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Research Article

Antibiotic Stewardship in Dental Procedures the Role of Family Medicine, Clinical Pharmacy, and Health Administration

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Abstract:

The escalating global crisis of antimicrobial resistance (AMR) demands urgent action across all medical disciplines, including dentistry. Dental practitioners are significant contributors to outpatient antibiotic consumption, with current prescribing patterns revealing substantial overuse and misuse for conditions such as irreversible pulpitis and apical abscesses where the primary treatment should be mechanical intervention. This comprehensive research paper argues that optimizing antibiotic use in dental procedures necessitates a fundamental shift from isolated decision-making to a robust, interprofessional collaborative model. The proposed framework integrates the unique and synergistic roles of four key pillars: Dentistry, as the primary diagnostician and proceduralist; Family Medicine, providing holistic patient context and coordinating complex medical needs; Clinical Pharmacy, offering expertise in pharmacotherapy, safety, and patient counseling; and Health Administration, building the essential infrastructure of policy, technology, and feedback mechanisms. By synthesizing current evidence, this paper demonstrates that only through this coordinated, systems-based

approach can antimicrobial stewardship (AMS) principles be effectively implemented, sustained, and scaled. The conclusion underscores that such collaboration is not merely beneficial but essential for preserving antibiotic efficacy, enhancing patient safety, and safeguarding public health for future generations.

1. Introduction

The discovery of antibiotics stands as one of the most transformative achievements in medical history, fundamentally altering the landscape of modern medicine and saving countless lives from once-fatal bacterial infections. However, the very efficacy of these "miracle drugs" is now under severe threat due to the relentless and accelerating crisis of antimicrobial resistance (AMR). AMR occurs when bacteria, viruses, fungi, and parasites change over time and no longer respond to medicines, making infections harder to treat and increasing the risk of disease spread, severe illness, and death. The World Health Organization (WHO) has declared AMR one of the top ten global public health threats facing humanity [1]. A significant driver of this crisis is the inappropriate and overuse of antibiotics across human health, animal health, and the food production sectors.

Within the broader healthcare system, dental practice represents a notable, and often overlooked, contributor to antibiotic misuse. While the primary treatment for dental infections is typically mechanical intervention, such as drainage or tooth extraction, antibiotics are frequently prescribed in dental settings, often inappropriately. Studies indicate that dentists are responsible for approximately 10% of all antibiotic prescriptions dispensed in the community in many countries, a figure that underscores their substantial role in antimicrobial usage [2]. Common inappropriate practices in dentistry include the prescription of antibiotics for conditions where they are not indicated, such as irreversible pulpitis without systemic involvement, apical abscesses that can be managed by surgical drainage alone, and as a routine prophylactic measure for certain patients without clear evidence-based indications [3].

The consequences of this over-prescription are twofold. Firstly, it contributes directly to the selection of resistant bacterial strains, not only within the oral cavity but throughout the human microbiome. Secondly, it exposes patients to unnecessary risks of adverse drug reactions, *Clostridium difficile* infections, and drug interactions. The challenge of optimizing antibiotic use in dentistry is complex, as it is influenced by a myriad of factors, including diagnostic uncertainty, pressure from patients, defensive medicine practices, and a lack of updated knowledge regarding prescribing guidelines [4]. Therefore, addressing this issue requires a move beyond siloed efforts and demands a collaborative, multi-disciplinary approach that integrates the unique expertise of various healthcare domains.

The concept of Antimicrobial Stewardship (AMS) has emerged as a cornerstone strategy in the global fight against AMR. The Infectious Diseases Society of America (IDSA) defines antimicrobial stewardship as "coordinated interventions designed to improve and measure the appropriate use of antimicrobial agents by promoting the selection of the optimal antimicrobial drug regimen, dose, route of administration, and duration of therapy" [5]. The primary goals of AMS are to achieve optimal clinical outcomes related to antimicrobial use, minimize toxicity and adverse events, reduce the costs of health care for infections, and limit the selective pressure on bacterial populations that drives the emergence of resistance. Historically, AMS programs have been predominantly implemented and studied in hospital inpatient settings, focusing on critical care, infectious diseases, and internal medicine.

However, the urgent need to extend these principles to the outpatient setting, including dental clinics, is now widely recognized. Successful AMS relies on the "Four D's" of antibiotic prescribing: the right *Drug*, at the right *Dose*, for the right *Duration*, and at the right *Time* (De-escalation when possible). Translating these principles into dental practice necessitates a paradigm shift from a culture of habitual prescribing to one of critical appraisal and evidence-based decision-making. While several guidelines, such as those from the American Dental Association (ADA) and the Faculty of General Dental Practice (UK), provide recommendations for antibiotic use in dentistry, their implementation in daily practice remains inconsistent [6].

This gap between guideline publication and real-world practice highlights the critical need for a robust implementation framework. It is here that the synergistic collaboration between dentistry, family medicine, clinical pharmacy, and health administration becomes not just beneficial, but essential. No single profession can tackle this challenge alone. Dentistry holds the primary responsibility for diagnosis and treatment decisions. Family medicine provides a holistic, patient-centered view of the patient's overall health and medication profile. Clinical pharmacy offers specialized expertise in pharmacology, drug interactions, and patient counseling. Finally, health

administration creates the structural and systemic environment that enables and sustains best practices. This paper will argue that effective antibiotic stewardship in dental procedures is fundamentally dependent on the integrated and proactive roles of these three key pillars: Family Medicine, Clinical Pharmacy, and Health Administration.

The role of **Family Medicine** in this collaborative model is pivotal. Family physicians often serve as the first point of contact for patients experiencing dental pain or swelling who are unable to access immediate dental care. In such scenarios, the family physician's role is not to provide definitive dental treatment but to manage pain and systemic symptoms appropriately and facilitate urgent dental referral, rather than reflexively prescribing antibiotics [7]. Furthermore, family physicians possess a comprehensive view of the patient's medical history, including allergies, comorbid conditions (e.g., immunocompromised status), and current medications. This information is crucial for assessing a patient's true need for antibiotic prophylaxis and for selecting the safest and most effective agent if one is genuinely indicated. Their longitudinal relationship with patients also positions them perfectly to educate individuals about the risks of antibiotic resistance and the importance of using these medications only when necessary.

Clinical Pharmacy brings a specialized dimension to the dental AMS team. Clinical pharmacists are experts in pharmacotherapy, pharmacokinetics, and pharmacodynamics. Their involvement can be transformative in several ways. They can assist in developing and implementing dentist-specific prescribing guidelines and treatment algorithms, ensuring they are pharmacologically sound [8]. They can provide real-time consultation to dentists on complex cases, such as patients with renal impairment requiring dose adjustment, or those on multiple medications where drug interactions are a concern. Moreover, clinical pharmacists are exceptionally skilled in patient education, counseling patients on the importance of adherence to the prescribed regimen, potential side effects, and the critical reason for not using antibiotics for viral infections or uncomplicated pain.

Ultimately, the sustainability of any AMS initiative hinges on the framework established by **Health Administration**. Healthcare administrators are responsible for creating the policies, providing the resources, and fostering the culture that enables best practices to flourish. Their role includes: integrating AMS protocols and decision-support tools into the dental clinic's electronic health record (EHR) system to prompt and guide appropriate prescribing [9]; allocating resources for the training and education of dental staff on AMS principles; establishing monitoring and audit systems with feedback to prescribers on their prescribing patterns; and crafting institutional policies that align with national AMR action plans. Without this administrative backbone, the efforts of individual clinicians, no matter how well-intentioned, are likely to be fragmented and unsustainable [10].

2. Interprofessional Roles in Antibiotic Stewardship

The escalating crisis of antimicrobial resistance (AMR) demands a shift from isolated, profession-specific interventions to a cohesive, systems-based approach. The conceptual framework for effective antibiotic stewardship in dental procedures is fundamentally rooted in the principles of Interprofessional Collaboration (IPC). This model moves beyond the traditional siloes of healthcare, where dentists, physicians, pharmacists, and administrators operate independently, and instead fosters a synergistic partnership where the knowledge, skills, and perspectives of each discipline are integrated to achieve a common goal: the preservation of antibiotic efficacy. The core premise of this framework is that the complexity of AMR cannot be addressed by any single profession alone; it requires a coordinated effort where the collective competency is greater than the sum of its individual parts [11]. This integrated model is visualized as a four-pillar structure, with Patient-Centered Care at its core, supported equally and indispensably by the pillars of Dentistry, Family Medicine, Clinical Pharmacy, and Health Administration.

At the heart of this framework lies the patient, whose safety and long-term health outcomes are the ultimate objective of all stewardship activities. Inappropriate antibiotic prescribing exposes patients to immediate risks like allergic reactions, gastrointestinal disturbances, and *C. difficile* infection, while also contributing to the long-term, population-level threat of AMR, which jeopardizes the effectiveness of future treatments for that same patient [12]. Therefore, every action within this interprofessional framework must be guided by the principle of providing the right care that minimizes harm and maximizes benefit for the individual patient. This involves shared decision-making, where patients are educated by the team about the rationale for withholding antibiotics when they are not indicated, thereby managing expectations and building trust in the clinical recommendations [13].

The first and most direct pillar in the dental context is the **Dental Practitioner**. The dentist's role is that of the primary diagnostician and proceduralist. Their stewardship responsibility begins with an accurate diagnosis, differentiating between conditions that require antibiotics (e.g., a spreading facial cellulitis, systemic involvement like fever and lymphadenopathy) and those that do not (e.g., localized abscess, irreversible pulpitis, pericoronitis), where the primary treatment is source control through incision and drainage, endodontic therapy, or extraction [14]. The dentist is responsible for adhering to and implementing evidence-based clinical practice guidelines, such as those from the American Dental Association, which clearly outline indications for prophylactic and therapeutic antibiotics. Furthermore, the dentist within this framework acts as a crucial communicator, initiating the conversation with the patient about antibiotic resistance and explaining the treatment plan that prioritizes definitive dental care over pharmacological masking of symptoms [15].

The **Family Medicine** pillar provides a critical longitudinal and holistic perspective on the patient's health. Family physicians often manage patients' complex medical histories, including conditions that may influence dental treatment decisions, such as immunocompromising diseases, history of infective endocarditis, or prosthetic joint replacements. While guidelines for antibiotic prophylaxis have narrowed significantly, the family physician is the key source of truth regarding a patient's true medical need for pre-medication [16]. Beyond prophylaxis, patients often present to their family doctor with dental pain when unable to see a dentist promptly. In this scenario, the stewardship role of the family physician is to provide appropriate analgesia and facilitate an urgent dental referral, resisting the pressure to prescribe antibiotics inappropriately. Their ongoing relationship with the patient positions them to reinforce stewardship messages, review a patient's complete medication list to avoid polypharmacy issues, and provide a safety net for managing any potential systemic spread of infection that the dentist has identified [17].

The **Clinical Pharmacy** pillar introduces specialized expertise in pharmacotherapy that is often outside the core training of dentists and physicians. Clinical pharmacists are the drug experts of the stewardship team. Their roles can be operationalized in several key ways. First, they are instrumental in developing and updating local antibiotic prescribing guidelines for dental infections, ensuring recommendations are based on local resistance patterns (antibiograms), are cost-effective, and specify the optimal drug, dose, and duration [18]. Second, they can provide real-time consults for complex cases, such as advising on antibiotic selection for patients with reported penicillin allergies (often misdiagnosed) or managing dosing in patients with renal or hepatic impairment. Third, and perhaps most impactful in an outpatient setting, is their role in patient education. Pharmacists can powerfully reinforce the dentist's message at the point of dispensing, counseling patients on the importance of adherence, the dangers of saving leftover antibiotics, and the reason why an antibiotic was not needed for their condition in the first place [19]. This "final check" in the community is a vital layer of defense against misuse.

The **Health Administration** pillar forms the essential structural foundation that enables the other three clinical pillars to function effectively. Without strong administrative support and system-level integration, stewardship efforts remain optional, personality-dependent, and unsustainable. Healthcare administrators are the architects of the system within which stewardship occurs. Their responsibilities are multifaceted. Firstly, they are tasked with creating and enforcing institutional policies that mandate adherence to prescribing guidelines and establish accountability [20]. Secondly, they are responsible for integrating decision-support tools directly into the workflow, most effectively through the Electronic Health Record (EHR). These tools can include pop-up alerts for non-guideline-concordant prescriptions, mandatory field completion for antibiotic indications, and pre-populated order sets for first-line agents [21].

Furthermore, administrators allocate the necessary resources for education and training, ensuring that all members of the dental team—from the front desk to the dental assistant to the dentist—receive ongoing education on AMS principles. A critical function of the administrative pillar is the establishment of a monitoring and feedback loop. This involves auditing prescribing patterns, tracking key metrics (e.g., rates of antibiotic prescriptions for specific diagnoses), and providing confidential, non-punitive feedback to prescribers about their performance compared to their peers and national benchmarks [22]. Finally, health administrators ensure that the stewardship program is aligned with broader public health goals and national action plans on AMR, securing the program's legitimacy and long-term funding. They create the culture of safety and continuous quality improvement that is the bedrock of sustained change [23].

Antibiotic Prescribing Patterns in Dental Procedures

Understanding current antibiotic prescribing patterns in dentistry is crucial for identifying the gap between evidence-based guidelines and real-world clinical practice, thereby highlighting the urgent need for robust antimicrobial stewardship interventions. A comprehensive analysis of global and national prescribing data reveals a consistent trend of overprescription and inappropriate use. Dentists are significant contributors to outpatient antibiotic consumption, accounting for approximately 10% of all antibiotic prescriptions in high-income countries and a substantially higher proportion in many low- and middle-income nations [24]. This high volume of prescribing is concerning, given that the primary management for the vast majority of acute dental conditions is procedural intervention, such as incision and drainage, endodontic therapy, or extraction, with antibiotics serving only as an adjunct in cases of spreading infection or systemic involvement.

Epidemiological studies consistently identify specific clinical scenarios where antibiotics are most frequently misused. One of the most common areas of inappropriate prescribing is for pulpitis. Despite clear guidelines stating that antibiotics are not indicated for irreversible pulpitis (characterized by spontaneous, lingering pain) in the absence of systemic signs like fever or swelling, studies show that a significant percentage of dentists continue to prescribe them for this condition. This practice represents a fundamental misunderstanding of the disease pathophysiology, as pulpitis is an inflammatory condition confined within the rigid walls of the tooth, inaccessible to the circulatory delivery of antibiotics [25]. Similarly, antibiotics are often prescribed for periapical abscesses that have been successfully managed by surgical drainage alone. In these cases, the removal of the source of infection through drainage or extraction obviates the need for antibiotic therapy, yet prescriptions are often written "just in case" or due to perceived patient pressure [26].

Another area of significant controversy and variation is antibiotic prophylaxis (AP). While AP is unequivocally recommended for a very small subset of high-risk cardiac patients (e.g., those with a history of infective endocarditis, prosthetic cardiac valves, or cardiac transplant with valvulopathy), its use for other conditions, particularly prosthetic joint implants, has been dramatically scaled back. Current guidelines from the American Dental Association and the American Academy of Orthopaedic Surgeons no longer recommend routine AP for patients with prosthetic joints, yet surveys indicate that many dentists continue this practice, often citing medico-legal concerns or habit [27]. This indicates a significant lag in the translation of updated evidence into clinical behavior, leading to the unnecessary exposure of thousands of patients to antibiotics.

The choice of antibiotic agents in dentistry also demonstrates patterns that often deviate from guideline recommendations. Amoxicillin is universally recognized as the first-line agent for treating odontogenic infections in patients without a penicillin allergy, due to its excellent bioavailability, spectrum of activity against common oral pathogens, and safety profile [28]. However, prescribing audits reveal problematic trends in drug selection. There is a notable overuse of broad-spectrum antibiotics, such as co-amoxiclav (amoxicillin-clavulanate), as a first-line choice for routine infections. While valuable for treating resistant or hospital-acquired infections, the routine use of these broader-spectrum agents exerts unnecessary selective pressure for resistance and should be reserved for cases that have failed first-line therapy or where resistance is suspected [29].

Furthermore, the duration of antibiotic therapy prescribed by dentists is frequently longer than necessary. For most common odontogenic infections, a 3- to 5-day course is sufficient once the source of infection has been controlled, with evidence showing that longer durations do not improve outcomes but do increase the risk of adverse effects and resistance [30]. Despite this, prescriptions for 7-day or even longer courses remain commonplace. This pattern of prolonged therapy is often rooted in tradition and a misplaced belief that it prevents relapse, rather than being based on contemporary pharmacological evidence. The combination of inappropriate drug selection and extended duration creates a "double hit" in terms of its contribution to the AMR crisis.

The drivers behind these problematic prescribing patterns are complex and multifactorial. A significant factor is diagnostic uncertainty. Differentiating between a localized infection that can be managed surgically and a spreading infection requiring antibiotics can be challenging, leading some dentists to err on the side of caution and prescribe [31]. Patient pressure and expectations play a substantial role; patients often equate being prescribed a "pill" with being taken seriously and receiving comprehensive care. Dentists may prescribe to maintain patient satisfaction, avoid negative online reviews, or save time that would otherwise be spent on patient education [32]. Additionally, the culture of "defensive dentistry," driven by fear of litigation if a rare complication like a spreading infection were

to occur, is a powerful motivator for inappropriate prescribing, even in low-risk scenarios.

Geographic variation in dental antibiotic prescribing is stark, reflecting differences in educational backgrounds, regulatory frameworks, access to care, and cultural norms. Studies across Europe have shown a several-fold difference in prescribing rates between countries, even after adjusting for the number of practicing dentists [33]. In many parts of the world, antibiotics are available over-the-counter without a prescription, which completely bypasses any professional stewardship and leads to rampant self-medication for dental pain. These global disparities underscore that the problem is not universal but is influenced by local systems, policies, and practices. This variation also suggests that solutions must be tailored to the specific barriers and drivers within a given healthcare environment.

The consequences of these current prescribing patterns extend far beyond the individual dental clinic. From a clinical perspective, patients are unnecessarily placed at risk of adverse drug events, ranging from common gastrointestinal disturbances to life-threatening anaphylaxis and *Clostridium difficile*-associated diarrhea [34]. From a public health perspective, every inappropriate prescription contributes to the selection of resistant bacterial strains. The oral cavity is not an isolated ecosystem; resistant genes can be transferred between bacteria in the mouth and those in other parts of the body. The high volume of dental prescribing thus has a measurable impact on community-wide resistance patterns, potentially rendering first-line antibiotics less effective for treating common infections like pneumonia, urinary tract infections, and skin infections [35].

Family Medicine: Coordination of Dental Antibiotic Prophylaxis and Care

Within the interprofessional framework for antibiotic stewardship in dentistry, the role of Family Medicine is uniquely positioned as a central hub for care coordination and holistic patient advocacy. Family physicians provide continuous, comprehensive care across the lifespan, managing a patient's complete medical history, including chronic conditions, medication profiles, allergies, and previous adverse drug reactions. This longitudinal, whole-person perspective is indispensable for making informed decisions regarding the necessity of antibiotic prophylaxis (AP) before dental procedures and for managing the interface between oral health and systemic disease. The stewardship role of the family physician is not to dictate dental treatment but to provide critical medical consultation, facilitate appropriate care pathways, and educate patients, thereby acting as a crucial counterbalance to the inappropriate prescribing pressures that often confront dentists [36].

The most historically significant, and often misunderstood, area of collaboration between dentistry and family medicine is antibiotic prophylaxis for the prevention of infective endocarditis (IE). IE is a rare but life-threatening infection of the heart's inner lining, and certain cardiac conditions predispose patients to a higher risk of adverse outcomes from this infection. Over decades, guidelines for AP have undergone substantial revisions, narrowing the scope of patients for whom it is recommended. Current guidelines from the American Heart Association (AHA) and the American Dental Association (ADA) now recommend AP only for patients with the highest risk of adverse outcomes from IE, including: those with prosthetic cardiac valves, a history of previous IE, certain forms of congenital heart disease, and cardiac transplant recipients who develop cardiac valvulopathy [37]. For the vast majority of patients, including those with mitral valve prolapse, rheumatic heart disease, and most congenital heart defects, AP is no longer recommended.

This paradigm shift has created a critical knowledge-practice gap. Many patients who were told they required AP years ago remain under the mistaken impression that this is still necessary for every dental visit. Furthermore, some dentists, wary of medico-legal repercussions, may be reluctant to forgo AP without explicit confirmation from the patient's physician. This is where the family physician's role becomes paramount. They are the definitive source for accurately assessing a patient's cardiac condition against the current guideline criteria. Upon receiving a dental consultation request for AP, the family physician's responsibility is to verify the patient's cardiac status and provide a clear, evidence-based recommendation—either confirming the need for AP based on high-risk criteria or, just as importantly, explicitly stating that AP is *not* indicated according to current standards [38]. This clear communication relieves the dentist of diagnostic uncertainty and medico-legal anxiety, preventing an unnecessary prescription.

Beyond infective endocarditis, the family physician's coordinating role extends to other complex medical scenarios. A prominent example is the management of patients with prosthetic joint implants. For years, routine AP for these patients was common practice in dentistry due to theoretical concerns about hematogenous seeding of the prosthesis. However, robust evidence has shown that the risks of antibiotic-related adverse events outweigh the benefits of preventing prosthetic joint

infection, which is exceedingly rare following dental procedures. Consequently, professional guidelines from orthopedic and dental associations no longer recommend routine AP for patients with prosthetic joints [39]. Despite this, confusion persists among patients and some clinicians. The family physician, often the primary care coordinator for a patient with a joint replacement, plays a vital role in reinforcing this updated guidance, educating the patient that AP is not required, and communicating this to the consulting dentist to align care and prevent unnecessary antibiotic use.

Another critical function of the family physician is serving as the first point of contact for patients experiencing dental pain or swelling who cannot immediately access dental care. In this common scenario, the physician's stewardship role is triage and temporization, not definitive dental treatment. The appropriate response is to manage symptoms with analgesics (e.g., ibuprofen or acetaminophen), provide urgent referral to a dentist for source control, and firmly resist the patient's or family's expectation for an antibiotic prescription [40]. Prescribing antibiotics in this context masks the symptoms without addressing the underlying dental cause, delays definitive care, and contributes to AMR. The family physician, trusted by the patient, can effectively explain why an antibiotic is not the correct treatment for a toothache and emphasize the importance of seeing a dentist promptly. This intervention is a powerful stewardship action that interrupts the cycle of inappropriate antibiotic demand and use.

Furthermore, family physicians are essential in managing patients with complex medical histories that may influence dental care and antibiotic selection. For a patient with a true, severe penicillin allergy, the family physician can recommend an appropriate alternative, such as clindamycin or azithromycin, based on the nature of the allergy and local resistance patterns [41]. For patients who are immunocompromised (e.g., from chemotherapy, organ transplantation, or HIV), the need for AP or therapeutic antibiotics may differ from the general population. The family physician, in consultation with the patient's specialist, can provide tailored advice to the dentist on the appropriate antimicrobial strategy, ensuring the patient is protected without resorting to unnecessarily broad-spectrum or prolonged antibiotic courses.

The coordination of care between family medicine and dentistry is fundamentally dependent on effective, bidirectional communication. Unfortunately, this communication is often fragmented or non-existent, leading to errors and inappropriate prescribing. The ideal model involves structured communication channels. When a dentist identifies a patient with a complex medical history, a formal consultation request should be sent to the family physician, specifying the planned dental procedure and asking for a clear recommendation on AP based on the patient's current medical status [42]. Conversely, when a family physician refers a patient for dental care, the referral should include a summary of relevant medical conditions and a statement on the need for AP. The integration of shared Electronic Health Records (EHRs) between medical and dental practices would be a transformative step, allowing both providers to access the same patient information, including problem lists, medications, and allergies, in real-time [43].

Patient education is another cornerstone of the family physician's stewardship role. During routine health maintenance visits, the physician should review the patient's medication list and inquire about any recommendations they have received regarding dental AP. This provides an opportunity to correct misconceptions and reinforce the modern, conservative approach to AP [44]. Educating patients that "more antibiotics are not always better" and that their physician and dentist are working together under the latest guidelines builds public understanding and trust, reducing patient-driven pressure on both types of clinicians to prescribe inappropriately.

The challenges to this ideal coordination are significant. They include time constraints during clinical encounters, lack of integrated health records, and persistent knowledge gaps about current guidelines among both physicians and dentists [45]. However, the consequences of poor coordination are tangible: thousands of patients receive antibiotics they do not need, increasing their personal risk of adverse events and contributing to the public health crisis of AMR. By embracing their role as care coordinators, family physicians can act as stewards not only of their own prescribing but also of the broader healthcare ecosystem. Their unique, patient-centered perspective allows them to bridge the historical divide between medicine and dentistry, ensuring that decisions about dental antibiotic prophylaxis are made collaboratively, based on the best available evidence, and always in the best interest of the patient's overall health [46, 47].

3. Clinical Pharmacy: Medication Management, Counseling, and Safety

Within the interprofessional antimicrobial stewardship (AMS) team for dentistry, the clinical pharmacist emerges as the pharmacotherapy expert,

providing a critical layer of medication management, safety, and patient education that directly addresses the gaps in current prescribing patterns. While dentists are experts in oral disease diagnosis and treatment, and family physicians in holistic medical management, the clinical pharmacist possesses specialized knowledge in pharmacology, pharmacokinetics, pharmacodynamics, and the principles of antimicrobial stewardship. This expertise is pivotal in translating broad AMS guidelines into precise, safe, and effective prescribing practices at the point of care. The role of the clinical pharmacist in this context is multifaceted, encompassing guideline development, prospective audit and feedback, direct consultation, and most importantly, patient counseling, all aimed at optimizing therapeutic outcomes while minimizing the risks of toxicity and resistance [48].

A foundational contribution of the clinical pharmacist to dental AMS is the development and localization of evidence-based prescribing guidelines and treatment algorithms. National guidelines provide a crucial framework, but they often require adaptation to local resistance patterns, formulary availability, and cost considerations. Clinical pharmacists, in collaboration with dental and medical colleagues, can lead the creation of concise, user-friendly decision-support tools. These tools can clearly outline first-line and alternative agents for common odontogenic infections, specify appropriate dosing based on infection severity and patient renal function, and recommend the correct duration of therapy (typically 3-5 days post-source control) [49]. By distilling complex guidelines into actionable protocols, the pharmacist empowers dentists to prescribe with greater confidence and accuracy, directly countering the problematic patterns of overly broad-spectrum and prolonged antibiotic use.

Beyond protocol development, the clinical pharmacist plays a vital role in monitoring and feedback through a process known as prospective audit and intervention. This involves systematically reviewing antibiotic prescriptions issued by the dental practice against the established guidelines. When a prescription is identified as non-concordant—for example, an unnecessarily long duration or the use of co-amoxiclav for a simple infection—the pharmacist provides direct, one-on-one, educational feedback to the prescriber [50]. This feedback is non-punitive and formative, focusing on the evidence base for recommended practices. Studies have consistently shown that this type of audit and feedback is one of the most effective strategies for improving prescribing behaviors in outpatient settings, as it provides timely, relevant, and personalized education that resonates with clinicians [51].

The clinical pharmacist's expertise is particularly invaluable in managing complex patient scenarios that frequently challenge general dental practitioners. One such area is the management of patients with reported penicillin allergies. A significant proportion of patients who report a penicillin allergy are not truly allergic upon formal evaluation; many have experienced a minor side effect like gastrointestinal upset. Mislabeled penicillin allergy leads to the use of broader-spectrum alternatives like clindamycin or fluoroquinolones, which are associated with higher risks of *C. difficile* infection and other adverse effects, and contribute more significantly to resistance [52]. The clinical pharmacist can assist in taking a detailed allergy history to stratify the risk and, when appropriate, recommend a first-line penicillin or cephalosporin, or guide the safe selection of a truly necessary alternative, thereby promoting the use of narrower-spectrum agents.

Another critical area is dose optimization for special populations. Dentists may be less familiar with adjusting medication doses for patients with impaired renal or hepatic function. A clinical pharmacist can calculate the correct dose adjustment for antibiotics like amoxicillin or metronidazole in a patient with chronic kidney disease, ensuring therapeutic efficacy while preventing drug accumulation and toxicity [53]. Furthermore, the pharmacist is instrumental in reviewing a patient's complete medication list to identify potential drug-drug interactions. For instance, they can advise on the significant interaction between metronidazole and alcohol, or the potential for antibiotics like clarithromycin to interact with certain statins, anticoagulants, or calcium channel blockers, thereby preventing adverse drug events and enhancing patient safety [54].

Perhaps the most accessible and far-reaching role of the pharmacist in dental AMS occurs at the community pharmacy level: direct patient counseling at the point of dispensing. This represents a final, critical checkpoint before the patient begins therapy. When a patient presents a dental antibiotic prescription, the community pharmacist has the opportunity to reinforce key stewardship messages. This includes verifying that the patient has indeed received, or is scheduled for, a definitive dental procedure to control the source of infection [55]. During counseling, the pharmacist can educate the patient on the importance of adherence to the prescribed course, the rationale for the specific duration (and why they should not save leftover pills), the potential side effects to watch

for, and crucially, the fact that antibiotics are not appropriate for viral infections or uncomplicated toothaches. This reinforcement from another healthcare professional significantly strengthens the message delivered by the dentist.

The implementation of clinical pharmacy services within dental practice, however, is not without its challenges. A significant barrier is the traditional separation between dental and pharmacy practices, both in physical location and in electronic health record systems. Dentists may not have direct, easy access to consult with a clinical pharmacist, and community pharmacists may not have visibility into the dental diagnosis or planned procedure [56]. Overcoming this requires intentional system design, such as creating formal consultation pathways between dental clinics and health-system pharmacists or integrating pharmacists into large, multi-specialty group practices that include dental services. Reimbursement models for pharmacist-provided cognitive services also need to be developed to sustain these interventions in the long term.

Despite these challenges, the impact of integrating clinical pharmacy into dental AMS is profound and measurable. From a patient safety perspective, it reduces the incidence of adverse drug events and *C. difficile* infections by promoting safer drug selection and appropriate duration. From a clinical outcomes perspective, it improves the appropriateness of prescribing, ensuring that patients who need antibiotics receive the right drug at the right dose for the right time, thereby improving cure rates and reducing relapse [57]. From a public health perspective, it is a powerful tool in combating AMR by curbing the overuse and misuse of antibiotics, particularly broad-spectrum agents. The pharmacist's role in patient education also fosters a more informed public, which is essential for changing the cultural perception of antibiotics as a panacea for pain [58].

Health Administration: Policy, Access, and Stewardship Infrastructure

While the clinical pillars of dentistry, family medicine, and pharmacy are the visible agents of change in antibiotic stewardship, their efforts are enabled, sustained, and scaled by the foundational pillar of Health Administration. Healthcare administrators are the architects of the healthcare system, responsible for creating the structural, financial, and cultural environment in which clinical care is delivered. Their role in antimicrobial stewardship (AMS) is not clinical in nature but is fundamentally systemic, focusing on policy development, resource allocation, technological integration, and performance measurement. Without this administrative backbone, even the most well-intentioned interprofessional collaborations risk being fragmented, sporadic, and ultimately unsustainable. The administrative pillar is therefore responsible for building the very infrastructure that allows the principles of AMS to be systematically embedded into the daily workflow of dental practice [59].

The most fundamental role of health administration in dental AMS is the development and enforcement of institutional policies and protocols. These documents translate national guidelines into actionable, local standards of care. An effective stewardship policy, endorsed by the organization's leadership, would clearly define indications for antibiotic prophylaxis and therapeutic use in dental procedures, mandate the use of first-line agents unless specifically justified, and establish standard durations of therapy [60]. Crucially, such a policy must be more than a document; it must be actively implemented and supported by the administration. This includes integrating it into new employee onboarding, providing regular updates to all clinical staff, and establishing a clear chain of accountability. By creating these formal expectations, administrators shift AMS from an optional "best practice" to a core component of clinical quality and professional responsibility within the dental facility, thereby mitigating the influence of individual habit or patient pressure on prescribing decisions.

A second critical administrative function is the strategic allocation of resources to support stewardship activities. AMS programs require dedicated time, personnel, and funding to be effective. Health administrators must justify and secure the budget for key resources, such as funding the time of a clinical pharmacist to conduct prospective audits and feedback, or supporting a designated "AMS champion" within the dental team [61]. This also includes investing in education and training for all members of the dental team—from dentists and hygienists to dental assistants and front desk staff—ensuring everyone understands their role in promoting appropriate antibiotic use. Furthermore, administrators are responsible for facilitating the interprofessional collaboration that is central to the proposed framework. This may involve funding the time for dentists, physicians, and pharmacists to meet, or creating formal consultation pathways and referral agreements between different departments or clinics, thereby breaking down traditional siloes [62].

In the modern healthcare landscape, technology is a powerful force multiplier for stewardship, and its implementation falls squarely within the purview of health administration. The integration of Clinical

Decision Support Systems (CDSS) into the Electronic Health Record (EHR) is arguably the most impactful technological intervention an administrator can champion. A well-designed CDSS can embed the institution's prescribing guidelines directly into the dentist's workflow. For example, when a dentist attempts to prescribe an antibiotic, the system can prompt them to select a diagnosis from a pre-populated list, display the recommended first-line agent and duration, flag non-guideline-concordant choices (e.g., a 7-day course for a simple infection), and require a justification for deviations [63]. This "nudge" architecture makes the right choice the easy choice and provides real-time, point-of-care education. Administrators are responsible for overseeing the procurement, customization, and implementation of such systems, ensuring they are user-friendly and clinically relevant rather than being perceived as burdensome alerts that are quickly ignored.

Another indispensable administrative tool is the establishment of a robust monitoring and feedback loop. Stewardship cannot improve what it does not measure. Health administrators must support the creation of systems to track antibiotic prescribing patterns. This involves collecting and analyzing data on key metrics, such as the overall rate of antibiotic prescriptions, the proportion of prescriptions aligned with guidelines, the use of broad-spectrum versus narrow-spectrum agents, and the average duration of therapy [64]. This data can be aggregated at the level of the entire practice, specific clinics, or individual prescribers. The administration's crucial role is to ensure this data is not just collected, but is fed back to prescribers in a structured, non-punitive manner. Providing dentists with confidential reports comparing their prescribing habits to their peers and to the institutional benchmark has been proven to be a highly effective driver of behavior change, appealing to professional pride and fostering a culture of continuous quality improvement [65].

Health administrators also play a vital role in addressing the critical issue of access to dental care, which is a significant, though often indirect, driver of antibiotic misuse. When patients face long wait times or cannot afford urgent dental care, they often seek help from primary care physicians or emergency departments, where providers, lacking the ability to provide definitive dental treatment, may inappropriately prescribe antibiotics as a stopgap measure [66]. From an administrative perspective, tackling this problem involves developing and promoting systems that improve access to timely, definitive dental care. This can include policies such as reserving appointment slots for urgent cases, implementing teledentistry consultations for triage, creating sliding fee scales for low-income patients, and advocating for better dental insurance coverage. By facilitating easier access to the correct treatment (dental procedure), administrators can help reduce the demand for the incorrect treatment (antibiotics alone) at the population level.

Beyond the walls of a single institution, health administrators operate at a macro level, engaging with public health policy and regulation. They are responsible for ensuring their organization's AMS program is aligned with regional and national antimicrobial resistance (AMR) action plans, as well as with standards set by accrediting bodies. In many countries, demonstrating an active AMS program is becoming a requirement for healthcare accreditation [67]. Administrators can also advocate for broader regulatory changes that support stewardship, such as legislation enabling pharmacist-led independent prescribing for specific indications or the implementation of statewide or national prescription drug monitoring programs that include antibiotics [68]. By engaging in this broader policy landscape, administrators help create a consistent, supportive environment for stewardship across the entire healthcare system.

The challenges facing administrators are significant. They must balance the upfront costs of implementing new technologies and dedicating personnel against long-term benefits that are often measured in public health outcomes rather than immediate revenue. They must navigate professional resistance to change and find ways to integrate new workflows into busy clinical practices. However, the consequences of inaction are far greater. The rising tide of AMR represents a fundamental threat to the safety and effectiveness of all medical care, and the financial and human costs of widespread resistance will dwarf the investments required for stewardship today [69].

4. Conclusions

The challenge of inappropriate antibiotic prescribing in dentistry is a multifaceted problem rooted in clinical uncertainty, cultural habits, and systemic barriers, and it consequently demands a multifaceted, interconnected solution. This research has delineated that the path forward lies in the deliberate and structured integration of the expertise of Family Medicine, Clinical Pharmacy, and Health Administration with the central role of the dental practitioner. The family physician acts as a crucial coordinator and consultant, ensuring that decisions regarding antibiotic prophylaxis and referrals are based on accurate medical history and current evidence, thereby preventing unnecessary

prescriptions. The clinical pharmacist serves as the pharmacotherapy expert, guiding optimal drug selection and duration, managing complex cases, and providing a final layer of safety and education at the point of dispensing. Ultimately, the health administrator provides the indispensable foundation, creating the policies, implementing the technology, allocating the resources, and fostering the culture of quality improvement that enables the entire interprofessional team to function effectively. The cumulative impact of this collaborative model extends far beyond the walls of the dental clinic. It represents a proactive and sustainable strategy to combat the global threat of AMR from a significant source of antibiotic consumption. By ensuring that antibiotics are used judiciously—only when truly indicated, with the most targeted agent, for the shortest effective duration—this framework directly protects individual patients from adverse drug events and protects the community from the spread of resistant pathogens. Embracing this interprofessional paradigm is therefore an ethical and practical imperative. It is a commitment to higher standards of patient care, responsible resource management, and the long-term preservation of one of medicine's most vital resources. The future of effective dental care and global public health depends on our collective will to build these bridges and work collaboratively towards a common goal.

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