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Antimicrobial resistance and its prevalence in anaerobic bacteria

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ABSTRACT

Antimicrobial resistance is one of the hot issues of the modern world. AMR proves to be of equal importance in all types of pathogens but a steeper curve of resistance in anaerobic bacterial species is a matter of great concern. The presence of anaerobes in food animals is one of the major health and economic issues all over the world. Transfer of resistance genes in these bacterial species mostly takes place by conjugation contributing to their wide distribution on the globe. There is a need for vigorous research in this area to reveal the mechanism and level of resistance in these bacterial classes which without any doubt will demand a lot of expertise, finance, and high-profile equipment.

Introduction

Antimicrobial resistance is a phenomenon in which organisms stop responding to antimicrobial therapy given in order to treat any animal or human disease. Antimicrobials are chemicals used to stop the growth of various entities like bacteria, fungi, and other such pathogens. This phenomenon takes place in organisms due to mutation or changes in their genetic makeup both genotypically and phenotypically [1]. Considering the causes and phenomena that lead to the rise of resistant organisms, the top factor is the misuse of antimicrobial agents while treating the disease. The misuse involves both under and overuse of certain antibiotics, mostly nonspecific for the disease. Moreover, a wrong diagnosis leads to wrong treatment and in return cause the pathogens to be resistant. Some other factors for example geography, hygienic conditions, and lack of disease prevention measures are often not taken seriously thus contributing to AMR [2].

Keeping in view of the rising rate of antimicrobial resistance, efforts are being made globally to combat this issue but still, a lot of areas need to be covered in this regard. Despite all the measures being taken and research being carried out on an important class of bacteria that has been gaining a very steeper curve of resistance for the past 3 decades, anaerobic bacteria need a lot of attention. The anaerobic class of bacteria is that which mostly inhabit the mucous membranes, and gastrointestinal tract and sometimes can be seen in the urinary tract [3]. These organisms are related to diseases like tetanus, gangrene, pneumonitis, diarrhea associated with *Bacteroides,* pus, abscess in lungs, bacteremia, and a number of GIT disorders. Some of the anaerobes are specially known for releasing toxins which are also a significant factor in antimicrobial resistance.

Prevalence of Antimicrobial Resistance:

The use of antimicrobials is increasing exponentially day by day. Antimicrobial resistance is a burning issue around the globe and is considered to pose some serious issues in the near future which may turn in the form of a pandemic leading to disastrous outcomes as there will be no cure for a disease caused by resistant organisms. About 131,109 tons of antimicrobials were used in 2013 for food animals only, which is expected to rise to 200,235 tons by 2030 [4]. One of the silent reasons for antimicrobial resistance is the use of antimicrobials in food animals for prevention purposes. The abuse of antimicrobials in food animals leads to antimicrobial residues in their meat and milk which in turn is consumed by humans making them enter the human body and leading to antimicrobial resistance. This silent factor can be controlled by the correct and proper use of antimicrobials specifically only in a time of need.

In the USA about 70% of antimicrobials were being sold for use in food animals and many other countries in Europe follow a similar percentage. AMR is causing more than 0.7 million deaths annually and this can rise to 10 million by 2050 [5]. The most important antibiotics being used in the treatment of anaerobic bacteria are metronidazole, clindamycin, beta-lactams, beta-lactamase inhibitors, and fluoroquinolones [6]. Currently, the most resistant anaerobic bacterial species to antimicrobial therapy is *Bacteroides fragilis.* According to recent research the pattern of resistance in *B. fragilis* shown a high amplitude of resistance against penicillin G, amoxicillin, cefmetazole, ceftizoxime, and clindamycin. Other anaerobic bacteria include *Clostridium perfringens*, *Prevotella, Fusobacterium, Porphyromonas* and the list goes on. The resistance pattern clearly showed a significant increase in resistance in the case of *Clostridium difficile* for imipenem and clindamycin while for *Prevotella* a higher rate of resistance was observed for penicillin and clindamycin. A study carried out in India has revealed that anaerobes has shown 32.6% resistance to metronidazole, 42.6% which was highest among all the studied antibiotics was shown against clindamycin, similarly tazobactam and cefoxitin revealed a resistance level of 38% and 35.3% respectively which is in fact quite high against these drugs which have just appeared in the market for public use [7].

Mechanism of resistance development in Anaerobes:

Anaerobic bacteria can pose serious issues to both human and animal health as they normally inhabit the animals' body and thus enter the food chain leading to a highly unavoidable one health problem. Moreover, an important aspect regarding the antimicrobial resistance is its transfer among organisms. Regarding the transfer of antimicrobial resistance, the most preferred method by bacteria is conjugation which pass on the resistance genes among bacteria. Resistance genes are mostly present on transposons, plasmids and chromosomal portions which are transferable in nature paving the path of spread of antimicrobial resistance among bacteria. Conjugative transposons are one of the key element in transferring of resistance among *Bacteroides* showing a tetracycline resistance gene transfer [8].

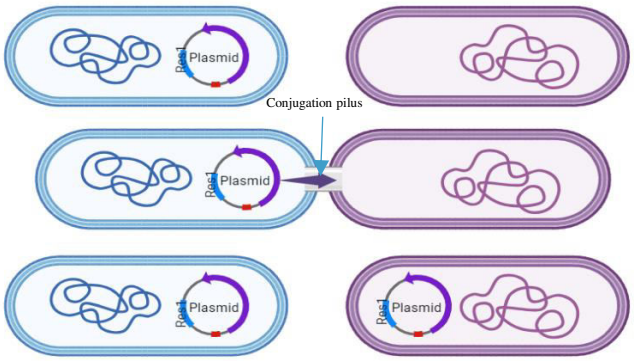

Figure 1 Transfer of resistance genes present in plasmid by conjugation (pilus)

CTnDOT transposon contains both the tetracycline resistance determinants and the genes for the formation of conjugating/mating bridge between bacteria.

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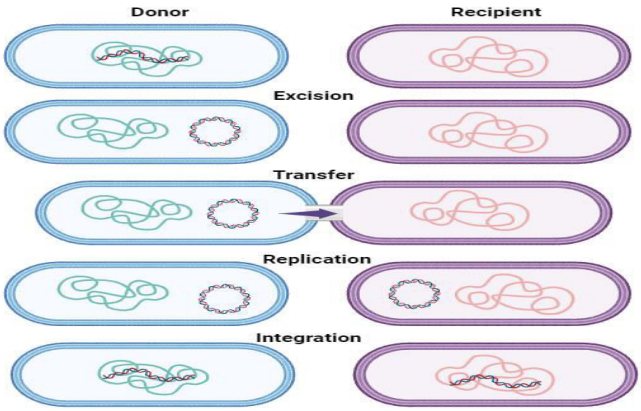

Figure 2 Ctndot transposon lifecycle

Issues of reporting resistance in Anaerobes:

Anaerobic bacteria cannot grow in the presence of oxygen and that is the main issue leading to such negligence in their case. These bacteria mostly die during sampling which causes difficulty in handling them and thus are overlooked. Isolation and sampling of these bacteria require a lot of expertise and advanced-level equipment which makes it an entirely difficult task. The requirement of very strict growth conditions contributes to less research on these bacteria. Anaerobes may require those growth mediums which are quite expensive and need some supplements for the best growth in the artificial media. Lack of resources and fundings in under developed countries is one of the main leading factor of less and poor reporting of the antimicrobial resistance prevalence in these fastidious bacteria [7].

Conclusion:

Despite all the issues in the handling and isolation of anaerobic bacteria this is the area requiring very serious attention regarding antimicrobial resistance. Although the research on anaerobic bacteria requires a good quality lab and expertise but the risk factor these species have imposed, make it the need of hour that some positive strategies should be devised to overcome the prevailing issue. On the whole the presence of bacteria like *Clostridium* in the poultry birds also demands the attention of the authorities to overcome the resistance issues in order to save major economic losses. Further, the importance of anaerobes in the human health sector is also unneglectable and fundings must be approved for the research against anaerobic bacterial species to get the exact figures of prevalence and antimicrobial resistance in these species.

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