A REVIEW ON PENICILLIN ANTIBIOTICS

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Abstract

Penicillin can be used to manage and treat a variety of infections. It belongs to the antibiotic class of beta-lactam. This activity highlights penicillin's advantages, mode of operation, and contraindications as a helpful antibiotic. In addition, this exercise will highlight the mechanism of action, adverse event profile, and other crucial factors crucial for interprofessional team members in the treatment of infection, such as off-label usage, dosing, pharmacodynamics, pharmacokinetics, monitoring, and pertinent interactions.

Keywords - Penicillin, inhibitor, administration, effect, patient.

Introduction

The first antibiotic to be clinically utilized was penicillin, which was done in 1941. It is a wonder that the first of its kind was found to be the least toxic medicine possible. *Penicillium notatum*, a fungus was the original source, however *P. chrysogenum*, a high yielding mutant, is now the main source.

Objectives:

• Define he penicillin's mode of action.

• List the consequences of penicillin.

• Describe how penicillin is administered.

• Talk about interprofessional team tactics for bettering communication and care coordination to advance the administration of penicillin and enhance results.

Indications

Penicillin is one of the most often prescribed antibiotics in the world and has several clinical applications. Penicillin can be used to treat a range of infections by gram-positive cocci, gram-positive rods (such as Listeria), the majority of anaerobes, and gram-negative cocci (e.g., Neisseria). [1] Importantly, a number of bacterial species have evolved penicillin resistance, especially enterococci. Today, enterococci infections are treated with gentamicin or a penicillin-and-streptomycin cocktail. [2] Penicillin resistance in some gram-negative rods can be attributed to the drug's poor capacity to penetrate the porin channel. [3] But later broad-spectrum penicillins are effective against gram-negative rods. Second-generation penicillins ampicillin and amoxicillin, which can also penetrate the porin channel, are efficient against Proteus mirabilis, Shigella, H. influenzae, Salmonella, and E. coli. Third-generation penicillins like carbenicillin can enter gram-negative bacterial porin channels. Fourth-generation penicillins like piperacillin are ineffective against the same bacterial species as third-generation penicillins are, including Klebsiella, enterococci, Pseudomonas aeruginosa, and Bacteroides fragilis. [4]

Process of Action

A peptidoglycan cell wall is frequently present around the bacterial plasma membrane to protect it from osmotic lysis and to give structural stability. The structure of the peptidoglycan wall is constantly altering throughout replication and development. The peptidoglycan in the cell wall doesn't cross-link when penicillin is present. [5] Catalysts for this process include proteins that bind penicillin, such as the enzyme DD-transpeptidase. The four-membered -lactam ring of penicillin can attach to the DD-transpeptidase, rendering it inactive forever. As a result, the bacteria are unable to construct their cell walls even though other proteins continue to break down the wall. [6] As the bacteria cell wall continues to disintegrate, osmotic pressure drives water into the cell, killing the bacteria. The cell wall is further eroded by peptididoglycan fragments because they can activate hydrolases and autolysins. To boost the efficiency of the penicillins, they can also be given with a beta-lactamase

inhibitor such clavulanic acid. The penicillin's beta-lactam ring can break down when particular bacteria express the enzyme beta-lactamase. Inhibitors of beta-lactamase prevent this from occuring. [7]

Most penicillin derivatives are not appreciably metabolised by the liver. Injectable versus oral administration will have different bioavailabilities. They are swiftly eliminated in the urine because they are water-soluble, and some of the drugs are also excreted in bile. The half-life of penicillin is only 2 hours, which is very little time. [8]

Administration

Penicillin G may be administered intravenously or intramuscularly. Penicillin G potassium for injection is offered in vials with 1, 5, and 20 million doses, respectively. Due to its lower bioavailability of less than 30% and easier digestion by stomach acid, penicillin G must be administered intravenously. Due to its short half-life, penicillin G is normally administered intravenously or intramuscularly in divided doses spaced 4 to 6 hours apart. Penicillin G benzathine administration ensures a constant, small dose of penicillin G over the course of two to four weeks.

Penicillin V and penicillin VK (the potassium salt of penicillin V) are available as 250 mg/5 mL, 125 mg/5 mL, 250 mg, and 500 mg tablets for oral treatment. After stomach acid is passed, penicillin V has a bioavailability of roughly 65%. It is ideal to provide penicillin V to a patient who is fasting since stomach acid breaks down the medication. The usual dose is between 125 mg and 500 mg every 6 to 8 hours, depending on the therapeutic indication and patient weight.

Patients must be instructed to finish the entire course of treatment, just like with any antibiotic, in order to stop bacterial resistance. Penicillin has a limited ability to cross the blood-brain barrier and can only treat particular types of bacterial meningitis. [9]

Patient Population Particular

expecting mothers: The FDA classifies Category B during pregnancy for penicillin G. With penicillin G, there are no significant adverse effects reported. Because of the higher rate of penicillin V elimination during pregnancy, the dose must be adjusted, either by increasing the standard dose or by decreasing the standard dose's dosing interval. [10]

Breastfeeding Women: Penicillin G and Penicillin V have been identified in low-fat milk concentrations which are unanticipated to induce negative effects in breastfeeding children, according to the literature. It has not been sufficiently assessed whether penicillin's adverse effects can lead to thrush or diarrhoea in infants by upsetting their gastrointestinal flora. Nursing mothers are permitted to use penicillin G or penicillin V. [11] [12]

Pediatric Population: Penicillin dosage for children is determined by their weight and body's exterior.

Patients with Renal Impairment: Although end-stage renal disease demands dosage adjustment, renal impairment is not a contraindication to penicillin. Depending on the glomerular filtration rate, these patients will either take a full loading dose followed by a half loading dose every 8 to 10 hours or every 4 to 5 hours. [13]

Adverse Effects

Penicillin V and G side effects include rash, stomach pain, urticaria, nausea, vomiting, and diarrhoea. Along with these side effects, Penicillin G may also cause muscle cramps, , tachycardia, flushing, tachypnea, fever, chills, muscle pain, headache, and hypotension.

Responses to Hypersensitivity: Hypersensitivity is the most frequent adverse drug reaction to penicillin and can appear suddenly or gradually. This kind of reaction begins to show itself 20 minutes after administration. Its distinctive symptoms include urticaria, pruritis, edoema, laryngospasm, bronchospasm, hypotension, vascular collapse, and death.

Delayed onset: This reaction happens 1–2 weeks after the start of treatment. Skin rashes, stomach pain, urticaria, myalgia, arthralgia, and fever are some of its unusual symptoms. [14]

Gastrointestinal System: More than 1% of patients reported having GI symptoms, which are frequently seen with oral treatment and include nausea, vomiting, and stomatitis. Additionally, during or after the treatment, pseudomembranous colitis is observed.

Hematologic Reactions: Patients who receive daily dosages of more than 10 million units or who have previously had higher amounts may develop hemolytic anaemia and neutropenia with Coombs positive results, which go away after the medication is stopped.

Metabolic Reactions: The salt form of penicillin G may cause electrolyte problems, such hyperkalemia, when given IV in a high dose.

Nervous System: In patients with decreased renal function, neurological symptoms such as hyperreflexia, myoclonic twitches, seizures, and coma are more prone to occur.

Urogenital System: Renal tubular injury is one of the urological symptoms associated with high IV dosages. Penicillins can also result in acute interstitial nephritis, a disorder characterised by inflammation of the kidneys' tubules and interstitium. [15] Acute interstitial nephritis may also manifest as hematuria, fever, and rash. Since the condition in this instance could lead to renal failure, stopping the medicine is advised.

Other: When given to syphilis patients, penicillin causes the Jarisch-Herxheimer reaction.

Drug-Drug Interactions

Because of their antagonistic effects, concurrent use of sulfonamides, erythromycin, and chloramphenicol should be avoided. Probenecid can prevent the tubular secretion of penicillin G, resulting in greater and longer plasma concentrations.

• By inhibiting tubular secretion, aspirin, phenylbutazone, sulfonamides, indomethacin, thiazide, furosemide, and ethacrynic acid prolong the half-life of penicillin. Additionally, probenecid lessens the amount of penicillin that is distributed.

Contraindications

Penicillin and its derivatives are contraindicated if a patient has a history of severe allergic reactions. Penicillin should also not be taken by anyone who has experienced Stevens-Johnson syndrome after receiving penicillin or a penicillin derivative. Due to the penicillin's low concentration in breastmilk, it is safe to use the antibiotics both during pregnancy and during nursing. When used alone to treat pneumococcal meningitis, penicillin has an antagonistic action with tetracycline and may result in a 2.6 times higher risk of fatality. [16] For penicillin to work, bacterial cell wall production must be in motion.

Penicillin has been linked to CDAD, a kind of diarrhoea caused by Clostridium difficile that can range in severity from mild diarrhoea to fatal colitis. Nearly all antibacterial drugs have been implicated with CDAD. The overgrowth of C. difficile is brought on by the use of antibacterial medicines, which change the colon's natural flora. Toxins A and B produced by this strain aid in the emergence of CDAD. Given that these illnesses are frequently resistant to antimicrobial therapies and may necessitate colectomy, the rate of morbidity and mortality during infections brought on by high toxin-producing strains of C. difficile can increase. It is advised to stop receiving continuing antibiotic therapy when diarrhoea caused by C. difficile (CDAD) is identified or suspected. Protein supplements, hydration and electrolyte control, antimicrobial therapy, and surgical evaluation ought to be put into practise in accordance with clinical requirements. [17]

Monitoring

Patients using penicillin do not often need to be monitored. However, to more accurately assess penicillin exposure and dosage during the treatment of enterococcal endocarditis, one study advised therapeutic drug monitoring. This attention to detail will lessen the possibility of antibiotic resistance while enhancing therapeutic effect. [18] Monitoring hematologic, renal, and hepatic function may be important when penicillin is taken for an extended period of time.

Toxicity

There is a little chance of toxicity with penicillin. Clinical practitioners can use these medications at substantially higher doses than other biologically active compounds without endangering patients. An intravenous dose of 5 g/kg of body weight is thought to be necessary to cause convulsions in a patient. Penicillin injections at large doses may cause local toxicity in sensitive areas, such as the subarachnoid space or the anterior chamber of the eye. There are claims that pure penicillin formulations have no negative effects on the lungs or veins. Several studies have shown that topical penicillin helps prevent coagulation in dental cavities. [19]

Improving Healthcare Team Results

Before recommending penicillin to a patient, the doctor and medical staff should confirm that the underlying infection is most likely brought on by a penicillin-sensitive bacterium. Additionally, any adverse drug reactions that should call for a follow-up appointment, such as persistent diarrhoea or a severe rash, should be disclosed to the patient by the doctor, pharmacist, and/or nurse. The pharmacist and physician must communicate with one another in order to properly deliver the medication to the

patient in an outpatient scenario. The pharmacist should discuss the best approach to administer the penicillin with the patient in addition to reminding them that they should finish the entire course of antibiotics. This interdisciplinary approach will lessen side effects while improving therapeutic results.

If a patient is having problems acquiring their medicines due to logistical or financial issues, a social worker can make sure they are filled. Contact between the clinician and the nurse will enable the patient to acquire the medication while being treated as an inpatient. The patient's medical team can work together to make sure there are no conditions that would make the patient's usage of penicillin inappropriate. If there are any serious adverse reactions that occur immediately after giving penicillin, such as anaphylaxis, the medical team should be alerted and the acute situation should be treated straight away. The situation can also be addressed with a board-certified infectious disease pharmacist to assess whether penicillin is the best choice given the patient's diagnosis and any additional medications the patient may be taking. A flattened hierarchy structure should also be in place to guarantee that reporting problems to a higher level can happen without resistance. Utilizing the entire healthcare team is crucial to ensuring the patient is at ease and receives the best medical care with the fewest complications.

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