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A review of use of antibiotics in dentistry and recommendations for rational antibiotic usage by dentists*

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Abstract

Dentists commonly prescribe antibiotics for controlling and treating dental infections. But there is a widespread abuse of antibiotics in medical and dental field. The inappropriate use of antibiotics results in increased treatment costs, increased risk of adverse events related to the antibiotic used and most importantly development and propagation of antimicrobial resistance. The definitive indications for use of antibiotics in dentistry are limited and specific. This review discusses the various principles and rationale behind antibiotic therapy in different fields of dentistry with stress on rational antibiotic use in dentistry

Introduction

Dentistry is a comprehensive speciality devoted to resolving dental infections or restoring and rehabilitating tooth structure lost to such bacterial processes. The use of antibiotics is an integral part of dentistry and prescribing antibiotics is a privilege that must not be abused. Irrational use of antibiotics will lead to an increased burden on the patient and the society by increasing treatment costs, adverse events and also the risk of development of resistant bacterial species. Antibiotic abuse has already been considered as a pandemic community issue by World Health Organization (WHO) [1], whilst the abuse of antibiotics by dentists is worldwide as shown by many reports [2–5].

The oral cavity is a complex biological ecosystem with very large number of organisms living in a biofilm [6]. The interaction of the organisms are complex and the change from health to disease state is associ-

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ated with a change in the balance of the ecosystem usually from the resident facultative anaerobes to obligate anaerobes for most pulpal and periodontal diseases [7]. Even though only a few of the micro-organisms cause odontogenic infections, in disease state, many other non pathogenic bacterial species contribute by maintaining an ecosystem favourable for survival and growth of the pathogenic species. The onset of disease is due to a shift in microbial flora. Understanding this ecological principle is important while treating oral and dental infections. Micro-organisms in a biofilm are consistently more resistant to usual dosage of antibiotics by 1000-1500 fold [8].

Management of odontogenic infections involves three phases; diagnosis, infection control and rehabilitation/restoration. Antibiotics are useful in the infection control phase. Based on the data collected and interpreted in the diagnostic phase, infection control phase involves removal of the infectious foci and resolving the infection. This will include use of antibiotics/antiseptic agents as well as surgical methods to resolve the infection. Until resolution of the infection, the response to the treatment should be assessed often.

Most dental pain is the result of infection induced inflammatory process in a closed compartment as in the pulp and the apical periodontal region or in sensitive and highly innervated soft tissue like the periosteum space, gingiva and periodontium. The general principle of management of all infectious processes is the removal of the foci of infection. Control of dental infections is by mechanical removal of the foci of infection. It can be achieved by removal of the infected pulp, scaling and root planning and drainage of the pus by incision when the soft tissue spaces are involved. Usually a combination of one or more of these techniques are utilised for maximum benefit. This, when supported by appropriate use of anti-inflammatory agents can result in prompt relief of pain as well as the infection. Antibiotics do not contribute to pain relief as they have no action on the inflammatory process that causes the pain [9–11]. With appropriate measures to remove the foci of infection, antibiotics are not necessary in most cases. An old surgical credo is "pus cannot be cured by penicillin".

Principles of antibiotic usage

In recent times, antimicrobial stewardship has been given lots of importance at the patient level and at the community level. Antimicrobial stewardship is defined as "the optimal selection, dosage, and duration of antimicrobial treatment that results in the best clinical outcome for the treatment or prevention of infection, with minimal toxicity to the patient and minimal impact on subsequent resistance." Joseph and Rodvold [12] summarised the 4 D's of antimicrobial therapy which is given in **Table 1**. An important consideration in starting antimicrobial therapy is to assess if the infection is localized and if the patient has an adequate immune response to control the bacteria if supported surgically. These considerations are summarised in **Table 2**.

In the presence of purulence, signs of inflammation, abscess or draining sinus tracts, the lesion/infection responds to local debridement measures in a healthy patient [12,13]. In an otherwise healthy patient, infections that have not crossed the dento-alveolar regions are amenable to treatment without

Table 1. 4 D's of antimicrobial therapy [12].

right **D**rug
right **D**ose
De-escalation to pathogen-directed therapy,
right **D**uration of therapy

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Table 2. Considerations for antimicrobial therapy [13]

Indicated clinical conditions for antimicrobial therapy	Non-indicated clinical conditions for antimicrobial therapy
1. Pyrexia within last 24 hours – indicates a systemic response to the infection	1. Pain – (Analgesics/ Anti-inflammatory drugs are indicated)
2. Systemic symptoms like malaise, fatigue, weakness, dizziness, rapid respiration and local tender lymphadenopathy – indicate an impending sepsis	2. Oedema – (Anti-inflammatory drugs indicated)
3. Trismus – indicates spread to perimandibular spaces and can extend to secondary spaces that can be potentially dangerous. Also trismus makes intraoral procedures difficult, which must wait until the trismus is relieved.	3. Redness/heat (Anti-inflammatory drugs indicated)
4. As a prophylaxis in patients with systemic conditions like rheumatic heart disease, endocarditis, heart / orthopaedic prosthesis.	4. Purulence – (Resolved by drainage of pus / debridement)
5. In patients with any kind of immunocompromise – AIDS, cancer, autoimmune diseases, corticosteroid therapy, patients with immune compromised diseases like cyclic neutropenia, pancytopenia, uncontrolled diabetes to name a few common ones.	5. Abscess – localized (e.g., alveolar abscesses, periodontal abscesses) – (Resolves by incision and drainage)
6. After solid Organ transplant/grafts (cardiac/renal/bone marrow/liver/osseous implants)	6. Draining sinus tract. (Removal of foci of infection resolves drainage and sinus tract may heal on its own or may have to be surgically excised.)

antibiotics. The infections that are about to breach the dentoalveolar regions and threaten to extend into deeper hard tissues or into the soft tissue fascial spaces in the head and neck region will need use of appropriate antibiotics along with surgical therapy [14–16].

Antibiotics appropriate for dental use

Different antibiotic prescribing trends are in practice among dentists [4,5,17]. Understanding the pharmacokinetics and pharmacodynamics is important for appropriate use of the antibiotics. In spite of a large of number of newer antibiotics being introduced in the market, there are a very few antibiotics that are useful in dental infections. Most infections of dental origin still respond to penicillin group of antibiotics [18] and routine use of newer antibiotics only adds to the cost and risk of antibiotic resistance to these agents. Aminopenicillins are not active against anaerobes but odontogenic infections that show anaerobic pathogenic bacteria still respond to these antibiotics and these antibiotics may act by changing the ecological niche that will result in death of the pathogenic anaerobes as well. [13]. Adding a drug with anaerobic cover like metronidazole has a synergistic effect. [19]. A list of drugs useful in dentistry are listed in **Table 3.** Bactericidal antibiotics are preferred when the host is immune compromised as bacteriostatic drugs require

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Table 3. Antibiotics useful in Dental Practice

Antibiotic used	Cidal/Static	Important characteristic
Amoxicillin	Cidal	- Better oral tolerance. - Less chances of toxicity. - Most odontogenic infections still respond to this drug.
Amoxicillin + clavulanate	Cidal	- Similar to amoxicillin with additional Beta lactamase resistance
Cephalosporins	Cidal	Useful in selective cases of penicillin allergy and have good activity against most oral pathogens but (should not used in cases of patients showing Type I hypersensitivity to penicillin group of drugs)
Metronidazole	Cidal	Active against obligate anaerobes but no activity against facultative anaerobes like Streptococci. Useful in stage of abscess formation.
Clindamycin	Static	Useful in penicillin allergic patients and has a wide spectrum of activity including anaerobes. Useful in penicillin allergic infections. Risk of superinfection.
Tetracyclines	Static	High concentrations achieved in bone and gingival tissues. Topical formulations available for use in periodontology
Aminoglycosides	Cidal/static	- Injectable drugs - Active against gram negative odontogenic infections - Used in combination with other drugs in severe odontogenic infections - Ototoxicity and hepatotixicity.
Macrolides antibiotics	Static	Rapid antimicrobial resistance develops with these newer antibiotics and so they must be avoided in dental settings when better choices are available.
Fluoroquinolones	Cidal	Moxifloxacin has been found to be active against most odontogenic micro-organisms. [90]. Useful in minor infections in penicillin allergic patients, but better alternatives are available and hence not recommended for routine use.

the host's immune system to completely eradicate the infection [20].

If the decision to prescribe an antibiotic is made, it may be necessary to use microbiological testing to choose the appropriate antibiotic. Microbiological testing by culture and sensitivity tests will help choose the best antibiotic. Samples are collected in an appropriate manner after consultation with the lab and sent immediately, preferably before starting any antibiotics. After collection of sample, treatment should be started immediately by use of empiric antibiotics. For minor infections, amoxicillin or amoxicillin/clavulanate is sufficient. A combination of beta-lactamase resistant penicillin group of drug and metronidazole is started in cases of serious odontogenic infections along with appropriate surgical therapy [16,19,21,22]. Routine culture and sensitivity are not recommended in minor odontogenic infections. These infections respond well to

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empiric antibiotic therapy with penicillin group of drugs. It and so routine culture and sensitivity is not cost effective [21]. In case of severe infections or infections showing rapid spread, culture and sensitivity might be recommended. One must remember that "waiting is wasting" in these scenarios. Empiric antibiotic therapy is started and later changed, if necessary, based on culture and sensitivity reports.

Appropriate dosage/frequency and duration

Discussing the detailed pharmacology of these drugs is beyond the scope of this article but a brief discussion of an important pharmacological profile of antibiotics may be helpful.

Antibiotics can have a concentration-dependent killing or a time-dependent killing. The concentration-dependent drugs cause bacterial death when present above a particular concentration. Increasing the concentration will result in faster killing. Thus a single high dose may suffice to achieve the effect. e.g, metronidazole. Time-dependent drugs have their best effect when present at therapeutic levels for a particular period of time. The therapeutic level of the drug must be maintained for long periods to achieve best effect. Increasing the concentration of the drug may have no effect on its efficacy. These drugs may be better used by increasing the frequency of administration rather than increasing the dose. Penicillin group of drugs belong to this profile [13]. This suggests the question of whether 250 mg of amoxicillin given 4 times a day is more beneficial than 500 mg of amoxicillin given 3 times a day Or is 250 mg of amoxicillin given thrice a day sufficient? And in each of these settings, what is the recommended duration of therapy ? Different prescribing trends are present without adequate evidence of their efficacy as there are no clear studies on the best dosages and frequencies as applicable to dentistry.

Higher dose of antibiotic given for a shorter duration are advocated in recent years [4]. This regimen would avoid selection of antibiotic resistant species and the risk of allergy or adverse events are not significantly raised for most dental specific antibiotics. Selection of antibiotic resistant species is common after using lower dose of antibiotics for longer periods of time. But before this, the first question to ask oneself is whether an antibiotic is indicated in that particular clinical setting in that particular patient [3].

A brief tabulation of management of most common conditions treated by a dentist with their management principles is listed in **Table 4.**

Antibiotics In Endodontic Practice

Most endodontic practice deals with acute and chronic pulpal and periapical pathologies. Evidence has shown that antibiotics have no effect on the pain in case.[10,23,24] Antibiotics are not useful in most endodontic infections because it is doubtful that systemic antibiotics are able to achieve an adequate therapeutic concentration within the necrotic pulp [25]. Meticulous endodontic technique by avoiding over instrumentation will avoid periapical infections and flare ups during the endodontic therapies [26]. Pain during endodontic treatment can be avoided by careful instrumentation. Non-steroidal anti-inflammatory drugs (NSAIDs) can be helpful to obtain pain relief [27]. Where endodontic treatment is not feasible or in patients with non-restorable tooth, extraction of the tooth will resolve

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Table 4. Management of common dental conditions.

Condition	Treatment Approach	Antibiotics
Uncomplicated endodontic lesion	- Debridement of root canal	No
Soft tissue swelling of endodontic origin (apical abscess / alveolar abscess)	- Debridement of root canal - Incision and drainage.	No
Endodontic lesion confined to the bone (apical periodontitis)	-Trephination of bone to relieve pressure and speed healing	No
Periodontal abscess	- Scaling / removal of irritant - Drainage of pus	No
Chronic periodontitis/ Gingivitis	Scaling and root planing	No
NUG without systemic complications in healthy patients.	- Debridement - Irrigation - Scaling and root planing	No
NUG with systemic complications or in immune compromised patients / ANUP / HIV associated NUG/NUP	-Debridement -Irrigation -Scaling and root planing -Systemic Antibiotics	Yes. Metronidazole is first choice. Penicillin group of drugs may be additional adjuvants [35]
Aggressive periodontal diseases / Refractory periodontal conditions	- Debridement - Scaling and root planing	May be considered early in generalized aggressive periodontitis [91]
Localized abscess	- Incision and Drainage - Removal of foci of infection	No
Fascial space infections	- Incision and drainage - Removal of foci of infection	Yes
Complicated endodontic / periodontic lesions with signs of systemic spread of infection /involvement of fascial spaces	- Removal of foci of infection - Incision and drainage	Yes
Systemically compromised patients with immune defects	Removal of foci of infection by any appropriate means	Yes (use of bactericidal drugs recommended)
Prior to uncomplicated / complicated extractions	-	No
Prior to periodontal surgeries / endodontic surgeries	-	No
Prior to Regenerative periodontal therapy with membranes / grafting	-	May be *
Prior to implant surgery	-	Not necessary in case of single implant placement.

* not supported by strong high quality evidence, NUG Necrotizing Ulcerative Gingivitis, NUP – Necrotizing Ulcerative Periodontitis, HIV – Human Immunodeficiency Virus

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the infectious process. As for endodontic surgeries, they do not require use of antibiotics in healthy patients usually, but may be used if deemed necessary by the clinician. [3]. Postoperative anti-inflammatory drugs will be sufficient to control pain. Postsurgical infection is not common after endodontic surgeries [28–30].

Acute peri-radicular abscess is a common endodontic infection. A recent review concluded that there is insufficient evidence to recommend use of antibiotics in cases of apical periodontitis or in acute peri-radicular abscesses [11]. In the management of acute peri-radicular abscesses, the abscess should first be drained by performing a pulpectomy or incision and drainage, and relieving any traumatic occlusion. If adequate drainage is achieved via incision and drainage, debridement, and medication of the canal system, antibiotics are not required generally [31,32]. In the event of systemic complications, such as fever, lymphadenopathy, or cellulitis or in an immunocompromised patient, antibiotics may be prescribed in addition to drainage of infection. [32].

Anyibiotics in Periodontal practice

Periodontitis is a bacterial infection and this has been used as a justification for the repeated routine use of antibiotics in periodontology. But the clinical relevance of bacteria being present in the tissues is still not clearly defined in periodontal infections and it is inappropriate to make clinical treatment such as to use adjunctive systemic antibiotics on this premise alone. Montiero et al., [33] conducted a survey regarding the use of systemic antibiotics by dentists for periodontal diseases and concluded that many dentists still use systemic antibiotics incorrectly, without regard to evidence in published literature, for inappropriate indications and using inappropriate protocols that are ineffective in periodontal therapy. There is considerable controversy on the use of microbial testing in periodontology. While some authors suggest that after appropriate and thorough mechanotherapy, microbial testing should be undertaken before starting antibiotic therapy [13] the benefit of microbial testing has also been questioned [34].

Gingivitis and chronic periodontitis

Gingivitis is a local infectious process and responds well to local mechanotherapy and antibiotic therapy is contraindicated [35]. Routine use of systemic antibiotics in treatment of chronic periodontitis is not justified in normal healthy patients. The risks of systemic antibiotics outweigh the benefits for use in periodontal diseases [13]. Periodontal pockets can be treated by local irrigation of antiseptic / antibiotic solutions. The removal of the calculus and infected tissue by scaling and root planing procedure with irrigation removes the infectious foci and resolves the inflammation. The main objective would be to disrupt the biofilm mechanically.

The interrelationship between periodontitis and glycemic control may be considered bidirectional [36]. Oral hygiene education and mechanical debridement of plaque and calculus combined with regular maintenance is important. When possible, a HbA1c of less than 10% should be established before surgical treatment is performed and systemic antibiotics are not needed routinely. Also, periodontal treatment seems to improve glycemic control [37,38], It was found that additional use of doxycycline did not offer significant benefit in glycemic control [37], but when doxycycline was used, the topical local delivery of doxycycline offered better glycemic control (decrease by 10.5%) [39] than systemic doxycycline (decrease by 4.7%) [40].

Aggressive periodontal diseases

Systemic therapy for treatment of the periodontal condition in conjunction with local therapy is indi-

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Table 5. Signs/symptoms of severe head and neck infections.

Signs/symptoms of systemic spread – pyrexia, malaise and worsening of general condition.
Rapid onset and progress
Infection in immunocompromised patients.
Large swelling involving submental/submandibular or parapharyngeal spaces – potential airway compromise
Presence of trismus indicates involvement of perimandibular spaces and is a serious sign.

cated in patients with aggressive periodontitis to eliminate the bacteria that invade the gingival tissues and can repopulate the pocket after scaling and root planing. The use of antibiotics is beneficial only after the biofilm has been disrupted by appropriate mechanotherapy and antibiotics should be used only after proper mechanotherapy has been used and has been unsuccessful. The use of combination of amoxicillin and metronidazole in aggressive periodontal diseases is well supported [41–44], however well designed controlled clinical trials are limited as shown in a recent review [45].

Acute lesions of gingiva/periodontium

The two most common acute gingival infections are necrotizing ulcerative gingivitis (NUG) and herpetic gingivostomatitis. Herpetic gingivostomatitis is a viral infection but may be complicated by superinfection with bacteria. These diseases occur most often in healthy patients, but patients with depressed immunologic responses have an increased risk for these gingival entities. Both may appear similar and the treatment by debridement is effective for NUG but may exacerbate herpetic gingivostomatitis. On the other hand, antiviral therapy is effective for herpetic gingival lesions but not for NUG. [35].

Necrotizing lesions cause extensive tissue destruction and necrosis. The treatment is mainly removal of the necrotic tissue with pain control. Antibiotics are not recommended in NUG patients who do not have systemic complications. [35,46]. However, in patients with immunologic deficiencies or patients with evidence of spread beyond the gingival tissues as in necrotizing ulcerative periodontitis (NUP) then systemic antibiotics are indicated *especially when local root planing and curettage is not possible immediately*. [35]. Regular daily follow up and debridement with irrigation is required for management of this lesion.

Necrotizing lesions of the gingiva and periodontium can progress dramatically in Human Immunodeficiency Virus (HIV) positive patients, thus it is necessary to utilize thorough local therapy combined with local use of antimicrobial mouthwashes such as chlorhexidine and meticulous oral hygiene by the patient. Systemic antibiotics may be used especially when systemic complications ensue or anticipated. Whenever possible, antibiotics should be avoided in significantly immunocompromised individuals to minimize the risk of opportunistic infections (i.e., candidiasis), superinfection, and micro-organism drug resistance [35,46,47].

Periodontal abscess

Periodontal abscesses can often be managed by curetting the pocket under local anaesthesia to remove plaque or any other aetiologic material. The use of systemic antibiotics may be indicated when patients have elevated temperatures or show signs of cellulitis and have systemic disease/immuno-

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Table 6. Considerations for peri implant infections.

Condition	Criteria for diagnosis	Treatment
Peri-implant Mucositis	Inflammation Bleeding on probing Peri-implantitis pocket depth < 4 mm No bone loss	A + B
Peri-implantitis graded according Renvert et al. [92]		
Peri-implantitis Grade 0	Failed implant Implant fracture Implant mobility > 1 mm horizontal movability	Explant
Peri-implantitis Grade 1 (mild)	BOP +/- Suppuration Peri implant pocket depth < 4 mm Bone loss < 2 mm Foreign Body in implant sulcus - ? cement	A + B
Peri-implantitis Grade 2	BOP +/- Suppuration PPD 4-6 mm Bone loss < 2 mm	A + B
Peri-implantitis Grade 3	BOP +/- Suppuration PPD > 6 mm Bone loss > 2 mm	A + B + C

BOP = bleeding on probing; PPD = Peri implant pocket depth.
A – Mechanical debridement (plastic scalers, rubber cup, air-abrasives), oral hygiene re-education & local antisepsis with chlorhexidine 0.1–0.2%, irrigation of Peri implant pocket with anti septic agents/antibiotic slurry and application of local antiseptic agent like chlorhexidine gel.
B – Removal of abutment.
C – Surgical access & Systemic antibiotic.

compromised condition. [35,47]. Antibiotic therapy alone without subsequent drainage and subgingival scaling is contraindicated. [35].

Periodontal surgeries

Systemic antibiotics are generally used after reconstructive periodontal therapy, although definitive information on the advisability of this measure is still lacking [48–51].

Simple routine periodontal surgeries do not need antibiotics in the postoperative period. Regenerative therapies using bone grafts, allografts and periodontal membranes sometimes require the use of antibiotics to prevent infection of the bone graft or the foreign material (membranes). Even though studies seem to suggest no additional benefit [49–52], current practice recommends use of antibiotics in this scenario. [35]. High dose for a short term, would be beneficial not exceeding 5 days, would be sufficient in most instances [35]. Consideration for peri-implant infections are tabulated in **Table 6.**

Topical antibiotics in Periodontology

There is a need to reduce the widespread and repeated use of topical antibiotics as advocated by some manufacturers. Topical antimicrobial therapy should be used with same caution as applied to systemic therapy. Their indications are similar to systemic antibiotic therapy in periodontology [13].

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Antibiotics in Oral and Maxillofacial Surgery

Antibiotics in minor oral surgery

Most oral surgical procedures in general dental practice and in the clinical practice involves simple or complicated extraction of teeth, preprosthetic hard tissue and soft tissue procedures, periapical surgeries, implant placements and soft tissue biopsy procedures. These surgical procedures are deemed clean contaminated procedures. Clean procedures usually do not have risk of postprocedural infections. Excellent aseptic precautions can reduce the infection risk to about 3% to 5% [53]. Antibiotics cannot reduce the risk of infection to below 1% and may not be warranted. Even though antibiotics are routinely used as surgical prophylaxis and in the postprocedural period, there is not enough evidence that such usages have a more favourable outcome in oral surgery. In general there is overuse of antibiotic prophylaxis in minor oral surgery [54–56,56]. A recent review concludes that about 12 patients have to be treated with antibiotic to prevent one infection and that the risks of antibiotic use significantly outweigh the benefits. [57]. The use of prophylactic antibiotics prior to implant placement is controversial. A systematic review supports the use of 2 g amoxicillin as presurgical prophylaxis [58] while a few other studies conclude that there is no added benefit [59–61]. There is no evidence that implant failure is prevented by antibiotic usage [13].

Antibiotics in complex odontogenic infections

Odontogenic infections begin with invasion by mixed bacterial flora and in the early stages facultative anaerobes such as streptococci predominate and cellulitis stage is established. Due to the change in the environment inside the infected regions, there is a change in the microflora from facultative to obligate anaerobes and there is formation of abscess. Cellulitis is a rapidly spreading progressive infection caused by facultative anaerobes whereas abscess is predominantly an obligate anaerobic infection with well defined margins, fluctuant and is filled with pus [13–16,21].

Severe infections of the head and neck should preferably be seen by a specialist early for combined antibiotic and surgical management. Severity may be indicated by signs/symptoms listed in **Table 5**.

Penicillin group of drugs remain the drugs of choice for early stages of odontogenic infections. After formation of abscess, drugs with anaerobic spectrum like metronidazole or clindamycin are indicated. As a general rule, if infection has been present for more than 2-3 days, it can be expected to have progressed to obligate anaerobic infection and addition of metronidazole along with amoxicillin is beneficial [16,19,21]. A short course of high dose antibiotics combined with surgical drainage and daily debridement/irrigation as indicated results in quicker resolution of the infection. In general it's recommended that the antibiotic therapy should be continued at least 2-3 days beyond resolution of symptoms. [21].

Antibiotic use in maxillofacial trauma

The general consideration is that wound closure of clean and clean contaminated wounds like intra oral mucosal lacerations or that can be rendered clean do not require routine use of antibiotics. Dirty wounds or infected wounds would need a debridement before closure or may be treated by delayed primary closure or left to heal by secondary intention. Antibiotics are not a substitute for surgical debridement. Routine use of surgical prophylaxis does not seem to offer additional benefit in reduction of infections [62–65]. Surgeries performed with due care for surgical asepsis do not require prophylactic dose of antibiotics beyond the first 24 hours. In-

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fected wounds and fractures/hardware should be treated as any maxillofacial infection and the same considerations are applicable including surgical removal of the infectious foci with adjunctive use of antibiotics.

Concept of surgical prophylaxis in Oral and Maxillofacial Surgery

The decision to use prophylactic antibiotics in non-infected cases should also be based on whether patients have any significant medical risk factors that could adversely affect their humoral and cellular immune mechanisms, and whether any systemic risks are associated with the bacteremia that accompanies tooth extraction. For patients in whom postoperative infection may be anticipated the use of chemoprophylaxis is recommended. There is no evidence that the use of antibiotics beyond 24-48 hours has any additional benefit. [66]. The classical studies on antibiotic prophylaxis recommend that the duration of the prophylaxis drug should NOT exceed 24 hours. Antibiotics given after that do not have a significant benefit and risk of adverse events and complications increase beyond that period.

The prophylactic dose of antibiotic is usually double the recommended dose [67]. The dose should be administered prior to surgery such that the peak concentration occurs at the time of taking the incision. Average peak serum levels are reached 60 -120 minutes after oral administration of amoxicillin and immediately after intravenous administration of amoxicillin [68,69]. Therefore, oral amoxicillin 1 gram (double the therapeutic dose of 500 mg) is recommended at least 1 hour prior to surgery (as the levels peak at about 60–120 minutes after administration) are cases done under local anaesthesia. Intravenous (IV) antibiotics can be given just prior to or a few minutes prior to taking the incision as immediately high levels are attained in the blood. IV administration is useful in cases done under general anaesthesia conveniently administered at the time of induction. The concept of antibiotic re-dosing may be applicable to complex surgeries of longer durations which is rare in usual dental practice. Use of multiple drugs have not been found to be beneficial [66]. To In patients who are allergic to penicillin, clindamycin may be used [54,70–72].

Pediatric considerations

Healthy paediatric population require the same consideration as healthy adults. There is often misuse of antibiotics in treating children [25]. They are commonly over-prescribed and over/underdosed. More often, dentists give in to request from the parent and fill a prescription for antibiotic even when not definitely indicated.

Antibiotic usage in compromised patients

The rationale behind using antibiotics in medically compromised patients with immune defect is that they are at a higher risk of infection and infections are more difficult to manage in this group of patients [13,57]. Studies in this population without antibiotics is not possible nor ethical. The use of antibiotics when used rationally may be beneficial in this group of patients. In neutropenic patients antibiotic prophylaxis is recommended by some especially when absolute neutrophil count (ANC) drop below 1000-1500/microlitre [46,73–76], while others feel it's not recommended [77]. In general a definite guideline/recommendation is lacking in this regard. [78]. So, the decision has to be made on a case by case basis in consultation with the treating physician/medical expert. These patients benefit with a bactericidal drug as their immune system may not be able to clear the infection efficiently with bacteriostatic drugs [20].

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Consideration for chemoprophylaxis in certain systemic conditions

Bacteremia occurs whenever there is manipulation of gingival tissue, integrity of the mucosal barrier is breached and during endodontic instrumentation. This can be potentially dangerous in patients with prosthetic cardiac valves or untreated cardiac valve/septal defects and in patients with allograft prosthetic joints. The indications for infective endocarditis prophylaxis are constantly being revised. Regional variations exist in the recommendations through the world and the dentist should follow the latest regional/national guidelines when present. It may be prudent to consult with the treating physician before any procedure is planned or refer to any card/pamphlet with instruction that the patient may carry as is customary in certain parts of the world. But over the past few years the patients for whom infective endocarditis prophylaxis is recommended has been decreased [79–83]. This is due to the lack of definite evidence linking infective endocarditis and the dental procedures [84–87]. The stress has been placed on cumulative bacteremia that occurs due to daily activities like brushing and flossing more than the bacteremia that occurs due to dental procedures [80,82,84]. Maintaining oral health in these at-risk patients can decrease occurrence of infective endocarditis [80,82,83].

Recent guidelines for antibiotic prophylaxis in patents with prosthetic joints has been issued which also recommends against the routine practice of antibiotic prophylaxis in these patients due to insufficient evidence for linking dental procedures to periprosthetic infections [88,89]. The recommendation is for maintenance of good oral hygiene. A detailed discussion of these special topics is beyond the scope of this article and the reader is encouraged to read through the references cited for a detailed discussion.

Conclusion

To summarise, the definitive indications for antibiotics in dentistry are limited and specific (see **Table 4**). Most odontogenic infections can be managed by removal of the focus of infection and they respond well to specific limited arsenal of antibiotics like amoxicillin and metronidazole. Appropriate antibiotic stewardship and rational prescription of antibiotics by dentists is urgently needed in view of the pandemic issue of antimicrobial resistance. Education in this regard is necessary during the training as well as in continuing dental education programs to curb antibiotic abuse.

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