Acta Odontologica Scandinavica, 2013; 71: 518–524

informa
healthcare

ORIGINAL ARTICLE

Odontogenic infections: An 8-year epidemiologic analysis in a dental emergency outpatient care unit

GEORG CACHOVAN[1]*, JIN-HO PHARK[2]*, GERHARD SCHÖN[3], PHILIPP POHLENZ[4] & URSULA PLATZER[1]

[1]*Center for Oral and Dental Medicine, Department of Restorative and Preventive Dentistry, University Medical Center Hamburg-Eppendorf, Hamburg, Germany,* [2]*Division of Restorative Sciences, Herman Ostrow School of Dentistry of USC, University of Southern California, Los Angeles, CA, USA,* [3]*Department of Medical Biometry and Epidemiology, and* [4]*Department of Oral and Maxillofacial Surgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany*

Abstract

Objectives. The purpose of this investigation was to analyze epidemiological patterns, clinical features and the management of odontogenic infections in patients undergoing treatment in a dental emergency outpatient care unit. ***Study design.*** A retrospective analysis of 58 161 case records of patients presenting to an emergency outpatient unit in Hamburg, Germany between 2000–2007 was performed. From this pool, patients with odontogenic infections were identified using an ICD-10 code, analyzing age, gender, medical co-morbidities, duration of pain, ratio of infiltrates/abscesses, affected teeth, management of infection and administered antibiotics. ***Results.*** Of the 58 161 patients, 5357 (9.2%) were identified as having odontogenic infections, with 2689 (50.2%) inflammatory infiltrates and 2668 (49.8%) abscesses. Mean age was 34.8 ± 16.8 years. As the primary site of odontogenic infection, the most significantly affected teeth were the maxillary and mandibular first molars. Patients in age-group 20–29 years (25.1%) utilized the emergency care unit more frequently than other age groups. Clindamycin was the most frequently administered antibiotic. ***Conclusions.*** Early recognition, diagnosis and management of odontogenic infections are requisite for avoiding or minimizing the development of potential complications. Strategies and evidence-based protocols should be developed within the dental ambulatory care sector, advancing interdisciplinary cooperation between general dentists and oral or maxillofacial surgeons.

Key Words: *risk factors, complications, antibiotics, management of infection*

Introduction

Infections of the oral and maxillofacial region often are of odontogenic origin caused by a polymicrobial flora of aerobic, facultatively anaerobic and anaerobic bacteria [1–3] and represent a significant problem, which requires emergency dental treatment when they are running an acute course.

Outside the dentists' regular consulting hours, the treatment of odontogenic infections is effected by emergency dental care. Emergency outpatient care units are the gateway between ambulatory and hospital settings, where patients are screened by dental practitioners before being referred to specialists or hospitals if necessary. The attending dentist must be familiar with odontogenic infections to reach a correct diagnosis [4], to initiate appropriate pain management [2,5], as well as to advise further treatment or referral. However, inappropriate referral should be avoided [6].

There are important differences in the features of odontogenic infections between hospitalized and non-hospitalized patients [7]. Unfortunately, diagnostic errors can result in multiple surgical excisions, long-term anti-infective therapy, even a fatal outcome, and increased healthcare costs, once they

Correspondence: Jin-Ho Phark, Division of Restorative Sciences, Herman Ostrow School of Dentistry of USC, University of Southern California, 925 W 34th Street, DEN 4112, Los Angeles, CA 90089-0641, USA. Tel: +1 213 740 5868. Fax: +1 213 740 7295. E-mail: phark@usc.edu
*Both authors contributed equally to the manuscript.

(Received 24 January 2012; revised 14 March 2012; accepted 13 April 2012)

ISSN 0001-6357 print/ISSN 1502-3850 online
DOI: 10.3109/00016357.2012.696694

require hospitalization. Because of an increasing incidence of odontogenic infections [2,7–9], this is of utmost importance.

Surveys are essential to obtain etiologic and epidemiologic data about odontogenic infections and achieve information about their prognosis and management in order to avoid or reduce hospitalization. To our knowledge, there are no data on the frequency of odontogenic infections in an outpatient emergency dental care setting. All previous published investigations on odontogenic infections include only small numbers of patients and only refer to hospitalized patients [2,10–14].

Therefore, the aim of this investigation was to assess epidemiologic data and to evaluate clinical features, as well as risk and predisposing factors of odontogenic infections in 58 000 patients of an after-hours dental emergency outpatient care unit. This investigation is to be regarded as a status quo with the intent of performing a prospective study to determine dentists' knowledge of emergency management of odontogenic infections and to help design more effective protocols for interdisciplinary cooperation between general dental practitioners and oral/maxillofacial surgeons.

Materials and methods

A total of 58 161 patients required emergency dental treatment at the outpatient care unit of the University Medical Center Hamburg-Eppendorf during the 8-year study period between January 2000 and December 2007. The unit is comparable to a general dental practice, with the difference that it operates only between 7 pm and 2 am. Among these patients, 5357 (9.2%) suffered from odontogenic infections. They were identified by hand search of the patient files on the basis of the International Classification of Disease, revision 10 (ICD-10) [8], using codes associated with odontogenic infections (K04.–K05.). This permitted diagnoses of infiltrates and abscesses and enabled prescription and treatment modalities. The dental records of these 5357 patients were reviewed and analyzed. The following data were recorded: gender, age, ratio of infiltrates/abscesses, underlying (systemic) diseases, duration of pain, affected teeth, surgical management of the infection, antibiotic therapy, allergies to antibiotics and referrals.

All dentists who participated in this study were calibrated, had at least 3 years of professional experience and collected data including demographic information, pain description and duration and past medical history using a standardized questionnaire. Diagnostic tests for dental and periodontal assessments, e.g. cold bite sticks, percussion and radiographic findings according to Brennan et al. [5] were done.

The collected data were entered into a computer database (Microsoft Excel, Version 2002, Microsoft, Unterschleissheim, Germany). The statistical analysis was carried out by the statistical package R (R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org). We created frequency tables and cross-tabulation for depiction of categorical characteristics and means, medians and ranges for quantitative variables.

To perform tests about differences in means, we used pairwise *t*-tests with equal variances for independent samples. Tests about differences in fractions

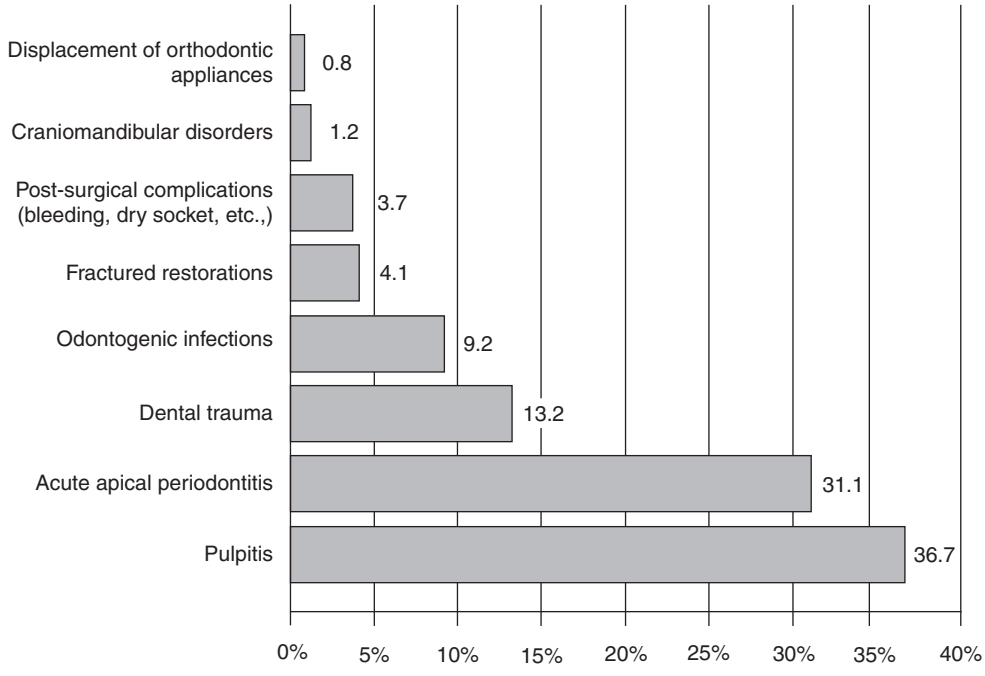

Figure 1. Reasons for emergency dental treatment.

Table I. Age by disease and gender distribution.

	Infiltrate		Abscess		Female		Male	
Age	*n*	%	*n*	%	*n*	%	*n*	%
0–9	236	8.8	248	9.3	207	8.9	277	9.1
10–19	227	8.4	212	8.0	230	9.9	209	6.9
20–29	707	26.3	635	23.8	615	26.5	727	24.0
30–39	592	22.0	559	21.0	424	18.3	727	24.0
40–49	419	15.6	470	17.6	356	15.3	533	17.6
50–59	285	10.6	331	12.4	268	11.5	348	11.5
60–69	158	5.9	153	5.7	151	6.5	160	5.3
70–79	50	1.9	42	1.6	52	2.2	40	1.3
80–89	12	0.4	14	0.5	18	0.8	8	0.3
90–99	1	0.0	1	0.0	0	0.0	2	0.1
Total	2687	100.0	2665	100.0	2321	100.0	3031	100.0

of categorical variables were performed with χ^2-tests. All tests were conducted at a significance level of $\alpha = 0.05$; we controlled for multiple testing by Bonferroni correction.

Results

After reviewing all 58 161 records, 5357 patients (9.2%) were identified as having had an odontogenic infection within the 8-year interval. Other reasons for emergency visits are shown in Figure 1. The characteristics of patients with odontogenic infections are presented in Tables I-V. Those who had inflammatory infiltrates numbered 2689 (50.2%) and the number of patients suffering from abscesses was 2668 (49.8%). There were 3033 males, of whom 1420 (46.8%) had an infiltrate and 1613 (53.2%) an abscess. A total of 2324 females was included in the study, 1269 (54.6%) suffering from an infiltrate and 1055 (45.4%) from an abscess. The male-to-female ratio was 1.3:1. The mean age of all patients with odontogenic infections was 34.8 years (SD = 16.8). The mean age of those who had infiltrates was 34.5 years (SD = 16.7) and in the abscess group 35.1 years (SD = 16.9). The majority of the patients were adults. The age distribution of patients in relation to odontogenic infections and gender, respectively, are shown in Table I. The highest incidence was in the age group 20–29 years, followed by the 30–39 years group. The epidemiologic data of five patients were not recorded and declared missing.

Table II. Concomitant diseases.

	Infiltrate		Abscess	
	n	%	*n*	%
None	1853	58.6	1828	57.8
Cardiovascular diseases	281	8.9	263	8.3
Neurological diseases	209	6.6	180	5.7
Respiratory tract diseases	184	5.8	184	5.8
Gastrointestinal diseases	107	3.4	106	3.4
Thyroidal diseases	102	3.2	97	3.1
Alcohol abuse	72	2.3	106	3.4
Diabetes mellitus	61	1.9	80	2.5
Dermatological diseases	64	2.0	67	2.1
Diseases of the locomotor system	58	1.8	52	1.6
Hepatic diseases	41	1.3	63	2.0
Ophthalmological diseases	44	1.4	44	1.4
Drug abuse	35	1.1	37	1.2
Haematopoetic diseases	31	1.0	27	0.9
Venereal diseases	14	0.4	13	0.4
HIV infection	2	0.1	9	0.3
Tuberculosis	2	0.1	5	0.2
Total	3160	100.0	3161	100.0

The medical co-morbidities are presented in Table II. Cardiovascular diseases, neurological disorders and diseases of the respiratory tract were predominant. Most of the reviewed odontogenic infections were of endodontic origin, with 80.6% within the infiltrate group and 63.9% within the abscess group. With regard to all affected permanent teeth of the upper and lower jaw, the most common infection site was the first molars (25.7%), followed by the third molars at 17.6% (Table III). There were statistically significant differences between the permanent first molars and other teeth ($p < 0.001$). In children, it is the molars that most frequently are infected.

Infection management was performed either surgically or non-surgically. In 3701 (69.1%) out of all 5357 cases, no surgical intervention was performed. From the 2689 patients within the infiltrate group, 77 patients (2.9%) were surgically managed with an incision and 15 (0.6%) with an extraction. Within the 2668 patients with abscesses, 1548 patients (58.0%)

Table III. Affected permanent and primary teeth.

Rank	Permanent teeth	*n*	%	Primary teeth	*n*	%
1.	First molars	1413	25.7	Second molars	252	43.5
2.	Third molars	968	17.6	First molars	234	40.4
3.	Second premolars	743	13.5	Central incisors	45	7.8
4.	Second molars	688	12.5	Canines	35	6.0
5.	First premolars	551	10.0	Lateral incisors	13	2.2
6.	Canines	501	9.1			
7.	Central incisors	319	5.8			
8.	Lateral incisors	316	5.7			
	Total	5499	100.0	Total	579	100.0

were treated with incisions and 16 (0.6%) with extractions. In cases where oral antibiotic intervention was necessary one of the antibiotics listed in Table IV was prescribed. From the 1656 patients who were treated surgically, 27.2% received a combined surgical and anti-infective therapy. Clindamycin was the most frequently administered antibiotic ($p < 0.001$). Among the 5357 patients, 5131 (96.18%) reported not being allergic to antibiotics. Among the few allergic patients, 3.82% were allergic to penicillin, 0.18% to sulfonamides, 0.16% to clindamycin, 0.07% to erythromycin, 0.07% to tetracycline and 0.01% to cephalosporin. In seven cases multiple allergies were reported. No adverse effects of antibiotic treatment were reported. After admission to emergency dental care, the patients were referred to various practitioners or specialists (Table V).

Table IV. Anti-infective therapy.

	Infiltrate		Abscess	
	n	%	*n*	%
Clindamycin	1848	68.7	1349	50.6
None	524	19.5	1121	42.0
Erythromycin	190	7.1	132	4.9
Penicillin	111	4.1	59	2.2
Amoxicillin + clavulanic acid	11	0.4	3	0.1
Doxycycline	0	0.0	3	0.1
Cephalosporin	3	0.1	0	0.0
Roxithromycin	1	0.0	0	0.0
Metronidazole	1	0.0	0	0.0
Ciprofloxacin	0	0.0	1	0.0
Sulfonamides	0	0.0	0	0.0
Tetracycline	0	0.0	0	0.0
Total	2689	100.0	2668	100.0

Table V. Referrals after emergency treatment.

Rank	Practice/institution	*n*	%
1.	General dentist	4196	78.3
2.	Maxillo-facial/oral surgery	927	17.3
3.	Outpatient department	233	4.4
4.	Otolaryngological practice	1	0.0
	Total	5357	100.0

Discussion

In this 8-year retrospective study, we observed that among patients who visited an outpatient emergency dental care facility during the evening and night hours, 9.2% suffered from odontogenic infections. For our study, it is possible that there was an accumulation of patients with odontogenic infections, because there was no other institution available for treatment of dental emergency cases between 7 pm and 2 am citywide. Other than this probability, there are no obvious correlations with other factors, such as temperature or atmospheric pressure [15], on the severity of odontogenic infections. The influence of other meteorological parameters, moon phases, diurnal influences or holidays has not been investigated yet and will be the subject of further research. The majority of the German population has access to dental healthcare through a mandatory health insurance. About 90% of the population is insured with statutory health insurance, whereas the rest mostly have private health insurance policies [16]. Therefore, this study might give a fairly representative picture of odontogenic infections in an ambulatory setting.

The total number of infiltrates (50.2%) and abscesses (49.8%) in our study is similar. Patients often consult emergency dental care at an early stage of inflammation. Therefore, it is not surprising that cases of infiltrates and abscesses overall are balanced. While Wang et al. [14] reported a predominant involvement of males in general, our data only showed significantly higher involvement of males in the abscess group. A possible reason for this observation might be that men were reported to have poorer health than women, to have lower engagement in preventive healthcare visits and to attend medical institutions only in urgent cases of illness [17].

Most of the odontogenic infections were of endodontic origin, followed by periodontitis and pericoronitis as the causative factors, matching the results of other studies [2,18]. Infection of odontogenic origin predominated in lower molars, which is consistent with other reports [2,12]. Sato et al. [2] found that in many cases affected lower molars were associated with perforation of the vestibular cortical bone. The source of infection in children most often was the deciduous posterior teeth. This finding correlates with those of Lin and Lu [11].

The patients' medical history of underlying systemic diseases has shown that cardiovascular disorders are predominant, which is in accord with Kim et al. [19]. The increasing number of neurological disorders we observed in our study has also been described in detail by Seppänen et al. [8]. Particularly patients with underlying diseases, e.g. atherosclerosis, cardiovascular diseases, neurological disorders, diabetes mellitus and risk factors such as alcohol abuse are predisposed to odontogenic infections [18,20,21]. Therefore, the presence of potential risk factors needs to be assessed [22]. In contrast, HIV-positives do not have an increased risk for developing serious odontogenic infections despite their immunodeficiency [23], although they have a significant hospital course compared to virus-negative patients [24]. In addition to systemic diseases, local factors in the oral cavity can contribute to the severity of an odontogenic infection. Besides poor oral health [25] and the type of microbial flora [26], preceding dental treatment is a risk factor as well [25]. Using the measurement of serum C-reactive protein, Seppänen et al. [25] found that all types of preceding dental treatment contributed to a less severe course of infection, while the response to an infection was strongest and the course of an infection was more severe if the patient had not received any dental or antimicrobial treatment in the recent past.

When surgical management was required, incision and drainage (30.3%) were the first-line treatment for all patients, followed by extraction (0.6%); 3701 patients (69.1%) were not treated surgically. Antibiotics were administered as single or adjunctive therapy to surgical intervention. Scutari and Dodson [12] reported on treatment in adolescents where antibiotics alone were prescribed in 46% of cases. In cases where pus was not apparent, the treatment was antimicrobial alone [18]. Antimicrobial therapy is indicated when the infection has perforated the bone cortex, spread into the surrounding tissue and when there are clear signs of systemic involvement [1]. Signs of spreading inflammation, such as pyrexia, lymphadenopathy, difficulty in swallowing and lockjaw [11], must be seen as indicators of the necessity for referral of patients to hospitals. Antibiotics should not be prescribed routinely but rather when certain risk factors are present [21,22]. In cases of endocardial problems in the patient, antibiotic prophylaxis is recommended [27].

Clindamycin was the most administered antibiotic in our study ($p < 0.001$) and in those in the literature. It has been reported to yield high bone concentrations [28] and is regarded by some authors as a first-line antimicrobial for the treatment of odontogenic infections [1,29–31]. During the study our departmental guidelines also regarded clindamycin as a first-line antibiotic. However, the role of clindamycin as a first-line antibiotic is not unquestioned and it is regarded by some authors as an alternative for penicillin or ampicillin-allergic patients, as well as cephalexin or azithromycin [32,33]. Several studies reported inappropriate antibiotic prescription patterns, emphasizing the necessity for clear guidelines and continuing education [34–38]. However, in this investigation emergency dentists had an appropriate level of knowledge about prescription of antibiotics due to calibration and a continuing education program. Anti-infective agents other than first-line antibiotics (Table IV) were given in this study, based on the patient's medical history, in cases of known intolerance, allergies or history of ineffective antibiotic therapy. No microbial analysis was performed in this emergency setting.

A retrospective study has some major disadvantages regarding bias in the medical records, e.g. Berkson's bias or Neyman's bias. The data rely on accuracy of written records or recall of individuals (recall bias). Important data may not be available [39]. Declarations by patients about prior anti-infective therapy or newly prescribed antibiotics often were imprecise. Therefore, these data were not evaluated. Allergies to medication often are incompletely documented in dental records, as are co-morbidities. Nonetheless, the rate of allergy in this study was comparable to other reports [40,41].

In most cases, the treated patients were advised to consult a general dentist (78.3%), whereas 17.3% of the patients needed to be admitted for oral/maxillofacial surgery. Although the majority of cases of odontogenic infections can easily be managed with analgesia, anti-infective therapy and an appropriate treatment by a general dentist or oral/maxillo-facial surgeon, the emergency dentist should be familiar with the management of more serious odontogenic infections. Since less-experienced dentists tend to refer patients more readily, calibration, continuing education and skill enhancement is necessary to avoid inappropriate referrals [6], which put an unnecessary burden on oral and maxillofacial surgeons.

Early recognition, diagnosis and management of dental infections, especially in emergency care situations, are requisite to avoid or minimize complications and to reduce healthcare costs [42]. The general dentist is responsible for a proper management of minor to moderate odontogenic infections. For serious cases, immediate referral to an oral or maxillofacial surgeon is advised in order to prevent potentially life-threatening consequences. This can be achieved by intensive teamwork between dentists and oral/maxillofacial surgeons located close to one another and easily obtainable for inquiries, as was the case in this study. Furthermore, there is a need to develop standard protocols and guidelines for the appropriate use of antibiotics and the management of odontogenic infections. These guidelines should be based on etiology and epidemiologic data, as well as on risk factors and the microbiological spectrum. They should also

use serum diagnostic and modern digital radiographic imaging to determine the severity of odontogenic infections in order to allow a precise determination of the optimal treatment options.

Acknowledgments

We thank Thomas Spitzer, Sheffield, UK, and Bernard Tandler, Department of Oral Biology and Medicine, School of Dentistry, Case Western Reserve University, Cleveland, USA, for editorial assistance, and Michael Supplieth, Department of Medical Biometry and Epidemiology, University Medical Center Hamburg-Eppendorf, Germany, for additional data management advice.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Dirks SJ, Terezhalmy GT. The patient with an odontogenic infection. Quintessence Int 2004;35:482–502.

[2] Sato FR, Hajala FA, Freire Filho FW, Moreira RW, de Moraes M. Eight-year retrospective study of odontogenic origin infections in a postgraduation program on oral and maxillofacial surgery. J Oral Maxillofac Surg 2009;67:1092–7.

[3] Sobottka I, Cachovan G, Stürenburg E, Ahlers MO, Laufs R, Platzer U, et al. *In vitro* activity of moxifloxacin against bacteria isolated from odontogenic abscesses. Antimicrob Agents Chemother 2002;46:4019–21.

[4] Ferrera PC, Busino LJ, Snyder HS. Uncommon complications of odontogenic infections. Am J Emerg Med 1996;14: 317–22.

[5] Brennan MT, Runyon MS, Batts JJ, Fox PC, Kent ML, Cox TL, et al. Odontogenic signs and symptoms as predictors of odontogenic infection: a clinical trial. J Am Dent Assoc 2006;137:62–6.

[6] Absi EG, Satterthwaite J, Shepherd JP, Thomas DW. The appropriateness of referral of medically compromised dental patients to hospital. Br J Oral Maxillofac Surg 1997; 35:133–6.

[7] Hwang T, Antoun JS, Lee KH. Features of odontogenic infections in hospitalised and non-hospitalised settings. Emerg Med J 2011;28:766–9.

[8] Seppänen L, Rautemaa R, Lindqvist C, Lauhio A. Changing clinical features of odontogenic maxillofacial infections. Clin Oral Investig 2010;14:459–65.

[9] Burnham R, Bhandari R, Bridle C. Changes in admission rates for spreading odontogenic infection resulting from changes in government policy about the dental schedule and remunerations. Br J Oral Maxillofac Surg 2011;49:26–8.

[10] Dodson TB, Perrott DH, Kaban LB. Pediatric maxillofacial infections: a retrospective study of 113 patients. J Oral Maxillofac Surg 1989;47:327–30.

[11] Lin YT, Lu PW. Retrospective study of pediatric facial cellulitis of odontogenic origin. Pediatr Infect Dis J 2006;25:339–42.

[12] Scutari P Jr, Dodson TB. Epidemiologic review of pediatric and adult maxillofacial infections in hospitalized patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1996;81:270–4.

[13] Seppänen L, Lauhio A, Lindqvist C, Suuronen R, Rautemaa R. Analysis of systemic and local odontogenic infection complications requiring hospital care. J Infect 2008;57:116–22.

[14] Wang J, Ahani A, Pogrel MA. A five-year retrospective study of odontogenic maxillofacial infections in a large urban public hospital. Int J Oral Maxillofac Surg 2005;34:646–9.

[15] Meningaud JP, Roudot-Thoraval F, Bertrand JC, Guilbert F. Do temperature and atmospheric pressure affect the incidence of serious odontogenic infection? Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:272–5.

[16] Wörz M, Busse R. Analysing the impact of health-care system change in the EU member states-Germany. Health Econ 2005;14(Suppl):133–49.

[17] Williams DR. The health of men: structured inequalities and opportunities. Am J Public Health 2003;93:724–31.

[18] Rahman Z, Hamimah H, Bunyarit S. Clinical patterns of orofacial infections. Ann Dentist Univ Malaya 2005;12: 18–23.

[19] Kim J, Chung W, Now H, Jang S, Yoo J, Han S, et al. A clinical study on the care of odontogenic infections in the patients with major bleeding disorders. J Korean Ass Oral Maxillofac Surg 2003;29:330–7.

[20] Peters ES, Fong B, Wormuth DW, Sonis ST. Risk factors affecting hospital length of stay in patients with odontogenic maxillofacial infections. J Oral Maxillofac Surg 1996;54: 1386–91; discussion 91–2.

[21] Riggio MP, Aga H, Murray CA, Jackson MS, Lennon A, Hammersley N, et al. Identification of bacteria associated with spreading odontogenic infections by 16S rRNA gene sequencing. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 103:610–17.

[22] Sancho-Puchades M, Herraez-Vilas JM, Berini-Aytes L, Gay-Escoda C. Antibiotic prophylaxis to prevent local infection in Oral Surgery: use or abuse? Med Oral Patol Oral Cir Bucal 2009;14:E28–33.

[23] Miller EJ Jr, Dodson TB. The risk of serious odontogenic infections in HIV-positive patients: a pilot study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;86:406–9.

[24] Carey JW, Dodson TB. Hospital course of HIV-positive patients with odontogenic infections. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;91:23–7.

[25] Seppänen L, Lemberg KK, Lauhio A, Lindqvist C, Rautemaa R. Is dental treatment of an infected tooth a risk factor for locally invasive spread of infection? J Oral Maxillofac Surg 2011;69:986–93.

[26] Bakathir AA, Moos KF, Ayoub AF, Bagg J. Factors contributing to the spread of odontogenic infections: A prospective pilot study. Sultan Qaboos Univ Med J 2009;9:296–304.

[27] Diz Dios P, Tomas Carmona I, Limeres Posse J, Medina Henriquez J, Fernandez Feijoo J, Alvarez Fernandez M. Comparative efficacies of amoxicillin, clindamycin, and moxifloxacin in prevention of bacteremia following dental extractions. Antimicrob Agents Chemother 2006;50:2996–3002.

[28] Bystedt H, Dahlbäck A, Dornbusch K, Nord CE. Concentrations of azidocillin, erythromycin, doxycycline and clindamycin in human mandibular bone. Int J Oral Surg 1978;7:442–9.

[29] Al-Nawas B, Maeurer M. Severe versus local odontogenic bacterial infections: Comparison of microbial isolates. Eur Surg Res 2008;40:220–4.

[30] Brook I, Lewis MA, Sandor GK, Jeffcoat M, Samaranayake LP, Vera Rojas J. Clindamycin in dentistry: more than just effective prophylaxis for endocarditis? Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005;100:550–8.

[31] Rush DE, Abdel-Haq N, Zhu JF, Aamar B, Malian M. Clindamycin versus Unasyn in the treatment of facial cellulitis of odontogenic origin in children. Clin Pediat 2007;46:154–9.

[32] Gould FK, Elliott TS, Foweraker J, Fulford M, Perry JD, Roberts GJ, et al. Guidelines for the prevention of endocarditis: report of the Working Party of the British Society for Antimicrobial Chemotherapy. J Antimicrob Chemother 2006; 57:1035–42.

[33] Wilson W, Taubert KA, Gewitz M, Lockhart PB, Baddou LM, et al. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. Circulation 2007;116:1736–54.

[34] Dailey YM, Martin MV. Are antibiotics being used appropriately for emergency dental treatment? Br Dent J 2001;191:391–3.

[35] Demirbas F, Gjermo PE, Preus HR. Antibiotic prescribing practices among Norwegian dentists. Acta Odontol Scand 2006;64:355–9.

[36] Salako NO, Rotimi VO, Adib SM, Al-Mutawa S. Pattern of antibiotic prescription in the management of oral diseases among dentists in Kuwait. J Dent 2004;32:503–9.

[37] Seager JM, Howell-Jones RS, Dunstan FD, Lewis MAO, Richmond S, Thomas DW. A randomised controlled trial of clinical outreach education to rationalise antibiotic prescribing for acute dental pain in the primary care setting. Br Dent J 2006;201:217–22.

[38] Segura-Egea JJ, Velasco-Ortega E, Torres-Lagares D, Velasco-Ponferrada MC, Monsalve-Guil L, Llamas-Carreras JM. Pattern of antibiotic prescription in the management of endodontic infections amongst Spanish oral surgeons. Int Endod J 2010;43:342–50.

[39] Hess DR. Retrospective studies and chart reviews. Respir Care 2004;49:1171–4.

[40] Gill C, Michaelides PL. Dental drugs and anaphylactic reactions. Report of a case. Oral Surg Oral Med Oral Pathol 1980; 50:30–2.

[41] Walters H. Antibiotic prophylaxis in dental surgery. Dent Update 1997;24:271–6.

[42] Thikkurissy S, Rawlins JT, Kumar A, Evans E, Casamassimo PS. Rapid treatment reduces hospitalization for pediatric patients with odontogenic-based cellulitis. Am J Emerg Med 2010;28:668–72.