Aminoglycoside Overview

Aminoglycosides are narrow-spectrum antibiotics used against gram-negative infections. They disrupt protein synthesis, resulting in bacterial cell death. Aminoglycosides have the ability to cause serious toxicities, including damage to the inner ear and kidney; therefore, their use should be limited.

PLAY PICMONIC

End in "-mycin"

Mice

Aminoglycosides typically have a suffix ending with "-mycin," except for Amikacin and Gentamicin, which end in "cin." Remember the most common drugs in this class with the acronym "GNATS," which represents Gentamicin, Neomycin, Amikacin, Tobramycin, and Streptomycin.

GNATS

Gentamicin

Magenta-gentleman-mouse

Gentamicin is used for gram-negative infections such as Pseudomonas aeruginosa and Proteus mirabilis but not for Neisseria or Legionella. Its clinical use is limited due to its side effects of ototoxicity and nephrotoxicity, and it cannot be given orally due to its lack of intestinal absorption. Combined with vancomycin or a beta-lactam antibiotic, gentamicin can treat serious infections caused by gram-positive cocci (Staphylococcus aureus, Enterococcus, and some Streptococci).

Neomycin

Neon-mouse

Neomycin is a popular topical aminoglycoside for eye, ear, and skin infections. It is not used as a systemic treatment, as it is highly ototoxic and nephrotoxic. It is used to reduce the risk of infection during intestinal surgery by eliminating intestinal bacteria. And because aminoglycosides are not absorbed well into the body through the GI tract, the risk of side effects is much lower when using it as a bowel prep for surgery. Neomycin can be used to treat hepatic encephalopathy by reducing ammonia-producing bacteria in the gut, but it's not the first-line option.

Amikacin

Moccasin-mouse

This aminoglycoside is used for Pseudomonas, Enterobacter, and Serratia infections. This medication can be given in the form of suspension, inhalation, or injection. Like other drugs in its class, it can lead to nephrotoxicity and ototoxicity, so patients should be carefully monitored if they have renal disease. This medication's key mechanism is the inhibition of translocation.

Tobramycin

Cobra-mouse

Tobramycin is used for gram-negative infections. It has slightly better coverage than gentamicin when treating pseudomonal infections of the lungs. It cannot be given orally but it is used in ophthalmic infections for bacterial conjunctivitis (Tobrex). It can also be inhaled via a nebulizer and given via an

injection into a muscle or as an IV infusion. This drug leads to nephrotoxicity and ototoxicity.

Streptomycin

Stripper-mouse

Streptomycin was the first aminoglycoside discovered and is used for mycobacterium tuberculosis infections. Streptomycin still can be used for TB, but it is infrequent because of the bacteria's resistance and the availability of newer, more effective TB drugs. It is given via injection into a muscle, usually the thigh or upper buttocks. This drug has the side effects of nephrotoxicity and ototoxicity.

Mechanism of Action

Bactericidal

Bacteria-sliders

Unlike bacteriostatic agents, which simply stop bacteria from reproducing, bactericidal agents actually cause bacterial cell death. Aminoglycosides bind to the 30S ribosomal subunit of bacteria and cause misreading of mRNA during protein synthesis. The production of nonfunctional proteins disrupts cell membrane integrity and key metabolic processes. They do not directly affect DNA replication, but inhibiting proper protein synthesis impairs bacterial growth and division. A higher concentration of medication leads to quicker eradication of the infection.

Requires Oxygen for Uptake

O2-tank Uptake-tube

Aminoglycosides require oxygen for uptake because their entry mechanism into bacterial cells depends on an energy-dependent transport system known as "energy-dependent phase I." This system uses the bacterial electron transport chain and requires oxygen to generate the proton motive force. This force is needed for the active transport of aminoglycosides across the inner bacterial membrane.

Synergistic with βlactam Antibiotics

(B lac) Black Beta-fish

Aminoglycosides are synergistic with βlactam antibiotics. This synergy occurs because βlactams disrupt the bacterial cell wall, enhancing aminoglycoside penetration. This combination is especially effective in treating serious infections like endocarditis caused by Gram-positive organisms such as Enterococcus.

Indications

Severe Gram-Negative Infections

Severed Gram-cracker Negative-devil

Aminoglycosides are typically used to treat serious infections caused by aerobic gram-negative bacilli. The most frequent use of these antibiotics is empiric therapy for serious infections, including septicemia, complicated intraabdominal infections, UTIs, and nosocomial upper respiratory tract infections.

Bowel Surgery Prep

Bowel-bowl Surgery

The aminoglycoside Neomycin is often used for bowel surgery prep to suppress bowel flora and decrease the risk of infection after surgery. Remember, aminoglycosides are not absorbed well into the body through the GI tract, so the risk of side effects is much lower when using them for bowel surgery preparation.

MECHANISM OF RESISTANCE

Bacterial Transferases

Bacteria Transformer

Bacterial transferases inactivate aminoglycosides by acetylation, phosphorylation, or adenylation.