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Antimicrobial Resistance-Types and Mechanism of Acquired Drug Resistance

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Abstract

Animals are routinely suffering from different infectious diseases that lead to a heavy productive and economic loss in livestock farming. To treat these infectious diseases, antibiotics are routinely used in animal husbandry practices. Different antibiotics are used to treat animal diseases without conducting antibiotic sensitivity tests. This will leads to untoward reactions in an animal's body. Misuse of antibiotics leads to the development of antimicrobial drug resistance. This antimicrobial drug resistance may be natural or acquired. Acquired antimicrobial drug resistance is developed by mutation, conjugation or transformation process. Antimicrobial drug resistance leads to development of microbes that are not susceptible to antimicrobials. Therefore, it is not possible to treat the animal disease effectively, leading to a heavy economic loss for farmers. Antimicrobial drug residues lead to health hazards to animal product consumers.

Introduction

Antimicrobial (antibacterial) drug resistance refers to the unresponsiveness of a microorganism to an antimicrobial drug even at the maximal level that the host tolerates. There are two types of antimicrobial resistance, 1. Natural resistance and 2) Acquired resistance.

1. Natural resistance:-

When an animal is inherently/genetically resistant to an antimicrobial agent, the resistance is called natural resistance.

Natural resistance occurs due to many factors, including-i) lack of penetration of the drug into a bacterial cell or ii) absence of metabolic pathway or iii) target site affected by drug or iv) rapid inactivation of the drug in the bacterial cell. e.g. 1. *Gram negative bacterias* are resistant to *Penicillin G and Vancomycin*. 2. *M. tuberculosis* is insensitive to *tetracyclin.*

This type of resistance does not pose a significant clinical problem.

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2. Acquired resistance:-

When an organism becomes resistant to an antimicrobial agent to whom it was previously sensitive, the resistance is called acquired resistance.

It develops after a period of time and is initially not known to practitioners. The acquired drug resistance can happen with any microbe (unlike natural resistance) and is a great threat to antimicrobial therapy. It is due to the inappropriate use of antimicrobial drugs. This type of drug resistance is a major clinical problem during the treatment of clinical cases. However, the development of resistance depends on the microorganism and the drug. Some bacteria are notorious for rapid acquisition of resistance e.g. *Staphylococci, coliforms, tubercle bacilli*. Others like *Streptococus pyogens* and spirochetes have not developed significant resistance to penicillin despite its widespread use for more than 50 years. Gonococci quickly developed resistance to Sulphonamides but develops resistance slowly and low-grade resistance to *penicillin*. However, in the past 30 years, highly penicillin-resistant gonococci producing penicillinase have appeared.

Mechanism of acquired resistance transmission:-

Acquired drug resistance may develop by mutation or gene transfer.

1. Mutation: It is a stable and heritable genetic change that occurs spontaneously and randomly among microorganisms. It is not induced by AMA. Any sensitive microbe population contains a few mutant cells that require a higher concentration of the AMA for inhibition. These are selectively preserved and get a chance to increase when the AMA eliminates the sensitive cells. Thus, it would appear that a sensitive strain has been replaced by a resistant one. e.g. When a single ant tubercular drug is used.

Acquired resistance by mutation may occur either in a single step or in a series of steps (multi steps).

i) Single-step mutation:

In this step, bacterial resistance develops in a single step due to mutation occurring in a powerful gene. It emerges rapidly and confers a high degree of resistance.

e.g. Resistance of *Enterococci* to *Streptomycin* and *Staphylococci* to *Rifampicin*.

ii) Multistep mutation: In this type, bacterial resistance develops in multiple steps due to mutation occurring in several different genes. Multi step mutation develops slowly and gradually and confers a slight resistance.

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e.g. Development of resistance in many organisms by multistep mutation to Erythromycin, *tetracycline and Chloramphenicol*.

2) Conjugation:-

It is a type of reproduction process in which AMA resistance gene (R factor) is transferred from one bacterium to another bacterium by direct contact through a pilus/bridge.

Pilus formation is coded by a resistance transfer factor (RTF) on a plasmid. Thus genes carrying resistance (R factor) and resistance transfer factor (RTF) are involved in transferring resistance via conjugation.

The gene carrying the resistance or 'R' factor is transferred only if another resistance transfer factor (RTF) is also present.

Conjugation frequently occurs in the colon, where many gram-negative bacilli come in close contact. Even non-pathogenic organisms may transfer R factor to pathogenic organisms, which may become widespread by contamination of food or water. e.g. *Streptomycin* resistance to *E.coli*, *Penicillin* resistance to *Haemopilus*, *Chloromphenico*l resistance to typhoid bacilli. It is particularly common in members of the *Enterobacteriaceae, Pseudomonas spp*. and anaerobes of the intestinal tract.

Concomitant acquisition of multidrug resistance has occurred by conjugation.

3) Transformation:-

A resistant bacterium may release the resistance carrying DNA into the medium and this may be imbibed by another sensitive organism becoming unresponsive to the drug. Acquisition of resistance by transformation is relatively infrequent and is of little clinical significance. Some strains of *pneumococci* and *Neisseria* have acquired resistance to Penicillin by transformation due to altered penicillin-binding proteins.

References

Kapoor, G. Saigal, S., Elongavan and A. (2017). Action and resistance mechanisms of antibiotics, Journal of Anaesthesiology Clinical Pharmacology, 33(3):300-305. doi: 10.4103/joacp.JOACP_349_15.

Munita, J. M. and Arias, C. A. (2016). Mechanisms of Antibiotic Resistance. Microbiology spectrum,*4*(2),10.1128/microbiolspec. https://doi.org/10.1128/microbiolspec.VMBF-0016-2015.

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Peterson, E. and Kaur, P. (2018). Antibiotic Resistance Mechanisms in Bacteria: Relationships between Resistance Determinants of Antibiotic Producers, Environmental Bacteria, and Clinical Pathogens. Frontiers in Microbiology, 9. URL=https://www.frontiersin.org/article/10.3389/fmicb.2018.02928.DOI=10.3389/fmicb.2018.02928.