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Antimicrobial Resistance (AMR) and Dentistry: A lethal connect

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Abstract

In the unfolding narrative of global health, the ominous spectre of antimicrobial resistance (AMR) looms large, presenting an ever more urgent challenge to public health systems worldwide. Antibiotics are a primary tool in the field of therapeutic medicine & dentistry & they saturate the Indian pharmaceutical markets. Dentistry places substantial reliance on use of antibiotics in prophylaxis & therapy, but this dependence contributes to the overuse & misuse of these drugs. A significant number of prescriptions are frequently deemed superfluous. Furthermore, antibiotics are readily accessible over the counter in addition to being subject to notable instances of overprescription. The absence of timely antibiotic culture & susceptibility tools accelerates the dissemination of resistance, resembling a wildfire.

Given current trends, it appears we are unwittingly fostering a situation akin to Frankenstein's monster. But is this foresight or mere paranoia? Our focus must centre not only on bolstering surveillance but also on the understanding of the need of antibiotics in dental treatment, advocating for responsible antibiotic usage & advancing research into innovative treatments, in return fortifying healthcare systems. Failure to curb the spread of antimicrobial resistance, at best- jeopardises individual health to a point of no return, & at its worst- undermines the sustainability of modern medicine as we know it. This article is aimed to depict the contemporary landscape of antimicrobial resistance within the realm of dentistry ,speculate on its potential detrimental trajectory.

Key words- Antimicrobial resistance (AMR); Overprescription; Dental treatment; Impending pandemic

1. Introduction

Antimicrobials are a group of medications that either eradicate or restrain the growth of microorganisms. This category includes antibiotics, antivirals, antifungals, and antiparasitics. They are essential drugs used to combat infectious diseases in humans, animals, and plants.Antimicrobial Resistance (AMR) arises when microorganisms like bacteria, viruses, fungi, and parasites develop insensitivity to these medicines. This renders antimicrobial drugs ineffective, making their infections challenging or impossible to treat. Consequently, there's an elevated risk of disease transmission, severe illness, morbidity and mortality.(1)

Upon the introduction of antimicrobials, most bacteria are eradicated, yet some persist. Development of resistance is an inherent process that unfolds gradually due to genetic shifts in pathogens.Through repeated cycles of exposure to antimicrobials, only the fittest survive, leading to the development of highly resistant strains. Human actions, especially the overuse and abuse of antimicrobials for treating, preventing, or controlling infections , hence, accelerate the emergence and spread of AMR.(1)

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review and recommend initiatives, and a Core Working Group on AMR to provide technical and operational support to India's national coordinating centre for AMR.

This was the result of a bilateral discussion between the premiers of India & US to tackle AMR in Indian Scenario(18).[FIGURE 5]

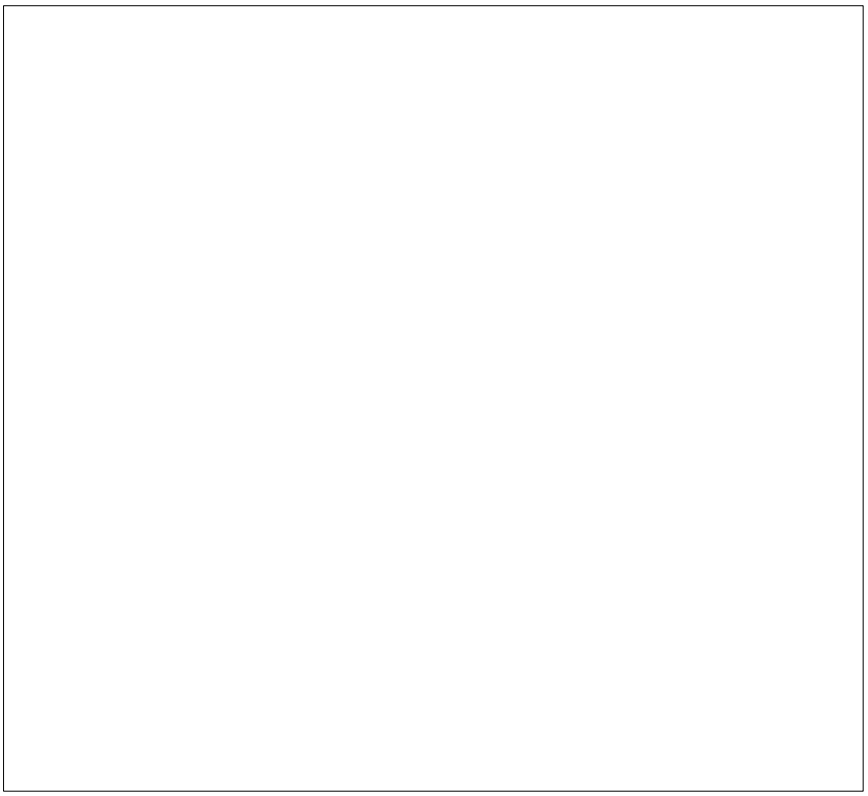

Figure 5 The priorities as formulated by NAP-AMR (18)

7.2. Approaches from a dental standpoint

Overuse of antibiotics in dentistry is a critical issue driven largely by the misconception that antibiotics are a universal remedy for all dental conditions, leading to their widespread self-prescription. The educated guesswork by many dental clinicians exacerbates the issue. But it would be another episode of negligence to address it as the only problem that requires significant attention. Each stage, from prescription to usage to disposal, represents a critical factor to potentially contribute to antibiotic pollution and concurrent AMR .

To keep prescription practices in check, it is crucial to establish long-overdue guidelines for prescribing antimicrobial drugs in dental sciences. Implementing practices such as reclaiming leftover antibiotics from patients or establishing systems similar to directly observed therapy short course (DOTS) could help mitigate this challenge as well. In fact, This practice alone can effectively monitor all three crucial stages - prescription, usage and disposal.

Implementing stewardship in densely populated countries like India poses challenges, but it is essential to regulate the dispensing of these drugs by pharmacists. Furthermore, raising awareness among the general public about the fact that antibiotics are not universally applicable and should only be used under the guidance of a licensed doctor is crucial.

It's concerning that non-chemical methods like heat treatment of dental refuse for bacterial inactivation have received insufficient research attention, possibly due to inadequate recognition of antimicrobial introduction into the environment by the dental community. Similar to the issue of antimicrobial agents ending up in landfills, improper management of dental waste is a significant contributor to antimicrobial pollution caused by the dental community.

Addressing these gaps in research and improving waste management practices are crucial steps towards reducing dentistry induced antibiotic pollution and safeguarding environmental and public health. Research in every relevant field must intensify if we are to effectively combat resistant bacteria.

7.3. Current methods for the prevention and treatment of oral infections

To combat oral infections associated with biofilms, improving oral hygiene with fluoride toothpaste is crucial but insufficient alone.(4) Antimicrobial dental materials have been developed for procedures such as restorations and implants to address this challenge effectively.According to Jiao et al(20), antimicrobial dental materials have been advanced through three mechanisms: releasing antimicrobial agents, contact killing, and multifunctional strategies. Nanoengineering has significantly boosted the development of new or enhanced dental nanomaterials with antibiofilm properties. Despite promising results in vitro, the clinical application of these materials faces challenges, particularly in terms of biocompatibility. Ramburrun et al.(19) recently provided a comprehensive review of emerging trends and advancements in antimicrobial materials for dental restorative, reconstructive, and replacement purposes.

Alternative strategies such as - antimicrobial photodynamic therapy (APDT), cold atmospheric plasma (CAP), probiotics, natural products, inhibitors of virulence factors, antimicrobial peptides have been investigated and clinically tested. These methods have been summarised in table.

Table 1 Summary of alternative strategies for treatment of oral infections.

S. no	Name of methodology	Mechanism	Remarks
1.	Antimicrobial Photodynamic Therapy (APDT)	- It utilises a photosensitizer and low-energy laser light with oxygen to produce reactive oxygen species (ROS), effective in bactericidal action. - APDT is studied extensively both in vitro and clinically. - It is applied independently and adjunctively in treating dental caries, endodontic diseases, periodontal diseases, and peri-implantitis. (21)	- research in this field is ongoing.
2.	Cold Atmospheric Plasma (CAP)	- CAP (Cold Atmospheric Plasma), an innovative approach, offers significant advantages over conventional antibiotics in dental clinical settings for managing biofilm infections. - CAP generates reactive oxygen and nitrogen species that infiltrate the biofilm, causing oxidative damage to bacterial membranes, extracellular DNA, and proteins.(20)	-
3.	Natural Products	- Plant-derived natural compounds such as phenolics, quinones, flavonoids, alkaloids, and terpenoids are recognized as valuable sources of quorum sensing inhibitors (QSI) for treating oral biofilm-related infections (22). - Coumarin, for example, inhibits P. gingivalis biofilm formation by targeting its quorum sensing system (23) - Curcumin has demonstrated the ability to reduce the expression of biofilm formation and virulence-related genes in both single-species and mixed-species biofilms of S. mutans and C. albicans [27].	-
4.	Antimicrobial Peptides (AMPs)	- Antimicrobial Peptides (AMPs) are short oligopeptides, typically less than a hundred amino acids long, naturally produced by organisms ranging from bacteria to humans as a frontline defence. They can also be synthesised chemically . - AMPs possess broad-spectrum activity against bacteria, fungi, viruses, and parasites, and they also exhibit antioxidant and antitumor properties [24]. - These peptides employ multiple mechanisms simultaneously, effectively killing microorganisms while modulating the immune response, which hinders the development of microbial resistance [25].	-it is one of the most promising treatment modalities , but clinical relevance is yet to be established.

5.	Probiotics	- Probiotics are living microorganisms possess beneficial traits like non-pathogenicity, safety, genetic consistency, and the capability to endure processing and administration conditions. - Lactobacillus spp. probiotics have demonstrated enhancements in clinical indicators of periodontal health by decreasing species associated with periodontitis.(28)	-research shows that oral microbiome is much more robust than gut microbiome.(11) Hence, its applicability in terms of amr is questionable. -research is ongoing in this field.

Abbreviation

AMP	Antimicrobial Peptides
AMR	Antimicrobial Resistance
APDT	Antimicrobial Photodynamic Therapy
ARG	antibiotic resistance gene
AWaRe	Access, Watch, Reserve
BPPL	Bacteria Priority Pathogens List
CAP	Cold Atmospheric Plasma
DOTS	Directly observed therapy short course
EPS	Extracellular polymeric substance
ESBL	Extended-spectrum β-lactamase
FDC	fixed-dose combinations
GLASS	Global Antimicrobial Resistance and Use Surveillance System
ICHP	Informal health care providers
INSAR	Indian Network for Surveillance of Antimicrobial Resistance
MALDI-TOFMS	Matrix-assisted laser desorption ionisation-time of flight mass spectrometry
MRSA	Methicillin-resistant Staphylococcus aureus
NAP-AMR	National Action Plan on Antimicrobial Resistance
NDM-1	New Delhi metallo-β-lactamase 1
NHS	National Health Service
NLEM	National List of Essential Medicines
OECD	Organization for Economic Cooperation and Development
QSI	Quorum sensing inhibitors
UK	united kingdom
WHO	World Health Organization

8. Conclusion

AMR probably could be another devastating catastrophe like the recent pandemic world has faced , unless we take note of the prevailing red flags and act upon swiftly .Data world wide has undoubtedly proven the menace of AMR in grevious medical situations in clinical practice .Dentistry, an allied field of the same , is mutely playing a role in AMR. Without a proper curriculum in any undergraduate & speciality teaching & no guidelines for antibiotic usage we are heading towards this apocalypse.

Government policies highlight One Health concept, yet fail to address rampant antibiotic misuse. Moreover, inadequate awareness and the glaring lack of comprehensive research hampers our grasp of how dental practices contribute to antibiotic resistance, leaving us blind to the true gravity of this crisis.

It's time we take control in terms of our policies & concurrently update our knowledge to follow the protocol ,else AMR will soon become an intractable alien for us !

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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