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Review Article

Antimicrobial Resistance: Antibiotics or Probiotics

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Abstract

Antibiotics can enhance human lives by treating or preventing diseases. The prodigious, indiscriminate and improper use of antibiotics has played a substantial role in the outspread/emergence of antibiotic resistance bacteria. In the current scenario, a major public-health threat is the resistance to antibiotics. In addressing the problem on antibiotic resistance, the use of probiotics in lieu of antibiotics for treating certain diseases of host organisms has been investigated. Probiotics play a preventive role rather than a therapeutic role and is, thus, considered the opponents to antibiotics. Probiotics are live microorganisms which when administered in adequate amounts confer a health benefit on the host. Most probiotics are common members of the human intestinal tract, and they are ingested in large amounts in functional foods. This review emphasizes on how antibiotics and probiotics face each other pertaining to antimicrobial resistance.

Keywords: antibiotics, probiotics, micro-organisms.

INTRODUCTION

Oral cavity is a complex biological ecosystem with very large number of organisms living in a biofilm [1]. The interaction of these organisms are complex and the change from health to disease state is associated with a change in the balance of the ecosystem usually from the resident facultative anaerobes to obligate anaerobes for majority of oral diseases [2]. Even though only a few of the micro-organisms cause odontogenic infections, in disease state, many other non pathogenic bacterial species contribute by maintaining an ecosystem favourable for survival and growth of the pathogenic species [3]. Proper understanding this mechanism is critical in treating oral infections especially with the aid of antibiotics.

Bacterial infections are common in medical and dental clinical practice which necessitates the use of antibiotics. Ever since their introduction in the mid-twentieth century in the form of sulfa drugs antibiotics have evolved more clinically and pharmacologically in response to the progressive challenges posed by bacterial infections [4]. The human body contains a very broad range of micro-organisms. Most of the clinical scenarios and infectious conditions arise due to polymicrobial flora. Generally antibiotic prescription is empirical. Based on clinical and bacterial epidemiological data, the germs responsible for the infectious process are suspected, and treatment is decided on a presumptive basis without obtaining pus or exudate cultures [5].

However, the National Center for Disease Control and Prevention estimate that approximately one-third of all outpatient antibiotic prescriptions are unnecessary [6]. In addition to having systemic side effects in the form of gastrointestinal disturbances to fatal anaphylactic shock, the indiscriminate and improper use of antibiotics can lead to antimicrobial resistance.

This lead to the ingress of Probiotics into the field of medicine. It is believed that all the bacteria in the human body are not detrimental to the human body. Some microbes have beneficial health effects on the host. These live microbes are termed as probiotics [7, 8]. There are the dietary supplements containing potentially beneficial bacteria or yeasts. These products help to activate health promoting flora and also suppress the pathologic colonization and disease spread [9]. This review emphasizes on how antibiotics and

probiotics face each other pertaining to antimicrobial resistance.

Antibiotics

Frequency, dose and duration play a pivotal role in the administration of antibiotics [10]. Prolonged courses of antibiotics destroy the commensal flora [11]. In addition, longer durations may result in the selection of resistant strains and a reduction in the ability of the oral flora to resist the colonization by harmful micro-organisms that are not normal residents, leading to superimposed infections by multi-resistant bacteria and yeasts [12].

Literature search revealed that the most commonly used antibiotics in dental practice are amoxicillin, metronidazole and amoxicillin and clavulanate [13]. Researchers observed that amoxicillin/clavulinic acid and clindamycin are the only orally administered antimicrobials with adequate pharmacokinetic/pharmacodynamic properties to be effective against the most commonly isolated oral pathogens for the treatment of orofacial and dental infections [14].

The antibiotic sensitivity of the bacteria found within the oral cavity is gradually decreasing, and a growing number of resistant strains is detected – particularly Porphyromona and Prevotella, though the phenomenon has also been reported for Streptoccocus viridans and for drugs such as the macrolides, penicillin and clindamycin [15]. Antibiotic prescription is almost invariably associated with the prescription of nonsteroidal antiinflammatory drugs (NSAIDs). There are many potential interactions between these two drug categories – the most common situation being an NSAID-mediated reduction of antibiotic bioavailability [16, 17].

Pertaining to use of prophylactic antibiotics, literature revealed that most dentoalveolar surgical procedures in fit, non-medically compromised patients, antibiotic prophylaxis is not required or recommended [18]. In the case of bacterial endocarditis, the absolute risk rate after dental treatment, even in at-risk patients, is considered very low and only patients in the high risk category require cover [19]. The type of antibiotic chosen and its dosing regimen should be dependent upon the severity of infection and the predominant type of causative bacteria.

Probiotics

The basis of its efficacy relies on the symbiosis of an established microbial ecology that resists the intrusion or overproduction of pathogens that lead to a diseased condition of the host organism [20]. By limiting the use of antibiotics, probiotic use may help decrease the rate of development of antibiotic-resistant strains secondary to widespread and rampant antibiotic use [21].

Certain micro-organisms which when administered in adequate amounts confer a health benefit on the host. These include Lactobacillus Species, Biffidobacterium Species, Streptococcus thermophiles, lactobacillus bulgaricus and Saccharomyces boulardi. Lactobacillus Species help in the protein and carbohydrate digestive enzymes, synthesizing vitamin K, vitamin B complex and bile salts break down. It is richly available in fermented foods like yogurt and dietary supplements [22, 23]. Biffidobacterium Species help in synthesis of vitamins. They produce beneficial short chain fatty acids by indigestible carbohydrates fermentation. Predominantly present in the large intestine [24, 25]. Streptococcus thermophiles & lactobacillus bulgaricus are found in intestinal tract; produce large quantities of lactase enzyme for metabolism of lactose, extremely useful for prevention and improvement of lactose intolerance and have antimicrobial activity [25]. Saccharomyces boulardi secrete proteases that break down bacterial enterotoxins and their binding to intestinal receptors is inhibited. They also synthesize vitamin production and reduce serum cholesterol level [27].

Mechanism of action of probiotics [3]

- Antimicrobial compound production like bacteriocins, hydrogen peroxide, dipicolinic acid and organic acid which inhibits the pathogenic growth of bacteria.
- Form biofilm and modifies microbial population.
- Alter immune response of the host by an increase in TGF-β, IL-10, decrease in TNF-α and an increase in the production of IgA.
- Decreases inflammation associated molecules by production of short chain fatty acids (Butyrate and lactate).
- Prevents apoptosis induced by cytokines.
- Balances the oral and gut microbial flora, thus making its colonization resistant to pathogenic bacteria.
- Antioxidant and Antigenotoxic activity
- Protection of intestinal barrier integrity and mucin production
- Increases the absorption of calcium and other minerals.
- Inhibits the pathogenic enteric bacterial growth by decreasing luminal pH.

Characteristics of microorganisms which act as probiotics [3]

- Probiotic should be acid resistant, bile resistant and confer positive health benefit on the host.
- It should have faster multiplication and high survival rate.
- It should posses the activity of faster and firm adherence.
- It should reduce or exclude adherence of pathogen.
- Produce antibacterial substances such as lactic acid, peroxide, and bacteriocins.

- Safe, non carcinogenic, non pathogenic, non invasive.
- Balanced flora is formed by co-aggregation.
- In order to deliver alive into the intestine, the probiotics should sustain enough to withstand the duration of manufacturing, processing, and packing

Benefits of probiotics

The complex microbiota of the human gut is considered to play important roles in several gastrointestinal functions. These functions include host nutrition, regulation of gut epithelial development, regulation of fat storage, stimulation of intestinal angiogenesis, inflammatory immune response, and pathogen resistance [28]. It is believed that a stable composition of the human gut microbiota is always beneficial for the human host habitat.

As non-digestible substances, probiotics have an important physiological effect on the host by provoking the growth or activity of the limited indigenous bacteria. Species of Lactobacillus and Bifidobacterium are the most frequently utilized probiotics. Dairy products and probiotic-fortified foods are the most common forms of probiotics. Capsules, tablets and sachets, including bacteria in freeze-dried form, are also available [1].

Probiotics aid the naturally occurring gut microbiota. Diarrhoea caused by antibiotics can be prevented by using some probiotic preparations. Various infections, particularly infections of mucosal surfaces such as the gut and vagina, have been treated successfully using these biological agents. Probiotic use is clinically proven to modulate infant gut microflora disturbance after antibiotic use [21, 28]. Perinatal and postnatal probiotic use is reported to have potential benefits in preventing future developments of allergies, asthma, gastrointestinal infections and obesity as these diseases are all associated with the interplay of gut microbiota and the development of the host immune system [29].

Common medical conditions with established non-microbial pathophysiologies, such as obesity and diabetes mellitus, and much rarer gastrointestinal disorders, such as irritable bowel syndrome, Crohn's disease, and necrotizing enterocolitis, are presently being associated with dysbiosis in the human gut microbiota. Deviation from what is accepted to be normal human gut microbial ecology appears to be part of the aforementioned diseases' pathophysiologies.[29] Therefore, more medical applications of probiotic use to maintain normal human gut microbial ecology are anticipated to appear in the near future.

Hazards with probiotics

Microbes used as probiotics are not exempted from the natural processes governing antibiotic resistance. It is imperative to screen microbes effectively for antibiotic resistance genes before using them as probiotics. A crucial aspect in studying antibiotic resistance in probiotic bacteria is to separate intrinsic resistance from acquired resistance [30].

Bacteria naturally present in foods or food supplements, or deliberately added to them, including probiotic bacteria, constitute a potential source of antibiotic resistance determinants. Especially some fermented foods, such as dairy products, possess an extremely high bacterial density, mostly composed of LAB, quantitatively comparable with the microbial population found in some parts of the human intestine. This microbial population represents a huge reservoir of antibiotic resistance genes whose ingestion could influence the presence, establishment, and dynamics of antibiotic resistance bacteria in our body.

Based on safety records, microorganisms used as probiotics can be placed in 3 broad groups - safe strains, doubtful strains, risky strains. There are 3 theoretical concerns regarding the safety of probiotic organisms: (1) the occurrence of disease, such as bacteremia or endocarditis; (2) toxic or metabolic effects on the gastrointestinal tract; and (3) the transfer of antibiotic resistance in the gastrointestinal flora [31]. strains.

Though probiotics are currently regarded as safe, it is imperative to implement proper regulation on their use in both livestock and human applications to effectively mitigate their potential contribution in the spread of antibiotic resistance genes in our natural environments.

CONCLUSION

Antibiotic misuse can be considerable reduced by enhancing the awareness among medical practitioners pertaining to the recommended guidelines for antibiotic use. Furthermore, there is a need for initiating awareness programs among the general public pertaining to need and hazards of antibiotic usage. Probiotics help to activate health promoting flora and also suppress the pathologic colonization and disease spread. They are considered as living drugs that can reduce antibiotic consumption and increase human health development. However, it is imperative to screen them effectively for antibiotic resistance genes before using them as purely reliable options.

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