Antimicrobial Resistance

A GLOBAL HEALTH CRISIS

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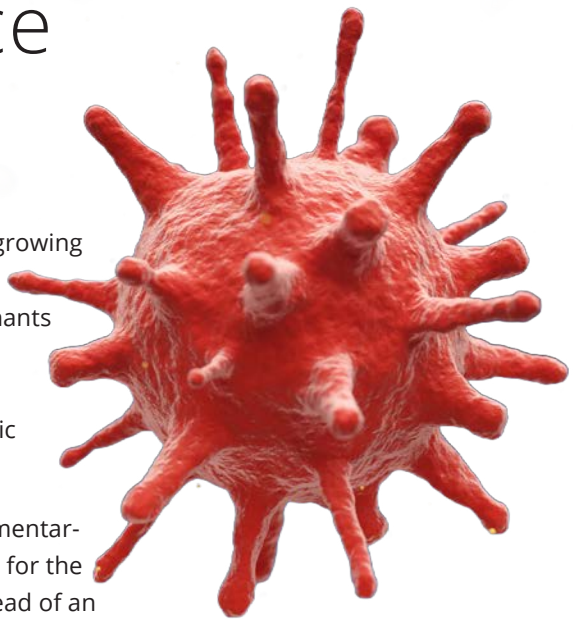

Global Impact of Antimicrobial Resistance (AMR)

Many medical and dental practitioners and associations have recognized the growing problem of antimicrobial resistance **(AMR)**. AMR takes place when the bacteria modify themselves by mutations or by exchanging resistant determinants so they can survive even though antibiotics are being used against them. In fact, some believe the improvements and advances that were made in treating diseases are starting to decline to the point where the end of antibiotic effectiveness is in sight.

Antimicrobials and antibiotics are a vital part of medical care providers' armamentarium for the treatment of disease and infections. Antibiotics need only be used for the management of active infectious diseases and/or to prevent the systemic spread of an infection. Antibiotics should not be used to treat viral diseases of any sort. Many argue that reduction in AMR can only occur following a significant reduction in antibiotic use.

AMR has far-reaching consequences, affecting both human health and the economy. According to the World Health Organization **(WHO)**, AMR is responsible for approximately 700,000 deaths annually, a number projected to rise to 10 million by 2050 if no action is taken.

AMR makes common infections, such as pneumonia, urinary tract infections, and sepsis, more difficult to treat. In addition, surgeries and cancer treatments that rely on antibiotics to prevent infections become riskier. The increased costs associated with prolonged hospital stays, the need for more expensive second-line treatments, and productivity losses in affected populations strain healthcare systems globally. Estimates suggest that AMR could cost the global economy up to $100 trillion by 2050. In agriculture, AMR threatens food production, with resistant infections in livestock and crops affecting yield and quality. This impact can lead to higher food prices and increased food insecurity in vulnerable regions.

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Antimicrobial Resistance (AMR) in Dentistry

AMR is one of the most pressing global health challenges, and its effects extend to every medical discipline, including dentistry. **Dentistry, often overlooked in discussions of AMR, plays a crucial role due to the frequent use of antibiotics to prevent and treat oral infections.** Dental practitioners commonly prescribe antibiotics for conditions such as periodontal infections, abscesses, and post-surgical prophylaxis. The misuse and overprescription of antibiotics in dentistry contribute to the development and spread of resistant bacterial strains, posing a significant threat to public health.

Although dentists do not treat as many patients with antibiotic therapy as our medical counterparts, antibiotic therapy is a valuable treatment option for certain dental infections; indeed, *antibiotics and analgesics are the most commonly prescribed medications by dentists*. It is estimated that 10 percent of all antibiotic prescriptions are dentally

related. One study found that dentists account for 7 percent of all community prescriptions of antimicrobials in the United Kingdom (U.K.). Although one might argue that 7 – 10 percent is not a major contributing factor, it has been reported that dentists wrote 3.5 million prescriptions annually. It has also been estimated that each dentist could be prescribing an average of 159 prescriptions per year, or roughly three prescriptions per week. Mathematically using the figures above, dentistry is accounting for roughly 200-300 million prescriptions a year in the United States (U.S.). To underscore the magnitude of this number, *more antibiotics are sold than over-the-counter drugs in the U.S.*

There are two major reasons that antibiotics are used in dentistry: 1) to treat oral infections and 2) to prevent bacteremia caused by dental treatment. If the dentist decides that antibiotics will be of benefit to the healing process, the antibiotic should be administered as soon as possible, and the most effective route of administration must be considered. The goal of antibiotic treatment is to use the smallest amount of the drug that is most effective against the organism causing the infection. The efficacy of the antibiotic must be monitored as well because if the antibiotic of choice is not improving the situation, a culture and susceptibility testing may be necessary in order to more correctly treat the infection. Antibiotic therapy for orofacial infections can produce excellent benefits in selected clinical situations; however, orofacial infections need to be treated with local drainage and not antibiotics when possible. This can include removal of the infected tooth with hope of achieving drainage through the socket or drainage through an incision of the area. Antibiotics should be considered as an addition to the treatment when there are signs of systemic involvement such as fever or diffuse swelling. Antibiotics should not be the main treatment modality for orofacial infections unless there is spreading cellulitis. The minimal duration of the prescription should be five days past the improvement or resolution of the patient's symptoms.

The American Academy of Pediatric Dentistry (AAPD) is sensitized to the upward trend of antibiotic resistance. With this recognition of the problem, the AAPD also has described specific clinical indications for antibiotic usage. The AAPD recommends conservative use of antibiotics to reduce the risk of developing resistance. The AAPD describes situations and/or principles that should be followed when prescribing antibiotics to a child.

The American Dental Association (**ADA**) also has acknowledged the antibiotic resistance phenomenon and its relevance to dentistry through the release of a report in the April 2004 edition of JADA, "Combating Antibiotic Resistance", wherein a special panel outlines ADA recommendations. The ADA believes that the benefit of the antibiotic [therapy] must be weighed against the known risks of antibiotic toxicity, allergy, and the development, selection and transmission of microbial resistance. These AAPD and ADA guidelines were created to help guide dentists in their practices and minimize unwarranted antibiotic use.

Drivers of AMR in Dentistry

Although antibiotics are effective and useful in treating infections, they should not be inappropriately used, or antibiotic-resistant micro-organisms will become more resistant and more plentiful in number. Furthermore, misuse and overuse of antibiotics have given rise to the growing problem of antibiotic resistance. When antibiotics are used correctly, there can still be problems because past antibiotic use can be linked to an individual developing resistant microbes.

Dental professionals do not appear to prescribe as much as their medical counterparts, but every profession with the ability to prescribe medication needs to be mindful of the antibiotic resistance problem. It is believed that reduction in antibiotic resistance can only occur following a significant reduction in antibiotic use. To prevent misuse and overuse of antibiotics, dentists need to be fully conversant with the indications and contraindications for prescribing antibiotics, proper dosing schedules, and the risk of allergic and toxic adverse reactions, superinfections, and development of antibiotic-resistant organisms. A major contrast between medicine and dentistry is that most dental infections can be treated successfully by removal of the source so there is no need to also use an antibiotic unless it is absolutely necessary. If it is determined that the benefits of the drug will outweigh the risks involved then the drug should be used; however, the exposure of the general population to antibiotics must be reduced to avoid pressuring bacteria into making evasive measures that will make otherwise useful antibiotics ineffective.

Several factors contribute to the emergence and spread of antimicrobial resistance in dentistry:

- **Overprescription of Antibiotics**: Dental practitioners often prescribe antibiotics in situations where they may not be necessary,

such as routine dental procedures or minor infections that can resolve without antimicrobial intervention.

- **Inadequate Diagnostic Tools**: In many cases, dentists rely on clinical symptoms rather than microbiological tests to determine the need for antibiotics. This empirical approach can lead to ineffective prescriptions, fueling resistance.
- **Patient Pressure and Expectations**: Patients sometimes expect antibiotics for pain or infections even when they are not warranted. To meet patient expectations or avoid dissatisfaction, some dentists may overprescribe antibiotics.
- **Incomplete Courses of Antibiotics**: Patients frequently fail to complete prescribed courses of antibiotics, which can leave surviving bacteria with the opportunity to develop resistance.

Consequences of Antimicrobial Resistance in Dentistry

The rise of AMR has profound implications for the practice of dentistry, impacting both routine care and complex surgical interventions. Some key consequences include: 1) Reduced Treatment Options: As oral pathogens become resistant to commonly prescribed antibiotics, dentists are left with fewer effective treatment options, leading to increased morbidity from untreated or poorly managed infections; 2) Increased Risk of Complications: Infections that fail to respond to standard antibiotic treatments can spread to other parts of the body, leading to serious complications such as osteomyelitis, cellulitis, or septicemia; 3) Compromised Surgical Outcomes: Oral surgeries, including tooth extractions, dental implants, and periodontal surgeries, rely on antibiotics to prevent post-surgical infections. Resistance to these antibiotics increases the risk of infection and impairs healing; and 4) Public Health Burden: AMR in dentistry adds to the broader public health challenge, as resistant strains of oral bacteria can spread within communities and healthcare settings.

Case Study: Methicillin-Resistant Staphylococcus aureus (MRSA)

Methicillin-resistant *Staphylococcus aureus* (MRSA) serves as a prominent example of the challenges posed by AMR. MRSA infections were once limited to hospitals but have now spread to the community. The bacterium is resistant to methicillin, penicillin, and other common antibiotics, making it a leading cause of difficult-to-treat infections. MRSA is associated with increased morbidity, longer hospital stays, and higher healthcare costs. Efforts to control MRSA include rigorous hygiene practices, antibiotic stewardship, and the development of new antimicrobial agents.

The Role of International Collaboration

Addressing AMR requires cooperation at the global level. International organizations, governments, and non-governmental organizations are working together to combat AMR through initiatives such as the Global Action Plan on AMR developed by the WHO, Food and Agriculture Organization (FAO), and World Organization for Animal Health (OIE). The plan outlines key priorities, including improving awareness, strengthening knowledge through surveillance, reducing the incidence of infections, and optimizing the use of antimicrobial medicines.

Strategies to Mitigate AMR in Dentistry

Mitigating AMR in dentistry requires concerted efforts at both individual and institutional levels. Implementing antimicrobial stewardship programs in dental practices can help curb the overuse and misuse of antibiotics. Dentists should adhere to evidence-based guidelines for prescribing antibiotics and avoid empirical use. Continuous education for dental professionals on the risks of AMR and the importance of judicious antibiotic use is crucial. Training programs should focus on infection control measures, appropriate antibiotic prescribing, and the importance of microbiological testing. Educating patients about the risks of antibiotic misuse and the importance of adhering to prescribed treatment regimens can help reduce unnecessary antibiotic demand. The use of rapid diagnostic tests to identify the causative agents of dental infections can guide more targeted antibiotic therapy, reducing the need for broad-spectrum antibiotics. Strengthening infection control measures in dental clinics, including sterilization protocols and proper hand hygiene, can reduce the need for antibiotics by preventing the spread of infections. Continued research into alternative antimicrobial agents, such as antimicrobial peptides, phage therapy, and probiotics, offers promising avenues to address AMR in dentistry.

Future Directions

While efforts to combat AMR are underway, the future of antimicrobial therapy may include several innovative approaches:

- **Phage Therapy**: The use of bacteriophages—viruses that infect and kill bacteria—offers a promising alternative to antibiotics. Phage therapy is specific to particular bacterial species, reducing the risk of collateral damage to the microbiome.
- **Antimicrobial Peptides**: These naturally occurring molecules, produced by many organisms, have the potential to be developed as new antimicrobial agents due to their broad-spectrum activity and ability to target resistant bacteria.
- **Nanotechnology**: Nanoparticles are being explored as delivery systems for antibiotics or as direct antimicrobial agents due to their ability to penetrate biofilms and target resistant bacteria.
- **CRISPR-Cas Systems**: CRISPR-Cas, a gene-editing technology, could potentially be harnessed to target and destroy resistance genes within bacteria, restoring their susceptibility to antibiotics.

Conclusion

Antimicrobial resistance is a growing concern in dentistry, with significant implications for patient care and public health. Dentists play a vital role in combating AMR by adopting responsible prescribing practices, educating patients, and employing infection control measures. The dental community must work in concert with broader healthcare efforts to address the AMR crisis and preserve the efficacy of antibiotics for future generations.

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