



Review Article Pharmaceuticals in Dentistry and the Imperative of Antibiotic Stewardship: A Narrative Review

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ABSTRACT

Objective: To review the pharmaceutical agents routinely used in dental practice, with emphasis on antibiotics, and to appraise the evidence and strategies for antibiotic stewardship in dentistry, including the South African context.

Methods: A narrative review of peer-reviewed studies, systematic reviews, clinical practice guidelines and policy documents addressing dental pharmacotherapy, antibiotic prescribing, antimicrobial resistance and stewardship.

Results: Dentists prescribe roughly one in ten outpatient antibiotics in several high-income settings, and a large share of dental prescriptions, particularly prophylactic prescriptions, do not align with guidelines. Evidence indicates that systemic antibiotics add little to definitive operative treatment in most pulpal and periapical conditions, whereas they are justified where there is systemic involvement, spreading infection or immunocompromise, and for the narrow group of patients at highest risk of infective endocarditis. South African studies show inconsistent prescribing after tooth extraction and continued antibiotic use for pulpitis, with dentists citing unclear guidelines. Adverse drug reactions, *Clostridioides difficile* infection and selection for resistance add to the cost of unnecessary prescribing. Effective stewardship combines accurate diagnosis, definitive local treatment, narrow-spectrum short-course therapy, patient communication, audit and feedback, and accessible national guidance. The same principles extend to analgesics, opioids and topical antimicrobial agents.

Conclusion: Dentists are important stewards of antimicrobials. Adopting evidence-based indications, locally relevant guidelines and routine prescribing audit could reduce avoidable antibiotic exposure without compromising patient safety.

Keywords: dental pharmacology; antibiotic stewardship; antimicrobial resistance; antibiotic prophylaxis; dental prescribing; South Africa

1. Introduction

Pharmaceutical agents are integral to modern dental practice. Local anaesthetics make operative and surgical care tolerable, analgesics control postoperative and emergency pain, antimicrobials manage selected infections, and topical agents such as fluoride and chlorhexidine support prevention and disease control [1,2]. Used appropriately, these agents improve outcomes; used indiscriminately, they expose patients to avoidable harm and contribute to wider public health problems.

Antibiotics warrant particular attention. Antimicrobial resistance (AMR) is among the leading threats to global health, with an estimated 1.27 million deaths directly attributable to bacterial AMR in 2019 [3], and projections of far higher mortality if current trends continue [4]. Every course of antibiotics exerts selection pressure, regardless of the setting in which it is prescribed. Dentistry accounts for a meaningful share of outpatient antibiotic use, in the order of 10% in several high-income countries [5-7], and multiple studies have found that a considerable proportion of this use is unnecessary or does not follow guidelines [8,9]. The call for dentists to reduce prescribing is not new [10], yet the problem persists.

Most dental diseases, including caries, pulpal inflammation, and periodontal and periapical disease, are localised conditions whose primary management is mechanical or surgical. Antibiotics are, at most, adjuncts for a limited set of circumstances [11,12]. Nevertheless, diagnostic uncertainty, time pressure, limited access to emergency dental care, patient expectation and unclear guidance continue to drive prescribing [9,13].

In South Africa, AMR has been recognised as a national priority [14], and hospital stewardship programmes have shown that structured interventions are feasible in the local setting [15]. The burden of resistance in the wider African region is considerable [16]. Dental-specific data, however, remain sparse, and available studies suggest variable, and at times guideline-discordant, prescribing [17,18].

The objective of this review was to (i) summarise the main classes of pharmaceuticals used in dentistry and their safety considerations, (ii) appraise the evidence on the appropriate use of antibiotics for therapy and prophylaxis, and (iii) synthesise practical antibiotic stewardship strategies, with attention to the South African context.

2. Materials and Methods 2.4 Ethical considerations

This review used only published and publicly available

2.1 Study design

This work is a narrative review. A narrative design was chosen because the topic spans several clinical domains (pharmacology, infectious disease, endodontics, periodontology, oral surgery and public health) and several types of evidence, which are not readily combined in a single quantitative synthesis.

2.2 Sources and selection of literature

Relevant literature was identified through targeted searches of PubMed/MEDLINE, the Cochrane Library and Google Scholar, supplemented by guideline and policy documents from the World Health Organization, professional dental and cardiology bodies, and the South African National Department of Health, and by hand-searching reference lists and the South African Dental Journal for local data. Search terms combined concepts such as dental or dentist, antibiotic, antimicrobial, prescribing, stewardship, prophylaxis, resistance, analgesic and opioid. Priority was given to systematic reviews, randomised trials, clinical practice guidelines, large prescribing surveys and national policy documents published in English. Sources were included if they addressed pharmaceutical use in dental practice, antibiotic indications or outcomes in dental conditions, adverse effects or resistance related to dental prescribing, or stewardship interventions.

2.3 Data synthesis

Findings were organised thematically: (i) pharmaceutical classes used in dentistry; (ii) the scale and appropriateness of dental antibiotic prescribing; (iii) harms associated with antibiotic use; (iv) evidence for therapeutic and prophylactic indications; and (v) stewardship strategies. No formal risk-of-bias assessment or meta-analysis was undertaken, and conclusions are interpretive.

sources. No human participants or patient-identifiable data were involved; ethical approval and informed consent were therefore not required.

3. Results and Discussion

3.1 Pharmaceutical agents used in dental practice

The principal classes of pharmaceuticals used in dentistry, together with their main uses and safety or stewardship considerations, are summarised in Table 1. Although antibiotics receive the greatest stewardship attention because of their population-level consequences, every class carries risks that depend on patient selection, dosing and drug interactions.

Table 1. Principal pharmaceutical classes in dental practice and key considerations.

Class	Principal dental uses	Key safety and stewardship considerations
Local anaesthetics (e.g. lidocaine, articaine)	Pain control for operative and surgical procedures	Weight-based maximum doses; caution with vasoconstrictors in significant cardiovascular disease; allergy is rare [1]
Non-opioid analgesics (NSAIDs, paracetamol)	Acute dental and postoperative pain	Ibuprofen, alone or combined with paracetamol, is among the most effective options for acute dental pain; caution with renal, gastrointestinal or bleeding risk, asthma and anticoagulant use [2,19]
Opioids	Rarely, for severe pain not controlled by non-opioids	Risk of dependence and diversion; opioid prescriptions to adolescents and young adults by dentists have been associated with later opioid use and misuse [20,21]
Systemic antibiotics	Odontogenic infection with systemic involvement; selected prophylaxis	Resistance selection, hypersensitivity, gastrointestinal effects and <i>C. difficile</i> infection, with clindamycin of particular concern [22,23]
Antifungals	Oral candidiasis (topical or systemic)	Azole antifungals interact with several drugs, including warfarin [19,24]

Class	Principal dental uses	Key safety and stewardship considerations
Antiseptic mouthrinses (e.g. chlorhexidine)	Adjunct for plaque control and gingivitis; surgical sites	Staining, taste disturbance and mucosal irritation; role is adjunctive and generally short-term [25]
Fluoride agents (toothpaste, varnish, silver diamine fluoride)	Caries prevention and arrest	Control of fluoride dose in young children; staining with silver diamine fluoride [26,27]
Sedatives and emergency drugs	Anxiety control; management of anaphylaxis and other medical emergencies	Requires training, monitoring and readily available equipment

3.2 Scale and appropriateness of dental antibiotic prescribing

Surveillance data from Australia, England, the United States and British Columbia show that dentists are consistent contributors to outpatient antibiotic use, and that prescribing patterns differ markedly between countries, which implies that a proportion of use is discretionary rather than evidence-driven [7,28]. A scoping review of the dental literature identified recurring patterns of misuse, including antibiotics for conditions in which they confer no benefit and unnecessary prophylaxis [9]. In a large analysis of prophylactic prescriptions before dental procedures in the United States, roughly four in five were judged inappropriate [8].

South African evidence, though limited, is concordant. An analysis of 2013 medical-scheme claims covering more than 50,000 extraction events found no consistent prescribing pattern and concluded that practice did not appear to follow a coherent set of guidelines [17]. A 2022 survey of dentists in the Durban metropolitan region (91 respondents from a sampling frame of 210; 43% response) reported amoxicillin (48%) and amoxicillin-clavulanate (46%) as the commonly prescribed agents, clindamycin as the usual alternative in penicillin allergy (58%), and a five-day course as the most frequent duration (78%) [18]. Facial swelling was the leading indication (89%), but 61.5% of respondents also prescribed antibiotics for irreversible pulpitis and 23.1% for reversible pulpitis, conditions for which antibiotics are not recommended [11,18]. While 80% acknowledged that dentists contribute to resistance, 71% cited unclear guidelines as a contributor, and the internet was the most frequently used source of information on antibiotics (36%) [18]. These findings should be interpreted cautiously, since the sample was small, drawn from closed professional groups in one region, and self-reported; they nonetheless point to a guidance and access-to-information gap that stewardship initiatives can address.

3.3 Consequences of unnecessary antibiotic use

The consequences of unnecessary antibiotic prescribing operate at both individual and population levels. At the population level, antibiotic exposure selects for resistant organisms, including within the oral microbiota, which can act as a reservoir of resistance determinants [29]. At the individual level, adverse reactions range from mild gastrointestinal disturbance and rash to anaphylaxis and *Clostridioides difficile* infection. Analyses of adverse reactions to antibiotics prescribed by dentists indicate that serious events are uncommon but not negligible, and that clindamycin accounts for a disproportionate share of severe reactions, including *C. difficile* infection [22]. A meta-analysis likewise identified clindamycin as one of the antibiotics most strongly associated with community-acquired *C. difficile* infection [23]. Because clindamycin is frequently chosen for patients reporting penicillin allergy, careful verification of allergy histories is an important stewardship measure, since many reported penicillin allergies are not confirmed on formal assessment.

3.4 Therapeutic antibiotic use: what the evidence supports

Pulpal and periapical conditions. An American Dental Association clinical practice guideline recommends against antibiotics for immunocompetent adults with symptomatic irreversible pulpitis, symptomatic apical periodontitis, pulp necrosis with localised swelling, or a localised acute apical abscess, advising instead definitive dental treatment with analgesics; antibiotics are suggested where there are signs of systemic involvement, such as fever or malaise, or where the patient is medically compromised [11]. A Cochrane review reached a consistent conclusion, finding no reliable evidence that adding systemic antibiotics to surgical intervention improves outcomes in adults with these conditions [12]. Antibiotics do not relieve dental pain in the absence of source control, a message that is central to patient communication.

Spreading odontogenic infection. Rapidly progressing swelling, trismus, difficulty swallowing or breathing, fever, or involvement of the floor of the mouth or deep fascial spaces indicate serious infection that requires antibiotics together with prompt source control and, frequently, urgent referral. Stewardship does not mean withholding antibiotics from these patients; it means ensuring that therapy is directed, timely and reassessed [11].

Periodontal disease. Mechanical debridement and patient-performed plaque control remain the foundation of periodontal therapy. Current European guidance advises against the routine use of systemic antimicrobials, reserving adjunctive amoxicillin and metronidazole for carefully selected patient

groups [30]. A systematic review found additional clinical benefit from adjunctive systemic antimicrobials in some patients, but with the trade-off of adverse effects and resistance pressure that supports restraint [31].

Tooth extraction and implant surgery. In otherwise healthy patients, prophylactic antibiotics reduce the risk of infectious complications after tooth extraction, but the absolute benefit is small, many patients must be treated for one to benefit, and mild adverse events occur [32]. Surgical technique, atraumatic handling and oral hygiene are therefore the first line of prevention. For dental implants, a single preoperative dose has been associated with fewer early implant failures, although the evidence base is limited and the decision is best individualised [33]. Table 2 summarises evidence-informed positions for common scenarios.

Table 2. Evidence-informed antibiotic stewardship positions for common dental scenarios.

Clinical scenario	Evidence-informed position	Stewardship action
Reversible or irreversible pulpitis	Antibiotics not indicated; no benefit for pain [11,12]	Definitive pulp therapy or extraction; appropriate analgesia
Localised acute apical abscess in an immunocompetent patient without systemic features	Antibiotics not routinely indicated when source control is achieved [11,12]	Drain and treat the source; arrange review
Spreading infection, systemic features or immunocompromise	Antibiotics indicated alongside source control [11]	Prescribe narrow-spectrum agent; consider urgent referral; reassess early
Routine extraction in a healthy patient	Small absolute benefit; high number needed to treat [32]	Emphasise surgical technique and hygiene; limit to higher-risk surgery
Implant placement	Limited evidence for a single preoperative dose [33]	Individualise by patient and procedural risk
Periodontitis	Not routine; adjunct only in selected cases [30,31]	Optimise mechanical therapy and plaque control first
Highest-risk cardiac conditions for infective endocarditis	Prophylaxis recommended before procedures that manipulate gingival tissue or the periapical region [34,35]	Single preprocedural dose; confirm risk category, liaising with the cardiologist where unclear
Other cardiac lesions, prosthetic joints, rheumatoid arthritis	Routine prophylaxis not generally supported [34,36]	No routine prophylaxis; individualise with the treating specialist

3.5 Antibiotic prophylaxis

Prophylaxis is the area in which guideline-discordant prescribing is most pronounced. For infective endocarditis, the underlying rationale is that bacteraemia from dental procedures can seed damaged or prosthetic cardiac tissue. However, bacteraemia also follows everyday activities such as toothbrushing and chewing [37], and the cumulative exposure from daily life greatly exceeds that from occasional dental procedures. For this reason the American Heart Association restricts prophylaxis to patients at highest risk, namely those with prosthetic cardiac valves or prosthetic material used for valve repair, previous infective endocarditis, selected congenital heart disease, and cardiac transplant recipients with valvulopathy, and only before procedures that manipulate gingival tissue or the periapical region of teeth or perforate the oral mucosa [34]. A recent review of the evidence supports prophylaxis in these high-risk groups [35]. Debate continues regarding the effect of reduced prophylaxis on incidence: a time-series analysis from England reported an increase in infective endocarditis incidence after guidance restricting prophylaxis was introduced, although causation could not be established [38].

In the Durban survey, many dentists reported prophylaxis for conditions outside the high-risk categories, including mitral valve prolapse with regurgitation (72.5%), mitral valve prolapse without regurgitation (54.9%) and rheumatoid arthritis (30.8%) [18]. Such prescribing exposes patients to the risks described in section 3.3 without evidence of benefit. For patients with prosthetic joints, guidelines vary internationally, and the weight of evidence does not support routine prophylaxis; decisions should be individualised with the treating orthopaedic surgeon [36]. Even in high-risk patients, adverse reactions to prophylactic antibiotics occur, underlining the need for a clear indication each time [39].

3.6 Antibiotic stewardship strategies in dental practice

Outpatient stewardship frameworks identify four core elements: leadership commitment, policies and practices that promote appropriate use, tracking and reporting of prescribing, and education and expertise [40]. In dentistry, these translate into practical measures at the level of the individual clinician, the practice and the health system. The World Health Organization AWaRe classification supports first-line selection from the Access group, such as amoxicillin and metronidazole, while discouraging routine use of Watch-group agents such as azithromycin [41]. At the clinician level, the following measures are widely supported:

- Establish a working diagnosis and treat the source of infection first; document the indication for every antibiotic prescribed.
- Reserve antibiotics for systemic involvement, spreading infection, immunocompromise or recognised high-risk prophylaxis.
- Prefer narrow-spectrum, first-line agents; avoid broad-spectrum or Watch-group agents without a specific indication.
- Use the shortest effective course and reassess at review, rather than defaulting to a fixed duration.
- Clarify penicillin allergy histories before choosing alternatives such as clindamycin.
- Counsel patients that antibiotics do not treat toothache, explaining that relief comes from definitive treatment and analgesia.
- Provide access to timely emergency dental care, so that antibiotics are not used as a substitute for an unavailable appointment.

At the system level, audit and feedback has shown promise. In the RAPiD cluster randomised trial in Scottish general dental practice, providing practitioners with feedback on their own prescribing reduced antibiotic prescribing [42]. Guidelines are most effective when they are concise, locally relevant, easily accessible and regularly updated, which is of direct relevance given that South African dentists in the Durban survey identified unclear guidelines as a driver of inappropriate use [18].

3.7 Stewardship beyond antibiotics

Stewardship principles apply to the wider formulary. In pain management, evidence favours optimised non-opioid regimens, with ibuprofen alone or combined with paracetamol performing well for acute dental pain, thereby limiting the need for opioids [2]. Because opioid exposure in adolescence has been associated with subsequent misuse [20], dentists have a particular responsibility to avoid routine opioid prescribing and to counsel patients on safe storage and disposal [21]. Topical agents also merit rational use: chlorhexidine is a useful short-term adjunct but not a substitute for mechanical plaque control [25], while fluoride-based strategies remain among the most effective and cost-effective approaches to caries prevention [26,27]. Systematic checking of medical histories and current medication also reduces the risk of clinically important drug interactions [19].

3.8 The South African context and recommendations

South Africa has a national AMR strategy [14], treatment guidelines and an essential medicines list that include dental conditions [43], and a track record of hospital-based stewardship [15], set within the WHO global action plan [44]. The available dental data, however, indicate that these resources have not yet translated into consistent practice in dentistry [17,18]. The following actions are suggested for consideration by the profession and policy makers:

- Develop and disseminate a concise national antibiotic guideline for dental practitioners, aligned with the national standard treatment guidelines and the AWaRe classification.
- Establish routine surveillance of dental prescribing, including analysis of medical-scheme claims data, which have already proved informative for extractions [17].
- Incorporate stewardship content into undergraduate curricula and continuing professional development, emphasising diagnosis and prophylaxis indications.
- Support public and patient education on the limited role of antibiotics in dental pain and on the risks of misuse.
- Encourage multicentre studies across public and private sectors to move beyond single-region surveys.

3.9 Limitations

This review has several limitations. As a narrative review, it did not follow a registered protocol, a formal quality appraisal, or a quantitative synthesis, and the selection of sources may reflect subjective judgement. Much of the prescribing data derive from high-income countries, and South African evidence is limited to a few small or region-specific studies. Guidelines evolve, and clinicians should consult current national and specialty guidance and exercise clinical judgement for individual patients; this review is not a substitute for such guidance.

4. Conclusion

Pharmaceuticals are indispensable to safe and effective dental care, but their benefits depend on appropriate selection and use. For antibiotics, the evidence indicates that most dental conditions are managed by definitive local treatment, that systemic antibiotics are warranted in a defined set of circumstances, and that prophylaxis should be restricted to patients at highest risk. Available South African data suggest persistent gaps between guidance and practice, associated with unclear guidelines and limited access to reliable information. Dentists are well placed to act as antimicrobial stewards by diagnosing accurately, treating the source of infection, prescribing narrowly and briefly when antibiotics are indicated, and communicating clearly with patients. Locally relevant guidelines, prescribing surveillance, education and audit with feedback would strengthen these efforts and help preserve the effectiveness of antibiotics for future patients.

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7. Conflict of Interest

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