

Rethinking the Prescription Pad Antimicrobial Stewardship in 21st-Century

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Abstract—Significant development regarding drug administration in endodontics has taken place over the recent past. Among the most noteworthy changes is the selective use of antibiotics and an effective pain management strategy. Although the process of endodontic debridement and instrumentation remains the basic approach used in the treatment of endodontic infections, drugs remain integral tools.

Antibiotic Stewardship: According to current guidelines, antibiotics are only indicated for systemic infections. Thus, they should not be used prophylactically to treat localized pain or inflammation. Their prescription becomes mandatory where there is an evident spread of infection. In addition, amoxicillin is still considered the best choice for its high bioavailability and safety. In special situations like regenerative endodontic therapy or avulsion of the tooth, application of topical treatment in the form of TPA becomes important.

Conclusion: Modern-day successful endodontics involves much more than just skillful technical performance because it includes a carefully planned and patient-specific approach in prescribing drugs. By applying both techniques in combination, clinicians achieve faster recovery.

Index Terms—Antibiotics, Endodontic infection, Microorganisms, Traumatic Injuries.

I. INTRODUCTION

A common understanding exists that root canal treatment is more than just mechanical cleansing and shaping of the tooth canals. Management of infection is equally important before, during, and after the procedure. For these reasons, pharmacology plays an

important role in endodontics, but this does not replace the conventional method.

However, in some cases, when infection may spread beyond the tooth, antibiotics are a reasonable choice. The question is not whether they should be used, but how and when it is safe to do so.

II. ENDODONTIC INFECTION

To understand why addressing endodontic infections requires more effort than administering antibiotics in necrotic teeth, it is highly favorable for bacterial colonization. This results in biofilm formation in the tooth cavity. Since the tooth lacks a vascular network, immune cells cannot reach the site of infection; thus, the pathogens become inaccessible to systemically delivered medications, whether taken orally or intravenously.

Therefore, infection must be removed through physical means, washed out of the root canal using irrigation solutions, and finally sealed. However, the means used to achieve this result may vary depending on the clinical situation, but the core idea will remain consistent in all treatment methods.[1]

III. ANTIMICROBIAL STEWARDSHIP

This is a coordinated health care approach to ensure optimal use of antimicrobial drugs, like antibiotics. Its primary goal is to maximise clinical outcomes while minimising the untoward effects of antimicrobial agents. This term was first applied by John McGowan and Dale Gerding in 1996. [2]

Several national and international organizations have published evidence-based guidance on antibiotic use in endodontics. The American Association of Endodontists (AAE) maintains that thorough root canal debridement is the cornerstone of managing endodontic infections, and that antibiotics are not a substitute for definitive treatment. It recommends amoxicillin, with or without metronidazole, as the first-line choice for non-allergic patients, and clindamycin for those with penicillin hypersensitivity, favoring narrow-spectrum agents to preserve gastrointestinal microbiota.[3]

Similarly, the European Society of Endodontology (ESE) stipulates that antibiotics should never be prescribed as a precautionary measure and are warranted only when systemic signs of infection are present — such as fever, malaise, lymphadenopathy, or trismus — or in medically compromised patients. The ESE recommends amoxicillin as the first-line agent, with metronidazole added when the response is inadequate. Both the AAE and ESE agree that antibiotic prescription must be driven by clinical evidence of systemic involvement, not by patient demand or clinical anxiety.[4]

While both the AAE and ESE provide clear, evidence-based frameworks, India conspicuously lacks a formal national position statement on antibiotic prescribing in endodontics. A national KAP survey further highlighted that approximately 77.3% of dental participants were unaware of the antimicrobial stewardship concept and the WHO AWaRe classification, with overprescription most prevalent among general dental practitioners. Prescribing pattern analyses revealed that amoxicillin and penicillin account for approximately 62% of antibiotic prescriptions in Indian dental practice, while broad-spectrum agents constitute 31%, with 80% of prescribing being empirical and a high rate of prophylactic overuse and misuse of indications.[4]

When it comes to antibiotics working locally in the canal, their effectiveness is seen at work inside the canal. Endodontic infection management follows a well-articulated hierarchy that makes perfect sense: the first step in treatment is mechanical therapy, and antibiotics, both systematic and topical, are used only as supplements to treatment and only if there is evidence to support their use.

IV. ANTIBIOTICS IN ENDOODONTICS

When a dentist prescribes a drug, they are not only treating a specific patient but making decisions with far-reaching consequences. Prescribing antibiotics for endodontic treatment is a combination of patient care and public health and overprescribing or under prescribing can have serious consequences. Striking a balance between these two concerns defines responsible for contemporary dentistry.[3]

The position of the American Association of Endodontics in this regard is systemic antibiotics serve as a supplement to treatment and are never intended to replace treatment itself. In most cases of endodontic disease, regardless of the patient's symptoms of pain and suffering, infections are confined to the root canal. The administration of antibiotic therapy on top of the usual treatment plan neither hastens recovery nor provides significant pain relief and reduces the occurrence of adverse effects. Instead, it only exposes patients to more antibacterial medication and adds to the growing problem of antibiotic resistance.[3]

Most notably, those diseases are often overprescribed by antibiotics but do not offer any significant advantage are:[3,5]

- Irreversible Pulpitis: It is a localized inflammatory response; the only way to relieve the pain is through proper treatment.
- Apical Periodontitis: Pain in the apical region but are otherwise asymptomatic; the infection remains localized.
- Chronic Apical Abscess with Sinus Tract: Since the infection already has its drainage pathway, antibiotics will serve no purpose whatsoever in such cases.

Whenever an infection crosses local boundaries and affects the whole body systemically,

Antibiotics are necessary. Clinical criteria for antibiotic prescription can be broadly grouped into four categories, as listed in Table 1. In case of immunocompromised patients; a localized abscess can quickly develop into a serious health issue due to compromised immunity of the patient. Similarly, fever, malaise, inexplicable trismus, or enlarged lymph nodes all point toward a systemic infection that cannot be managed locally. A rapidly developing abscess, spread of cellulitis, or osteomyelitis needs immediate systemic treatment. Another case where antibiotics

may come in handy is when an infection produces a chronic exudate despite thorough intracanal treatment. [3,4]

Table 1: Indications for Systemic Antibiotic Use in Endodontics

Category	Clinical Indicators
Acute Apical Abscess in Immunocompromised Patients	Localized fluctuant swelling; patient with systemic disease causing impaired immunological function
Acute Apical Abscess with Systemic Involvement	Elevated body temperature >100°F; malaise; unexplained trismus; lymphadenopathy
Progressive Infections	Rapid onset of swelling (<24 hrs); cellulitis or spreading infection; osteomyelitis
Persistent Infection	Chronic exudation unresolved by regular intracanal procedures and medications

Understanding when antibiotics should be used increases competence among clinicians and when they won't contribute positively to treatment outcomes and help antibiotic stewardship.

When there is an indication for systemic use of antibiotics in odontogenic infections, there needs to be careful attention given to the antibiotic selected like Amoxicillin has been chosen as the antibiotic of choice based on its superiority to Penicillin VK, as patients experience better adherence and increased effectiveness, along with reduced risk of gastrointestinal side effects.

If the infection appears to be difficult to treat or is highly associated with the presence of obligatory anaerobes, like in periapical abscesses, then the use of metronidazole can complement the amoxicillin treatment. This combination of therapy allows the treatment to cover the obligatory anaerobes that the amoxicillin may not effectively eliminate. [3,6]

An important consideration is the duration of the treatment period based on the patient's response. It has

been recommended that the duration of treatments should ideally range between three and seven days until significant improvement occurs, since there are no additional benefits gained beyond this point, but the increased risk for developing resistance to the drugs.

Co-amoxiclav:

For infections that involve bacteria with β -lactamase enzymes such as *Staphylococcus aureus* or *Prevotella* species, the use of co-amoxiclav would be the most appropriate. Clavulanic acid acts by inhibiting the enzyme that breaks down amoxicillin, hence making it effective against resistant organisms. But application should be reserved only for cases like patients with an impaired immune system or in those with an inadequate response to regular amoxicillin in 48 to 72 hours. Standard doses consist of either 625 mg (500/125) every 8 hours or 1000 mg (875/125) every 12 hours.[6]

Managing Penicillin Allergy

Patients with Type I hypersensitivity reaction can follow these alternatives:

Table 3:

Patient Profile	First-Line Antibiotic	Alternative (Penicillin Allergy)
Standard	Amoxicillin 500 mg every 8 hours	Clindamycin 300 mg every 6 hours
Severe / Refractory	Amoxicillin + Metronidazole 500 mg (if no improvement in 48–72 hrs)	Azithromycin 500 mg day 1, then 250 mg daily

The choice between these two should be guided by the severity of the infection, the patient's medical history, and their likelihood of completing the course.

V. ANTIBIOTIC THERAPY IN TRAUMATIC DENTAL INJURIES

Most frequent traumatic dental injuries happen to children and teenagers. And while the initial injuries leave patients susceptible to infection, which could jeopardise their recovery if not treated timely. The

most dangerous issue associated with that situation is inflammatory root resorption, which can be prevented by proper administration of antibiotics.[7]

However, the word 'proper' is significant here. According to the IADT (International Association of Dental Traumatology), there is a clear set of instructions for determining the cases when antibiotic treatment is necessary (Andersson et al., 2012).

Luxation Injuries

As far as the use of antibiotics after luxation injuries, do not have any effect. Appropriate splinting, follow-up, and monitoring should be the priority here; with exceptions, such as patients with certain medical conditions that predispose them to infections or surgical treatment of accompanying injuries.. [7]

Replantation of Avulsed Teeth

An avulsed tooth becomes contaminated with various pathogens which comprises the periodontal ligament and pulpal healing. This healing is enhanced if antibiotics are administered together with local measures. Doxycycline and amoxicillin are the most recommended agents.. [7]

2: Systemic Antibiotic Use in Traumatic Dental Injuries

Traumatic Injury	Systemic Antibiotics as Adjunct	Type of Antibiotic
Tooth Fracture	No	—
Concussion / Subluxation	No	—
Luxation Injuries of Permanent Dentition	No	—
Extrusion	No	—
Replantation of Avulsed Teeth	Yes	Tetracycline, Doxycycline

VI. TOPICAL ANTIBIOTICS IN ENDODONTICS

An important aspect of current endodontic pharmacotherapy is the possibility of delivering highly concentrated doses of antibiotics to the target area of infection located within the root canal, thus creating the effect of local action without systemic toxicity.

The use of topical antibiotics as intra-canal medications are a vivid example of the application of this method for the treatment of polymicrobial biofilms with a minimum risk of systemic toxic effects.

- Pulp Capping

The rationale for using antibiotics for pulp capping is clear - to control bacteria to preserve pulp vitality. Various antibiotics like penicillin, tetracycline are used, nevertheless, there is strong evidence of their superior efficacy in relation to biologically active materials like Mineral Trioxide Aggregate (MTA) or calcium silicate cements, which actively support dentinal bridge formation and pulp healing.[8]

- Root Canal Treatment

The use of intracanal antibiotics has seen a long journey throughout history. The advent of Grossman's polyantibiotic paste in 1951, known as PBSC — a combination of penicillin, bacitracin, streptomycin, and caprylate sodium suspended in a silicone vehicle — is considered a remarkable discovery for its time, representing one of the first major attempts to achieve chemical elimination of biofilm residing in root canals. Each component served a targeted purpose: penicillin against gram-positive organisms, bacitracin for penicillin-resistant strains, streptomycin for gram-negative organisms, and caprylate sodium as an antifungal agent. However, PBSC demonstrated notable limitations, particularly its ineffectiveness against anaerobic microorganisms, which are key players in endodontic infections. These shortcomings, compounded by the risk of allergic reactions, led the FDA to prohibit PBSC for endodontic use in 1975.[9] In response, a modified formulation known as PBSN was developed, in which nystatin replaced caprylate sodium to provide more reliable antifungal coverage. Nevertheless, PBSN retained the same fundamental antibacterial limitations of its predecessor and similarly fell out of clinical favour due to its continued inefficacy against anaerobic bacteria. These collective shortcomings drove the search for more effective intracanal medicaments. Currently, various studies strongly support calcium hydroxide as the better choice for interappointment intracanal medication in terms of consistency, tolerance, lesser likelihood of tooth staining, and the absence of antibiotic resistance contribution. [9,10]

- Regenerative Endodontic Procedures (REPs)

Topical antibiotics are useful in immature necrotic teeth to create conditions conducive to proper root development. Triple Antibiotic Paste (TAP) is widely used as an intracanal disinfectant, comprising three synergistic components: metronidazole, which disrupts anaerobic bacterial DNA synthesis; minocycline, which provides broad-spectrum bacteriostatic activity; and ciprofloxacin, which targets gram-negative organisms. At a concentration of 100 µg/mL, TAP demonstrates high antibacterial efficacy against endodontic bacteria while remaining non-toxic to Stem Cells of the Apical Papilla (SCAP), making it particularly valuable in regenerative endodontic procedures. [11]

Despite its clinical benefits, TAP is not without limitations. A well-documented drawback is tooth discolouration and changes in the mechanical properties of radicular dentine, both strongly attributed to the minocycline component. Furthermore, minocycline lacks reliable efficacy against *Enterococcus faecalis*, a dominant organism associated with endodontic failure. To address these concerns, several modifications of TAP (mTAP) have been proposed, replacing minocycline with alternatives such as cefaclor, clindamycin, or amoxicillin. Among these, modified TAP incorporating clindamycin was found not to induce clinically visible discolouration up to three weeks after placement. When minocycline is omitted entirely, the resulting Double Antibiotic Paste (DAP) — comprising ciprofloxacin and metronidazole — serves as a simpler alternative, demonstrating comparable clinical and radiographic outcomes to calcium hydroxide in teeth with necrotic pulps and apical periodontitis.

Beyond regenerative endodontics, the clinical applications of TAP include pulp revascularization, management of refractory periapical infections, treatment of traumatised teeth with extensive canal contamination, and incorporation into medicated gutta-percha points during obturation. Regardless of the formulation used, the components should be mixed in equal proportions (1:1:1) to a final concentration of 0.1 to 1.0 mg/mL, ensuring effective antimicrobial action while preserving the periapical stem cell environment essential for tissue regeneration. [11,12]

- Avulsion and Replantation

Dissimilar to systemic antibiotics, immersion of the avulsed roots in diluted tetracycline solution, typically

1 mg of doxycycline (prevent resorption and promoting periodontal ligament revascularization) or minocycline in 20 mL of saline for five minutes, has proved to be more effective. However, doxycycline has drawbacks like antibiotic resistance and tooth staining.[7]

VII. CONCLUSION

Modern-day endodontics requires a different approach from earlier times. Successful management of endodontic disease today demands a combination of precise surgical intervention and disciplined antimicrobial prescribing, where each element supports the other, achieving outcomes that neither could accomplish independently.

It must be emphasized that systemic antimicrobial therapy serves solely as a supportive measure to the mechanical elimination of infection and should never replace it. Both the AAE and ESE reinforce this principle, advocating antibiotic use only when clinical evidence of systemic involvement is present. The cornerstone of endodontic management remains thorough debridement and disinfection of the root canal system.[3,4]

Ultimately, the guiding principle of contemporary endodontic practice is that of clinical judgment — a thorough understanding of the patient's condition, a respect for evidence-based guidelines, and the discipline to prescribe antimicrobials judiciously, only when truly warranted.

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