Amoxicillin as an alternative treatment to the widely prescribed penicillin in Vietnam. The past, present, and future potential of antibiotic treatments.

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Abstract

Amoxicillin and penicillin are effective antibacterial drugs, which remain the most popular for treatment of bacterial infections. Finding the antibacterial effectiveness between them and explaining global threat by resistant against bacteria is for this study. Penicillin kills sensitive gram-negative bacteria by acting as a cell wall biochemical inhibitor. Amoxicillin, a semi-synthetic offshoot, has broader activity against gram-negative in addition to positive bacterial strains. Nevertheless, abuse and over utilization of antibiotics has led to the emergence of resistance as well which is threatening public health status. Issues, including mistreatment and excessive farming use promote the growth of Antibiotic Resistant Bacteria. Such antibiotic over use among patients in Vietnam is characterized by a phenomenon of using penicillin as the drug. The region requires alternative drugs and knowledge on their proper utilization to curb this problem due largely to omissive improvements spurred from within across this boarder line While increasing the use of amoxicillin is just another possible remodel, its prevalence may also result in resistance. In order to address antibiotic resistance, the use of alternative agents should be considered from an identical family but with a different structure. Other classes of penicillin-allergic antimicrobial drugs include unrelated antibiotics such as tetracyclines, quinolones, macrolides amine glycoside s and solid salt (glycopeptides. Finding effective treatments that would reverse antibiotic resistance calls for the production of new antimicrobial agents, adherence to prudent use principles and public awareness. Knowledge on penicillin and amoxicilline comparative effaciousness as well as correct use of antibiotics may serve for combating the development deficit in an essential element of public health is that concerning with antibiotic resistance.

Bacteria are single-cell microorganisms that are involved in a multitude of physiologic and pathologic processes. Bacteria can be either gram-positive or gram-negative, and antibiotics have been developed to treat both types. Especially, Vietnam is the country where people are used to using antibiotics daily. These two types of bacteria primarily have different cell wall structure and composition. While gram-negative bacteria have a thin outer membrane layer, gram-positive bacteria do not. In lieu of an outer membrane, gram-positive bacteria (Staphylococcus) have thick layers of peptidoglycan, which is 10 to 40 times thicker relative to the cell wall of gram-negative bacteria (E. coli) (1). In particular, bacterial infections are among the leading causes of death globally, emphasizing the need for novel treatment courses and antibiotics. However, antibiotic resistance poses a serious threat to future use. Both types of bacteria can cause infections

Penicillin is the most famous and was one of the first antibiotics discovered. In 1928, Alexander Fleming accidentally discovered the first antibiotic, penicillin, while studying bacteria . He noticed that a mold called Penicillium notatum released a substance that killed bacteria. Fleming's findings laid the foundation for the development of antibiotics (3). Penicillin kills susceptible gram-negative bacteria by specifically inhibiting the transpeptidase that catalyzes the final step in cell wall biosynthesis, which is the cross-linking of peptidoglycan (4). Penicillins may be used to treat a wide range of infections caused by susceptible bacteria, such as: dental abscess, ear infections (eg, otitis media), gonorrhea, pneumonia, respiratory tract infections, rheumatic fever, scarlet fever, skin infections (5).The peptidoglycan molecule in the cell wall,

which gives the wall the strength it needs to survive, is inhibited by penicillin from being synthesized by the bacteria(6). Penicillin V (orally administered) and G (intravenously) can cause adverse reactions such as nausea, vomiting, diarrhea, rash, abdominal pain, and urticaria. Penicillin G can also cause adverse reactions such as muscle spasms, fever, chills, muscle pain, headache, tachycardia, flushing, tachypnea, and hypotension (7). Based on these side effects, chemically similar formulations and analogs have been developed as alternative treatments to penicillin. Currently, there is a concern of overuse of penicillin as a general antibiotic treatment course, mostly by parents for their their sick children (8). Antimicrobials make up more than half of the medications used in Vietnam and are the most frequently purchased medications in neighborhood pharmacy (9). Despite being against Vietnamese law, it appears that 88–97% of pharmacies still sell antibiotics without a prescription. According to a study conducted in Vietnamese hospitals, one-third of patients who had received an antibiotic had an unsuitable medical indication for their admission. Antimicrobials make up more than half of the medications used in human medicine in Vietnam and are the most frequently purchased medications in neighborhood/local community pharmacies (10).

Following the success of penicillin, the discovery and development of other antibiotics rapidly accelerated given their therapeutic utility. Streptomycin, discovered in 1943, was the first effective treatment for tuberculosis, a deadly pathology of the lungs and airways. In subsequent years, antibiotics like tetracycline, erythromycin, and ciprofloxacin were discovered, each targeting specific types of bacteria (11). Among these derivatives with arguably the most clinical benefit is amoxicillin. First developed in 1958 and commercially approved/available in the early 1980’s, amoxicillin is an alternative treatment course that has become widely used across the globe (12).

Amoxicillin, although in the same general family of antibiotics as penicillin, appears to be more effective in treating a wider range of bacterial infections. Penicillin and amoxicillin are both derived from penicillium fungi, but they have different biochemical structures that substantially favors the use of amoxicillin. As a semi-synthetic form of penicillin, the minor pharmacologic modification enhances its effectiveness against a spectrum of different bacteria spanning gram-negative and gram-positive (13).

The widespread use of antibiotics has led to dramatic improvements in healthcare, allowing for the successful treatment of once life-threatening infections. They have been instrumental in reducing mortality rates, increasing life expectancy, and improving the overall quality of life (14). However, the overuse and misuse of antibiotics has led to the development of antibiotic resistance, a global public health concern. Bacteria can adapt and become resistant to the actions of antibiotics, rendering them ineffective. This has necessitated the development of new antibiotics and a more cautious approach to their use. Antibiotic resistance can be caused by overuse, inappropriate prescription, extensive agricultural use (15). Bacteria become

antibiotic-resistant. These bacteria may infect humans and animals, and the infections they cause are harder to treat than those caused by non-resistant bacteria. The drugs that work against non-resistant bacteria lose efficacy. Since infectious diseases continue to be a major cause of morbidity and mortality, the current antimicrobial resistance crisis will likely worsen the situation (16).

Bacterial infections can occur at any site in the body. Air, water, food, or living vectors are means of transport that bacteria are transmitted through. Once a person is infected, clinically apparent disease may or may not be seen, and only in a small subset of infections do we see clinically significant disease. Numerous methods are able to spread bacterial infections. A sufficient number of the species must endure in the environment and get to a susceptible host in order for the disease to spread. Numerous bacteria have evolved to live in water, soil, food, and other environments. Before being passed from one person to another, some bacteria infect their vectors, such as animals or insects (17). A distinctive four-membered beta-lactam ring is present in penicillin and other beta-lactam family antibiotics. Penicillin kills bacteria by binding its beta-lactam ring to DD-transpeptidase, preventing it from cross-linking its peptidoglycan substrate, and stopping the formation of new cell walls. A bacterial cell without a cell wall is susceptible to outside water and molecular pressures, which quickly results in the cell's demise. Human cells are not protected by a cell wall, so penicillin treatment kills bacteria without harming them(18).

For conditions like strep throat, bacterial pneumonia, bacterial meningitis, and the bacteria that causes syphilis, a doctor might prescribe penicillin. Penicillin is effective against numerous other bacterial infections. However , I would mention amoxicillin since in addition to killing bacterias as penicillin, it also kills some kinds of gram-positive bacterias, demonstrating therapeutic advantage related to penicillin.

An example of the clinical utility of amoxicillin relative to penicillin is demonstrated by the current clinical recommended for treating syphilis. In addition to other bacterial infections, it is also prescribed for ear infections, pneumonia, and oral (mouth) infections. Additionally, it can combat bronchitis and other lung infections like sinus infections. For urinary tract infections, the majority of which are brought on by the bacteria *E. coli*, amoxicillin used to be the antibiotic of choice (19).

Antimicrobial infections is an urgent global public health threat, killing at least 1.27 million people worldwide and associated with nearly 5 million deaths in 2019. In the U.S., more than 2.8 million antimicrobial-resistant infections occur each year. More than 35,000 people die as a result, according to CDC's 2019 Antibiotic Resistance (AR) Threats Report. When *Clostridium difficile*—a bacterium that is not typically resistant but can cause deadly diarrhea and is

associated with antimicrobial use—is added to these, the U.S. toll of all the threats in the report exceeds 3 million infections and 48,000 deaths(20).

Bacteria can be resistant to antimicrobial by various mechanisms, bacterias can produce. The World Health Organization stated that antibiotic resistance is a global threat to public health in a report in 2014. Disease-causing bacteria are already resistant to all the initial antibiotics in many parts of the world, and they are quickly developing resistance mechanisms to last-resort treatments. Some bacteria that are resistant to antibiotics are very contagious and can spread quickly throughout a family or community, posing a serious risk to the public's health. Pharmaceutical development of new antibiotic agents is decreasing as bacteria continue to develop resistance to some of the strongest antibiotics currently on the market. This is due to a number of factors, such as low profitability because of short therapy cycles, a lack of novel therapeutic targets or methods for eliminating bacterial cells, and low levels of side effects tolerance among medical professionals(21).

In contrast to the Western hemisphere and its unwavering reliance on the multitude of pharmacotherapies for treating bacterial infections, Vietnam has a limited number of treatments available. Adding to this, not many alternative treatments are well known or well believed by patients. This combination of factors is a major contributing cause for penicillin overuse and potentially AR. In parents' minds, some kind of sickness such as high body temperature, coughing or having a runny nose are so normal that they can all be treated by the antibiotic they have used for decades - penicillin. These facts might lead to a very big problem explained in the research is antibiotic resistance, affecting the public health in general and people's life in individual. Amoxicillin has been known to deal with a wider range of bacteria since some chemical compounds have been changed, they might be very useful when a person's body resists penicillin. However, amoxicillin might be so similar to penicillin and also can be resistant if it is not useful. There are many other antibiotics to avoid resistant infection such as ampicillin, amoxicillin-clavulanate, dicloxacillin, nafcillin, piperacillin-tazobactam.

Antibiotic resistance infection can be treated by changing the types of antibiotic used, which may be in the same family but different chemical compounds. Tetracyclines (e.g. doxycycline), quinolones (e.g. ciprofloxacin), macrolides (e.g. clarithromycin), aminoglycosides (e.g. gentamicin) and glycopeptides (e.g. vancomycin) are all unrelated to penicillins and are safe to use in the penicillin allergic patient (22).

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