Tazo-backgammon

Tazobactam and sulbactam are beta-lactamase inhibitors. Tazobactam is often combined with piperacillin while sulbactam is combined with ampicillin.

Hypersensitivity Reactions

Hiker-sensitive-crying

Because penicillin and antipseudomonals are relatively similar in structure, individuals with hypersensitivity reactions to penicillins can also demonstrate hypersensitivity reactions to antipseudomonals. Hypersensitivity reactions are characterized by an overreaction of the body's immune response. Common symptoms include rashes, hives, itchy eyes, and swollen tongue or face. Some individuals can have an anaphylactic reaction.