Krishi Netra

Antimicrobial Resistance: Interactions Involved In Emergence And Spread Of Microbes

Konderu Niteesh Varma[1]*, T. Kavya[1] and D. Vijaysri[1]
[1]Division of Microbiology, ICAR-IARI, New Delhi-110012
Corresponding author: niteeshagri@gmail.com

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Abstract

Antimicrobial resistance is one of the most pressing global threats of our time. It is developing rapidly and threatens to outstrip the rate at which new antimicrobials are introduced. Genetic recombination allows bacteria to rapidly disseminate genes encoding for antimicrobial resistance within and across species. Antimicrobial stewardship, best use, and infection prevention are the most effective ways to slow the spread and development of antimicrobial resistance. Bacteria are social organisms that commonly live in dense communities surrounded by a multitude of other species. The competitive and cooperative interactions between these species not only shape the bacterial communities but also influence their susceptibility to antimicrobials. Several studies have shown that mixedspecies communities are more tolerant toward antimicrobials than their mono-species counterparts and interspecies interactions influence resistance development. Thus, the efficacy of any antibiotic treatment is dependent on different kinds of social interactions existing within a poly-microbial bacterial communities present at the site of infection.

INTRODUCTION

Antimicrobial resistance (AMR) is one of the critical global threats. It's growing fast and could become more serious than the speed at which we are creating new drugs to fight infections. AMR became an important issue in the 1960s when resistance plasmid and transmissibility were detected and recognized global AMR threat in 1998. WHO developed the Global Strategy for the containment of Antimicrobial Resistance in 2001. WHO and member states observed 2011 as the year of Antimicrobial resistance to building momentum for rational use of antibiotics. Resistance of microorganisms to antimicrobial agents to which it is previously sensitive called as antimicrobial resistance. Antimicrobials is a wider term that includes all agents that act against microorganisms, namely bacteria, fungi, viruses and protozoa. Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites change or mutate over time and no longer respond to medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death. An antimicrobial drug works against only one type of organism.

Antimicrobials are of different types;

1. Antibiotics (Antibacterials): Prevent or treat infections caused by Bacteria.
2. Antifungals: Prevent or treat infections caused by Fungi.
3. Antivirals: Prevent or treat infections caused by Viruses.
4. Antiparasitics: Prevent or treat infections caused by Parasites.

There are four different types of mechanisms which increases AMR in microbes (Nikaido, 2009):

1. Limiting uptake of drug
2. Modification of drug target
3. Inactivation of a drug
4. Active efflux of a drug

Impact of interspecies interaction:

The probability of acquiring resistance by the microorganisms depends on the genetic variability of a population prior to the antibiotic treatment (i.e., standing genetic variation) and the additional mutations generated during treatment. There are both competitive and cooperative interactions lies in between the species present in the mixed population which leads to acquire resistance towards antimicrobials.

Impact of Interspecies Interactions on Population Size:

As per the definition, the competitive interactions that typically dominate in mixed-species communities will decrease the population size of a given species. In contrast, cooperative interactions, although rare in a diverse consortium, will increase the population size. A larger population size results in a greater variety of mutants, fewer mutations occur in smaller populations. As the mutation is high there is the more chance of getting resistance to the microbes (Wit et al., 2022).

Impact of Interspecies Interactions on Mutation Rate:

Competitive interactions not only influence the population size but also can enhance the mutation rate and thus increase the probability that a resistant phenotype emerges. In addition, competitive interactions between P. aeruginosa and Candida albicansincreased the mutation rate of P. aeruginosa. This increased mutability was attributed to intense competition for iron, which reduced the activity of antioxidants. The induction of the persistence phenotype via competition or interspecies signaling could thus further increase the number of mutations generated in a mixed-species community.

Impact of Interspecies Interactions on the Spread of Resistant Mutants:

The spread of resistant mutants due to inter species interactions is carried out by two ways (Andersson and Hughe, 2010)

i. Selection pressure.
ii. Horizontal resistance.

Only the resistant microorganisms will survive when they are treated with antimicrobials. Selection pressure helps in spread of resistance from one organism to other or from environment to the susceptible organisms by which every microbe wants to acquire resistance and helps it to survive antimicrobials treatments.

Horizontal gene transfer (HGT; also known as lateral gene transfer) is the non-sexual movement of genetic information between genomes (Davies and Davies, 2010).For example, competition can increase transfer of genes via transformation. In addition to this emergency stress response to DNA damage has been shown to increase the conjugative transfer of antibiotic resistance genes. Since the SOS stress response system is also activated by antibiotics and bacteriocins competition could also enhance the spread of resistance genes via conjugation.

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