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Antibiotics in dental practice: how justified are we

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Antibiotics are prescribed by dentists in dental practice, during dental treatment as well as for prevention of infection. Indications for the use of systemic antibiotics in dentistry are limited because most dental and periodontal diseases are best managed by operative intervention and oral hygiene measures. The use of antibiotics in dental practice is characterised by empirical prescription based on clinical and bacteriological epidemiological factors, resulting in the use of a very narrow range of broad-spectrum antibiotics for short periods of time. This has led to the development of antimicrobial resistance (AMR) in a wide range of microbes and to the consequent inefficacy of commonly used antibiotics. Dentists can make a difference by the judicious use of antimicrobials – prescribing the correct drug, at the standard dosage and appropriate regimen – only when systemic spread of infection is evident. The increasing resistance problems of recent years are probably related to the over- or misuse of broad-spectrum agents. There is a clear need for the development of prescribing guidelines and educational initiatives to encourage the rational and appropriate use of drugs in dentistry. This paper highlights the need for dentists to improve antibiotic prescribing practices in an attempt to curb the increasing incidence of antibiotic resistance and other side effects of antibiotic abuse. The literature provides evidence of inadequate prescribing practices by dentists for a number of factors, ranging from inadequate knowledge to social factors.

Key words: *Dental practice, periodontal disease, oral hygiene*

INTRODUCTION

Antibiotics are routinely prescribed in dental practice for either prophylactic or therapeutic use. Prophylactic antibiotics are prescribed to prevent diseases caused by the introduction of members of the oral flora to distant sites or to a local, compromised, site in a host at risk[1]. In most cases, prophylaxis is used to prevent endocarditis, whereas therapeutic antibiotics are prescribed mostly to treat diseases of the hard and soft tissues in the oral cavity after local debridement has failed[2].

Dentists prescribe medications for the management of a number of oral conditions, mainly orofacial infections[3]. As most human orofacial infections originate from odontogenic infections, the prescription of antibiotics by dental practitioners has become an important aspect of dental practice. For this reason, antibiotics account for the vast majority of medicines prescribed by dentists[4].

Dentists' use of antibiotics is characterised by a number of particularities. In effect, antibiotic prescription is empirical; the clinician does not know what microorganism is responsible for the infection because cultures are not commonly grown from the patient's pus or exudate. Based on clinical and bacterial epidemiological data, the types of microorganisms responsible for the infectious process are suspected, and treatment is decided on a presumptive basis, fundamental on probabilistic reasoning[5].

Antibiotic use may be associated with unfavourable side effects, ranging from gastrointestinal (GI) disturbances to fatal anaphylactic shock and development of resistance. The increasing antibiotic-resistance problems of recent years are probably related to the over- or misuse of broad-spectrum agents, such as cephalosporins and fluoroquinolones[6]. As a result, a new era has emerged in which some species of bacteria are resistant to the full range of antibiotics presently available, with methicillin-resistant *Staphylococcus aureus* being the most widely known example of this extensive resistance. These serious complications associated with antibiotic use have encouraged studies investigating the antibiotic-prescribing practices of dentists[7–10].

The empirical and broad use of antibiotic prophylaxis is clearly no longer acceptable, but details on responsible prescribing remain problematic. In the dental community, there has been a general trend towards over-prescribing[11,12]. One of the surveys in USA found that only 39% of dentists and 27% of physicians followed guidelines for antibiotic prophylaxis appropriately[13]. Many practitioners rely on the recommendations of other practitioners — who often cite anecdotal evidence — or decide that, when in doubt, the wise and conservative course is to prescribed[14].

The present review discusses the specific prescribing practices of general dentists with regard to antibiotic prophylaxis for dental procedures and the guidelines generally used in dental practice for the prescription of antibiotics.

RATIONALE FOR ANTIBIOTIC USAGE IN DENTAL PRACTICE

The human oral cavity contains a very broad range of microorganisms. Some authors speak of more than 500 different species, and Liebana *et al.*[15] even reported that all known microorganisms associated with humans are at some time found in the oral cavity as either transient (the majority) or resident (only a few) species.

The bacteria that cause odontogenic infections are generally saprophytes. The microbiology in this sense is varied, and multiple microorganisms with different characteristics can be involved. Anaerobic and aerobic micro-organisms are usually present in the oral cavity, and numerous aerobic species cause odontogenic infections — the most common being *Streptococcus* spp. The microorganisms most commonly isolated from the oral and maxillofacial regions are listed in *Table 1*.

In the course of dental caries, the bacteria that penetrate the dentinal tubules are mainly facultative anaerobes (i.e. *Streptococcus* spp., *Staphylococcus* spp. and *Lactobacillus* spp.). When the pulp tissue becomes necrosed, the bacteria advance through the pulp canal and the process evolves towards periapical inflammation[16]. The peri-apical infection warrants the rationale for the systemic administration of the antibiotics.

WHEN ANTIBIOTICS SHOULD BE INDICATED

Antibiotic prophylaxis for infectious diseases of dental or oral origin is more prevalent than the antibiotic treatment of such infections. Antibiotics are not an alternative to dental intervention; rather they are adjunctive to clinical intervention. The major use of antibiotic prophylaxis in dental procedures is for procedures that cause bleeding in the oral cavity, and administration of antibiotics for such cases has become common practice among dentists[14]. Antibiotics are also commonly indicated in dental practice for treating immunocompromised patients, patients with evident signs of systemic infection and if the signs and symptoms of infection progress rapidly[17].

Antibiotics are typically prescribed in dental practice (i) for the treatment of acute and chronic infections of odontogenic and non-odontogenic origins, (ii) as prophylactic treatment to prevent focal infection in patients at risk (as a result of systemic conditions such as endocarditis, artificial heart valves and congenital heart disease) and (iii) to prevent local infection and systemic spread among patients undergoing surgical oral or dental treatment.

Table 1 Types of bacteria, according to requirement of oxygen for growth, isolated from upper respiratory tract and head and neck infections[23]

Infection	Aerobic and facultative anaerobic organisms	Anaerobic organisms
Cervical lymphadenitis	*Staphylococcus aureus**	Pigmented *Prevotella*
	Mycobacterium spp.	*Porphyromonas* spp.*
		Peptostreptococcus spp.
Postoperative infection disrupting oral mucosa	*Staphylococcus* spp.	*Fusobacterium* spp.
	*Enterobacteriaceae**	*Bacteroides* spp.*
	Staphylococcus spp.*	Pigmented *Prevotella*
		Porphyromonas spp.
		Peptostreptococcus spp.
Deep neck sites	*Streptococcus* spp.	*Bacteroides* spp.*
	Staphylococcus spp.*	*Fusobacterium* spp.*
		Peptostreptococcus spp.
Odontogenic complications	*Streptococcus* spp.	*Pigmented prevotella*
	Staphylococcus spp.*	*Porphyromonas* spp.*
		Peptostreptococcus spp.
Ororpharyngeal: Vincent's angina necrotic ulcerative gingivitis	*Streptococcus* spp.	*Fusobacterium necrophorum**
	Staphylococcus spp.*	*Spirochetes*
		Prevotella intermedia
		Fusobacterium spp.

*Organisms that have the potential to produce beta-lactamase.

Antibiotics for odontogenic infections

Despite the high incidence of odontogenic infections, there are no uniform criteria regarding the use of antibiotics to treat them. A considerable percentage of pain of dental origin originates from acute and chronic infections of pulpal origin, which necessitates operative intervention, rather than antibiotics. Non-indicated clinical cases for antibiotic use, which are commonly practised by dentists, include acute periapical infection, dry socket and pulpitis[18].

The clinical situations that require antibiotic therapy on empirical basis are limited, and they include oral infection accompanied by elevated body temperature and evidence of systemic spread, such as lymphadenopathy and trismus[19]. Facial cellulitis, which may or may not be associated with dysphagia, is a serious disease that should be treated promptly by antibiotics because of the possibility of spread of infection via lymph and blood circulation, with the development of septicaemia.

Chronic inflammatory periodontal conditions do not require routine use of antibiotics; systemic antimicrobials should only be used in acute periodontal conditions where drainage or debridement is impossible, where there is local spread of the infection or where systemic spread has occurred[9].

Whereas some authors consider the natural and semisynthetic penicillins (amoxicillin) to be the options of first choice[20], others prefer the combination of amoxicillin and clavulanic acid owing to the increase in resistance to the penicillins and low level of bacterial resistance to this combination, with a broad-spectrum action, pharmacokinetic profile, tolerance and dosing characteristics[21].

Penicillinase-resistant penicillin or an ampicillin-like derivative is prescribed for infections caused by penicillinase-producing *Staphylococcus* spp. or those involving gram-negative bacteria. Patients allergic to penicillin are treated with clindamycin 300 mg (65%), which is the drug of choice, azithromycin (15%) or metronidazole-spiramycin combination (13%)[22]. Some authors have proposed clindamycin as the drug of choice in view of its good absorption, low incidence of bacterial resistance and the high antibiotic concentrations reached in bone[23]. The antibiotics useful for treating patients with odontogenic infections are listed in *Table 2*.

Table 2 Antibiotics commonly used to treat odontogenic infections

Antibiotic	Administration route	Posology
Amoxicillin	p.o.	500 mg/8 hours 1000 mg/12 hours
Amoxicillin/ clavulanic acid	p.o. or i.v.	500–875 mg/8 hours* 2000 mg/12 hours* 1000–2000 mg/8 hours†
Clindamycin	p.o. or i.v.	300 mg/8 hours* 600 mg/8 hours†
Azithromycin	p.o.	500 mg/24 hours, three consecutive days
Ciprofloxacin	p.o.	500 mg/12 hours
Metronidazole	p.o.	500–750 mg/8 hours
Gentamycin	i.m. or i.v.	240 mg/24 hours
Penicillin	i.m. or i.v.	1.2–2.4 million IU/24 h‡ Up to 24 million IU/24 hours†

i.m., intramuscular; i.v., intravenous; p.o., per os (oral).
*p.o. administration.
†i.v. administration.
‡i.m. administration.

Antibiotics for non-odontogenic infection

Non-odontogenic infections require prolonged treatment. Such infections include tuberculosis (TB), syphilis, leprosy and non-specific infections of the mucosal membranes, muscles and fascia, salivary glands and bone.

New synthetic antibiotics, such as fluoroquinolones, are the drug of choice for management of non-odontogenic infections and are indicated for bone and joint infections, genitourinary (GU) tract infections and respiratory tract infections and extend the bacterial spectrum to include gram-negative bacilli, gram-positive aerobic cocci and, in the case of third-generation fluoroquinolones (moxifloxacin), anaerobic organisms[24]. Bone and anaerobic infections are managed by prescribing clindamycin (orally) or lincomycin (parenterally)[25].

In the case of a primary oral tubercular lesion, an empirical treatment given for TB can cure the oral tubercular lesion, even in the absence of histopathological evidence[26]. The treatment of specific infections caused by mycobacteria requires the use of antibiotics for long periods of time (6 months to 2 years) and includes the administration of dapsone, clofazimine and rifampicin for leprosy, and associations of ethambutol, isoniazid, rifampicin, pyrazinamide and streptomycin for TB[27].

Prophylactic use of antibiotics

Prophylactic antibiotics, taken before a number of dental procedures, have been advocated (i) to reduce the likelihood of postoperative local complications (such as infections or dry socket) or serious systemic complications (such as infective endocarditis), (ii) in surgical excision of benign tumours and (iii) in immunocompromised patients.

Prophylaxis against systemic spread

The use of antibiotics as prophylaxis for focal infection is a common practice. Although the potential

exists for oral microorganisms to seed and infect distant tissues after oral procedures, there is no substantiated evidence that this occurs. Consequently, the issue of when and for what conditions systemic prophylactic antibiotics are necessary is controversial.

Infective endocarditis is an uncommon, but serious and often life-threatening, condition. Some studies have shown that dental procedures are trigger factors for few cases of endocarditis[28]. Lockhart reported an increased incidence of infective endocarditis following dental extraction and periodontal surgery[29]. Ottent *et al.* reported that bacteraemia was associated with 74% of patients following tooth extraction[30].

The American Heart Association (AHA) 2007 guideline[31] recommends infective endocarditis prophylaxis only for those whose underlying cardiac conditions are associated with the highest risk of an adverse outcome. Such conditions include: the presence of prosthetic heart valves; previous history of infective endocarditis; unrepaired cyanotic congenital heart disease; in the 6-month period following complete repair of a congenital heart defect with prosthetic material or a device; repaired congenital heart disease with residual defects or adjacent to the site of a prosthetic patch or device; and cardiac transplantation recipients who develop valvulopathy.

Even if all patients at risk of developing infective endocarditis were given antibiotic prophylaxis, it might only prevent 5.3% of cases[28]. There is a larger likelihood of bacteraemia related to normal daily activities than from dental procedures[32]; therefore, some argue that the era of antibiotic prophylaxis is over[33]. In the case of bacterial endocarditis (infective endocarditis), the absolute risk rate after dental treatment, even in at-risk patients, is considered very low[34]. This is consistent with recent guidelines from the British Society for Antimicrobial Chemotherapy[35], which recommended that only patients in the high-risk category require coverage with Antibiotics.

Recently, the AHA[36] has also provided the following new talking points for clinicians: infective endocarditis is much more likely to occur following frequent exposure to random bacteraemias associated with daily activities than from bacteraemia caused by a dental, GI tract or GU tract procedure; prophylaxis may prevent an exceedingly small number of cases of infective endocarditis, if any, in people who undergo a dental, GI tract or GU tract procedure; the risk of antibiotic-associated adverse events exceeds the benefit, if any, from prophylactic antibiotic therapy; and maintenance of optimal oral health and hygiene may reduce the incidence of bacteraemia from daily activities and is more important than prophylactic antibiotics for a dental procedure to reduce the risk of infective endocarditis.

Prophylaxis against local infection

Prophylaxis of local infection is taken to comprise the administration of antibiotics on a pre-, intra- or postoperative basis, to prevent the proliferation and dissemination of bacteria within and from the surgical wound. Various surgical procedures are routinely covered by administration of systemic antimicrobials, including impacted third molars, orthognathic surgery, implant surgery and periapical surgery.

The evidence for antibiotics acting to prevent infection of surgical wounds in the mouth is poor to non-existent, indicating that pre-operative parenteral antibiotic prophylaxis for routine third-molar surgery in medically fit patients is unwarranted[37]. For most dentoalveolar surgical procedures in fit, non-medically compromised patients, antibiotic prophylaxis is not required or recommended[35].

Immunocompromised patients represent a special category of patients for dental professionals because such patients are more prone to bacteraemia, which may rapidly lead to septicaemia. Therefore, antibiotic prophylaxis may be given in such cases. Antibiotic coverage is also mandatory in patients with uncontrolled diabetes, who have to undergo invasive dental treatment[38].

There is no scientific basis for recommending systemic antibiotic prophylaxis before invasive dental treatment in patients with total joint prostheses[39]. According to the American Dental Association and the American Academy of Orthopedic Surgeons, evaluation is required of antibiotic prophylaxis in patients with total joint prostheses in the presence of immune deficiency[40]. The use of antibiotics in endodontics should be indicated for those patients with signs of local infection and fever[41].

APPROPRIATE SELECTION OF ANTIBIOTIC: DOSAGE AND DURATION

Oral antibiotics that are effective against odontogenic infections include penicillin, clindamycin, erythromycin, cefadroxil, metronidazole and the tetracyclines[42]. The type of antibiotic chosen and its dosage are dependent on the severity of infection and the predominant type of causative bacteria.

The most commonly used antibiotics in dental practice, penicillins in general, were found to be the most commonly prescribed antibiotics by dentists[43]; the most popular antibiotic was amoxicillin[7], followed by penicillin V[10], metronidazole and the combination of amoxicillin and clavulanic acid[44].

Patients who are allergic to penicillin should benefit from clindamycin; which is active against some oral anaerobic and facultative bacteria and has the advantage of good bone penetration. However, increasing

the dose of this antibiotic may increase the possibility of serious side effects such as neutropenia and pseudomembranous colitis[45].

The ideal duration of antibiotic treatment is the shortest cycle capable of preventing both clinical and microbiological relapse. Most acute infections are resolved within 3–7 days. When oral antibiotics are used, a high dose should be considered to help achieve therapeutic levels more rapidly[46].

In recent years, more attention has been given to short courses of antibiotic. Rubenstein explained that short-course antibiotic therapy requires antibiotics to have certain characteristics, such as: rapid onset of action; bactericidal activity; lack of propensity to induce resistant mutants; ease of penetration into tissues; activity against non-dividing bacteria; unaffected by adverse infection conditions (low pH, anaerobiasis, presence of pus, etc.); administration at an optimal dose; and an optimal dosing regimen[47].

CONDITIONS NOT WARRANTING/ CONTRAINDICATIONS FOR THE USE OF ANTIBIOTICS

Consideration for antibiotic prophylaxis should be given in patients with kidney and/or liver failure and in pregnant or lactating mothers (as antibiotics may have an indirect effect on their infants). Dose adjustments are required for dental procedures in patients with kidney failure to avoid an increased plasma concentration of the drug. Almost all antibiotics, except cloxacillin, clindamycin, metronidazole and macrolides, require dose modification in patients with renal insufficiency[48]. Dose adjustment can be carried out by reducing the amount administered in each dose or by increasing the interval between doses (without modifying the amount of drug)[49].

Patients with liver failure require a dose reduction of erythromycin, clindamycin, metronidazole and anti-tuberculosis drugs. Oral zinc supplementation is effective in hepatic encephalopathy and consequently improves patients' health-related quality of life[50].

Almost all antibiotics are contraindicated during pregnancy as a result of their major side effects. Risk of having a spontaneous abortion during the early pregnancy are associated with gestational use of diclofenac, naproxen, celecoxib, ibuprofen and rofecoxib, alone or in combination[51].

In general, all antibiotics can cause three potential problems for nursing infants. First, they can modify the bowel flora and alter gut defence mechanisms; this can result in diarrhoea and malabsorption of nutrients. Second, they may have direct effects that may or may not be dose related. Lastly, and often ignored, is that antibiotics can alter and interfere with microbiological culture, resulting in babies being investigated for sepsis[52].

DISCUSSION AND CONCLUSION

Antibiotic therapy is mandatory and essential in medicine and dentistry. Dentists are not always aware of the most current clinical guidelines regarding antibiotic prophylaxis, even though guidelines are available. This is the reason for the empirical prescription of antibiotics and the adverse consequences of antibiotic use. Antibiotic use may be associated with unfavourable side effects, ranging from gastrointestinal disturbances to fatal anaphylactic shock and development of anti-microbial resistance. Minimising the occurrence of antibiotic misuse and abuse has global implications for the containment of antibiotic-resistant strains of bacteria.

Development of resistance to drugs by microbes is a natural phenomenon but is enhanced by the inappropriate use of antimicrobials. A few strains that are naturally resistant and those with acquired resistance emerge as the dominant forms as a result of the selective pressure exerted following exposure to antimicrobials[53]. The antibiotic sensitivity of the bacteria found within the oral cavity is gradually decreasing, and a growing number of resistant strains have been detected – particularly *Porphyromonas* and *Prevotella*[54] – although the phenomenon has also been reported for *Streptoccocus viridans* and for drugs such as the macrolides, penicillin and clindamycin[55]. Resistance has been reported against all beta-lactam antibiotics (including penicillin derivatives and cephalosporins), clindamycin, ciprofloxacin, erythromycin and tetracycline[56].

The proper use of antibiotics is related to the principles of infection management, microbiology of infectious agent and host response, and the pharmacology of the particular agent. In the clinical setting, these principles are modulated by a number of factors. These factors need to be understood to ensure appropriate prescribing of antibiotics.

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Conflicts of interest

None declared.

REFERENCES

1. Dajani AS, Taubert KA, Wilson W *et al*. Prevention of bacterial endocarditis: recommendations of American heart association. *J Am Dent Assoc* 1997 277: 1794–1801.

2. Fine DH, Hammond BF, Loesche WJ. Clinical use of antibiotics in dental practice. *Int J Antimicrob Agents* 1998 9: 235–238.
3. Dar-Odeh N, Ryalat S, Shayyab M *et al.* Analysis of clinical records of dental patients attending Jordan University Hospital: documentation of drug prescriptions and local anesthetic injections. *Ther Clin Risk Manag* 2008 4: 1111–1117.
4. Lewis MA. Why we must reduce dental prescription of antibiotics: European Union Antibiotic Awareness Day. *Br Dent J* 2008 205: 537–538.
5. Vallano A, Izarra A. Principios de terapéutica antimicrobiana. *Medicine* 2006 9: 3196–3203. doi:10.1016/S0211-3449(06) 74153-4.
6. Wise R, Hart T, Cars O *et al.* Antimicrobial resistance is a major threat to public health. *BMJ* 1998 317: 609–610.
7. Palmer NO, Martin MV, Pealing R *et al.* An analysis of antibiotic prescriptions from general dental practitioners in England. *J Antimicrob Chemother* 2000 46: 1033–1035.
8. Palmer NO, Martin MV, Pealing R *et al.* Paediatric antibiotic prescribing by general dental practitioners in England. *Int J Paediatr Dent* 2001 11: 242–248.
9. Addy M, Martin MV. Systemic antimicrobials in the treatment of chronic periodontal diseases: a dilemma. *Oral Dis* 2003 9: 38–44.
10. Demirbas F, Gjermo PE, Preus HR. Antibiotic prescribing practices among Norwegian dentists. *Acta Odontol Scand* 2006 64: 355–359.
11. Epstein JB, Chong S, Le ND. A survey of antibiotic use in dentistry. *J Am Dent Assoc* 2000 131: 1600–1609.
12. Jaunay T, Sambrook P, Goss A. Antibiotic prescribing practices by South Australian general dental practitioners. *Aust Dent J* 2000 45: 179–186.
13. Nelson CL, Van Blaricum CS. Physician and dentist compliance with American Heart Association guidelines for prevention of bacterial endocarditis. *J Am Dent Assoc* 1989 118: 169–173.
14. Tong DC, Rothwell BR. Antibiotic prophylaxis in dentistry: a review and practice recommendations. *J Am Dent Assoc* 2000 131: 366–374.
15. Liébana-Ureña J, González MP, Liébana MJ *et al.* Composición y ecología de la microbiota oral. In: Liébana-Ureña J, editor. *Microbiología Oral*. Madrid: McGraw-Hill; 2002. p. 514–525.
16. Brook I. Microbiology and management of endodontic infections in children. *J Pediatr Dent* 2003 28: 13–18.
17. Henry M, Al R, Beck M. Effect of Penicillin in postoperative endodontic pain and swelling in symptomatic necrotic teeth. *J Endod* 2001 27: 117–123.
18. Salako N, Rotimi VO, Adib SM *et al.* Pattern of antibiotic prescription in the management of oral diseases among dentists in Kuwait. *J Dent* 2004 32: 503–509.
19. Swift JQ, Gulden WS. Antibiotic therapy – managing odontogenic infections. *Dent Clin North Am* 2002 46: 623–633.
20. Berini L, Gay C. Normas generales de tratamiento de la infección odontogénica. Antibioticoterapia. Profilaxis de las infecciones postquirúrgicas y a distancia. In: Gay C, Berini L, editors. *Tratado de Cirugía Bucal. Tomo I*. Madrid: Ergón; 2004. p. 617–638.
21. Maestre-Vera JR. Opciones terapéuticas en la infección de origen odontogénico. *Med Oral Patol Oral Cir Bucal* 2004 9: 19–31.
22. Sequra-Eqea JJ, Velasco-Ortega E, Torres-Logares D *et al.* Pattern of antibiotic prescription in the management of endodontic infections amongst Spanish oral surgeons. *Int Endod J* 2010 43: 342–350.
23. Kirkwood KL. Update on antibiotics used to treat orofacial infections. *Alpha Omegan* 2003 96: 28–34.
24. Parra J, Peña A, Martínez MA *et al.* Quinolonas, sulfamidas, trmetoprima, cotrimoxazol. *Medicine* 2006 9: 3538–3543. doi:10.1016/S0211-3449(06)74213-8.
25. Bystedt H, Dahlback A, Dornbusch K *et al.* Concentrations of azidocillin, erythromycin, doxycycline and clindamycin in human mandibular bone. *Int J Oral Surg* 1978 7: 442–449.
26. Selvamuthukumar SC, Aswath N, Anand V. Pattern of oral lesions in tuberculosis patients: a cross-sectional study. *J Indian Acad Oral Med Radiol* 2011 23: 199–203.
27. Ramu C, Padmanabhan TV. Indications of antibiotic prophylaxis in dental practice- Review. *Asian Pac J Trop Biomed* 2012 2: 749–754.
28. Vander Meer JT, Thompson J, Valkenburg HA *et al.* Epidemiology of bacterial endocarditis in the Netherlands II antecedent procedures and uses of prophylaxis. *Arch Intern Med* 1992 152: 1869–1873.
29. Lockhart PB. An analysis of bacteremias during dental extraction. A double-blind placebo-controlled study of chlorhexidine. *Arch Intern Med* 1996 156: 513–520.
30. Otten JE, Pelz K, Christmann G. Anaerobic bacteremia following tooth extraction and removal of osteosynthesis plates. *J Oral Maxillofac Surg* 1987 45: 477–480.
31. American Academy of Pediatric Dentistry. Guideline on use of antibiotic therapy for patients at risk of infection: American Academy of Pediatric Dentistry (AAPD). (2007).
32. Danchin N, Duval X, Leport C. Prophylaxis of infective endocarditis: French recommendations 2002. *Heart* 2005 91: 715–718.
33. Pallasch TJ. Antibiotic prophylaxis: problems in paradise. *Dent Clin North Am* 2003 47: 665–679.
34. Pallasch TJ. Antibiotic resistance. *Dent Clin North Am* 2003 47: 623–639.
35. Lawler B, Sambrook PJ, Goss AN. Antibiotic prophylaxis for dentoalveolar surgery: is it indicated? *Aust Dent J* 2005 50: S54–S59.
36. Farbod F, Kanaan H, Farbod J. Infective endocarditis and antibiotic prophylaxis prior to dental/oral procedures: latest revision to the guidelines by the American Heart Association published April 2007. *Int J Oral Maxillofac Surg* 2009 38: 626–631.
37. Thomas DW, Hill CM. An audit of antibiotic prescribing in third molar surgery. *Br J Oral Maxillofac Surg* 1997 35: 126–128.
38. Ali D, Kunzci C. Diabetes Mellitus: update and relevance for dentistry. *Dent Today* 2011 12: 45–50.
39. Pallasch TJ, Slots J. Antibiotic prophylaxis and the medically compromised patient. *Periodontol* 2000 1996: 107–138.
40. American Dental Association; American Academy of Orthopedic Surgeons. Antibiotic prophylaxis for dental patients with total joint replacements. *J Am Dent Assoc* 2003 134: 895–899.
41. Abbott PV, Hume WR, Pearrmar JW. Antibiotics and endodontics. *Aust Dent J* 1990 35: 50–60.
42. Peterson LJ. Antibiotics for oral and maxillofacial infections. In: Newman MG, Kornman KS, editors. *Antibiotic/Antimicrobial Use in Dental Practice*. St. Louis, Mo: Mosby; 1990. p. 159–171.
43. Al-Mubarak S, Al-Nowaiser A, Rass MA *et al.* Antibiotic prescription and dental practice within Saudi Arabia; the need to reinforce guidelines and implement specialty needs. *J Int Acad Periodontol* 2004 6: 47–55.
44. Kuriyama T, Absi EG, Williams DW *et al.* An outcome audit of the treatment of acute dentoalveolar infection: impact of penicillin resistance. *Br Dent J* 2005 198: 759–763.
45. Trexler MF, Fraser TG, Jones MP. Fulminant pseudomembranous colitis caused by clindamycin phosphate vaginal cream. *Am J Gastroenterol* 1997 92: 2112–2113.

46. Leekha S, Terrell CL, Edson RS. General principles of antimicrobial therapy. *Mayo Clin Proc* 2011 86: 156–167.

47. Rubinstein E. Short antibiotic treatment courses or how short is short? *Int J Antimicrob Agents* 2007 30: S76–S79.

48. Kappel J, Calissi P. Nephrology: 3. Safe drug prescribing for patients with renal insufficiency. *CMAJ* 2002 166: 473–477.

49. Livornese LL Jr, Slavin D, Gilbert B *et al.* Use of antibacterial agents in renal failure. *Infect Dis Clin North Am* 2009 23: 899–924.

50. Ioannidou E, Shaqman M, Burleson J *et al.* Periodontitis case definition affects the association with renal function in kidney transplant recipients. *Oral Dis* 2010 16: 636–642.

51. Haas DA, Pynn BR, Sands TD. Drug use for the pregnant and lactating patient. *Gen Dent* 2000 48: 54–60.

52. Mathew J. Effect of maternal antibiotics on breast feeding infants. *Postgrad Med J* 2004 80: 196–200.

53. American Academy of Microbiology. Antibiotic Resistance: An Ecological Perspective on an Old Problem. A report from the American academy of microbiology. (2009). Available from: http://academy.asm.org/images/stories/documents/antibioticresistance.pdf. Accessed 26 February 2014.

54. Brescó-Salinas M, Costa-Riu N, Berini-Aytés L *et al.* Antibiotic susceptibility of the bacteria causing odontogenic infections. *Med Oral Patol Oral Cir Bucal* 2006 11: E70–E75.

55. Aracil B, Minambres M, Oteo J *et al.* High prevalence of erythromycin-resistant and clindamycin-susceptible (M phenotype) viridans group streptococci from pharyngeal samples: a reservoir of mef genes in commensal bacteria. *J Antimicrob Chemother* 2001 48: 592–594.

56. Ready D, Bedi R, Spratt DA *et al.* Prevalence, proportions, and identities of antibiotic-resistant bacteria in the oral microflora of healthy children. *Microb Drug Resist* 2003 9: 367–372.

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