Management of odontogenic infection at a district general hospital

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Key points

Describes groups at risk of prolonged admission for management of odontogenic infection.	Describes a retrospective method for estimating the socioeconomic status of study participants.	Provides information on the economic impact of hospital admission.

Introduction Severe odontogenic infections require hospital admission for antimicrobial chemotherapy and/or surgical management. They are usually preventable by regular dental attendance, and represent a significant economic cost to patient, hospital and society. **Aims** To review the presentation, management, and demographics of odontogenic infection at a District General Hospital. **Methods** Retrospective analysis of 100 consecutive patients admitted under the care of the department of Oral & Maxillofacial Surgery at the Royal Surrey County Hospital. **Results** Of 100 patients, the male:female ratio was 54:46 with a mean age of 36 years and mean length of stay (LOS) of 2.38 nights. Twenty-nine percent received no treatment prior to admission. Age, male gender and multiple space infection were associated with increased LOS. Diabetes, smoking and treatment prior to admission did not influence LOS significantly. **Discussion and conclusion** Aggressive management of odontogenic infection should be considered for older, male patients with multiple space involvement. Patients in this study stayed 238 nights in hospital. Assuming an average bed cost of £400 per night, this incurs a cost of £95,200 to the NHS in this small study for an often preventable condition. The implications for the greater NHS are likely to be very significant.

Introduction

Management of dental problems can be straightforward and affordable when identified early. Treatment includes the placement of dental restorations, endodontic treatment, incision and drainage of localised infections, scaling and root planning and appropriate dental extractions.[1] However, severe spreading infection can occur when dental disease is left untreated, with severe consequences. Complications include airway obstruction, sepsis, cavernous sinus thrombosis, mediastinitis and death. Management may be more complex, resulting in prolonged hospitalisation and use of an operating theatre.[1,2]

Odontogenic infection cases in this study all required admission to hospital and are defined as a maxillofacial infection caused by an infected tooth. An aging UK population[3] and National Health Service (NHS) budget cuts[4] are creating an era with significant financial pressures on the UK public health system. It is therefore essential to minimise costs while maintaining high quality patient care.

By identifying factors affecting length of stay (LOS) in hospital, it may be possible to identify groups of patients at risk of prolonged admission. This would justify more aggressive management when appropriate, to reduce LOS and the associated economic costs.

Similar studies have been reported,[5–7] with only one carried out in a British population.[8] Previous studies have not investigated the association between treatment prior to admission and LOS.

Aim

To retrospectively review the clinical and demographic aspects of 100 consecutive patients admitted to the Royal Surrey County Hospital for management of odontogenic infection over a two-year period.

Objectives

- To describe the clinical presentation, demographics, management and outcome of patients presenting with odontogenic infection
- To identify how various clinical and demographic factors relate to LOS in hospital
- To estimate the economic cost of hospital admission.

Materials and methods

Patient selection

This study evaluated 100 consecutive patients admitted to the Royal Surrey County Hospital (RSCH) for the management of odontogenic infection between October 2014 and September 2016. Patients were identified retrospectively from various sources, including a department 'on-call' logbook, operating theatre logbooks, clinical coding and an electronic 'handover sheet.' Patients who did not require admission for management, and those with non-odontogenic infection were excluded from the data.

Table 1 Summary of results

Variable	Mean	Standard deviation		Frequency (n)	Percent
Age	36.17	17.36	**Preadmission treatment**		
Temperature (celsius)	37.19	0.61	None	29	29
Length of stay (nights)	2.38	1.92	Surgical	18	18
IMD Decile	7.01	2.44	Antibiotics	62	62
	Frequency (n)	**Percent**	Unknown	1	1
Gender			**Post-admission treatment**		
Male	54	54	Oral antibiotics	1	1
Female	46	46	IV antibiotics	100	100
Referral source			Tooth extraction	93	93
Primary care	9	9	Intraoral incison and drainage	72	72
Secondary care	33	33	Extraoral incision and drainage	32	32
A&E	57	57	**Fascial space involved**		
Unknown	1	1	Submandibular	52	39.1
Past medical history			Buccal	52	39.1
Diabetes	7	7	Sublingual	10	9.02
Alcoholism	2	2	Submental	10	7.52
Drug addiction	2	2	Parapharyngeal	2	1.5
HIV	0	0	Canine	1	0.75
Steroids	3	3	Periorbital	1	0.75
Chemotherapy	0	0	Pretracheal	1	0.75
Tobacco smoking	39	39	Prevertebral	1	0.75
Preadmission treatment			Submasseteric	1	0.75
None	29	29	**Complications**		
Surgical	18	18	Airway obstruction	6	6
Antibiotics	62	62	Ludwig's angina	4	4
Unknown	1	1	Mediastinitis	0	0
			Necrotising fasciitis	0	0
			Sepsis syndrome	4	4

Data collection

Following identification of patients fitting the criteria, charts were requested and examined. Variables were acquired from both the electronic and written patient record and recorded in an electronic spreadsheet. Variables included: age, gender, admission date, LOS, admission temperature, pre-existing medical conditions, preadmission management, post-admission management, fascial space involvement, causative tooth, complications, referral source and residential postcode.

LOS in this study was defined as the number of nights spent in hospital by a patient from the date of admission to discharge. Pre-existing medical conditions recorded were those with a potentially immunosuppressive effect including diabetes mellitus, alcoholism, drug abuse, HIV, steroids, chemotherapy and tobacco smoking. Preadmission management included no treatment or surgical/dental treatment. Post admission management included oral antibiotics, intravenous antibiotics, tooth extraction, intraoral incision and drainage, and extraoral incision and drainage. Complications were the presence of airway obstruction, sepsis syndrome, Ludwig's Angina, mediastinitis and/or necrotising fasciitis. Referral source was either from a primary care or secondary care facility, or from an accident and emergency department 'walk-in.'

'Level of deprivation' was used as a substitute for the socioeconomic status of patients. In order to assess level of deprivation, the English Index of Multiple Deprivation (IMD) decile score was used. The British government calculates this score by ranking the 32,844 small areas in England from most deprived to least deprived and dividing them into ten equal groups. These range from the most deprived ten percent of small areas nationally to the least deprived ten percent of small areas nationally. Therefore, a score of one indicates an area is within the most deprived 10%, and ten least deprived 10%.[9]

IMD decile for each patient was calculated by inputting patient postcodes into the British Department of Communities and Local Government online 'IMD by Postcode' tool[10] and IMD decile data collected.

Fig. 1 Population distribution graph

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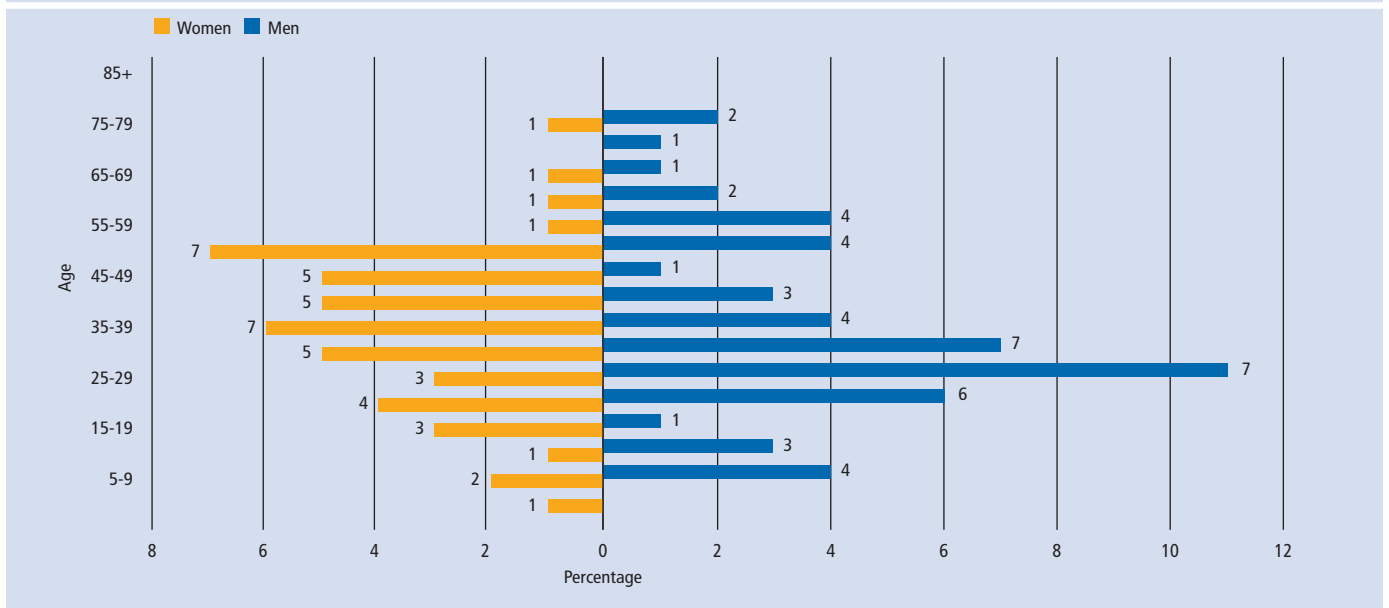
Statistical methods

Basic descriptive statistical analysis was carried out for all patients. Relationships between the data were analysed using the Spearman's rank correlation coefficient for continuous variables (age, temperature, level of deprivation, IMD) while the t-test was used for discrete variables (medical conditions, gender, preadmission management, post admission management, fascial space, dental origin of infection, complications, referral source.)

A ten-patient pilot study was carried out to confirm study feasibility prior to commencement.

Results

Univariate descriptive statistical analysis was carried out for each variable in the study (Table 1.)

The number of males (54%) outweighed the number of females (46%) in the study. Mean age was 36.17 years. The modal age range at admission differed between females (50–54 years) and males (25–29 years.) (Fig. 1).

The majority of patients (57%) were admitted from the accident and emergency department, whilst only 9% came from primary care. Thirty-three percent of patients were transferred to the department from another hospital. The origin of referral of one patient was unknown. Mean body temperature on admission was 37.17 °C.

Prior to admission, most patients had been treated using antibiotics alone (52%). Ten had antibiotics in conjunction with surgical treatment, 8% were treated surgically alone and 29% had received no treatment at all. This was unrecorded for one patient.

Table 2 Teeth involved in infection		
Source tooth	Percentage	Frequency (n)
Lower 2nd molar	26.21	38
Lower 1st molar	24.14	35
Lower 3rd molar	15.86	23
Lower 2nd premolar	7.59	11
Upper 1st molar	5.52	8
Lower 1st premolar	4.14	6
Upper 2nd molar	4.14	6
Lower canine	3.45	5
Upper lateral incisor	2.07	3
Upper canine	2.07	3
Upper 2nd premolar	2.07	3
Upper 1st premolar	1.38	2
Lower lateral incisor	0.69	1
Upper central incisor	0.69	1
Lower central incisor	0	0
Upper 3rd molar	0	0

On admission, all patients needed intravenous antibiotics, 93% tooth extraction, 79% intraoral incision and drainage and 32% extraoral incision and drainage. No patients received oral antibiotics. The most common treatment combination was IV antibiotics, extraction and intraoral drainage (59%).

Two percent of patients were alcoholics, two percent drug abusers and two percent were taking corticosteroids. No patients had a history of chemotherapy or HIV. Seven percent of patients were diabetic. Smoking status was recorded for 99/100 patients in this study. The incidence of smoking in the studied population was greater than the national average of 19%, at 39%.

Sixty-three percent of patients were diagnosed with a single causative tooth, while 37% of patients had multiple 'causative' teeth recorded.

Mandibular teeth formed a clear majority (82.07%) of causative permanent teeth (Table 2), with the lower second (26.2%) and

Table 3 Association of various factors with LOS		
Variable	Statistical test	p
Diabetes*	-1.93658	0.055677
Smoking*	-0.42869	0.669099
Treatment prior to admission*	-0.55636	0.579244
Number of fascial spaces involved†	0.30639	0.001930
Gender*	-2.64000	0.009669
Age†	0.28080	0.004660
Admission temperature†	0.03390	0.742992
Complications*	-4.62214	0.000012
IMD†	-0.12230	0.230280
*Two-tailed t-test and †Spearman's rank		

first (24.1%) molars as the predominant cause of infection.

Of the 17.93% of upper causative teeth, the upper first molar (5.5%) and second molar (4.1%) were the most commonly involved. The upper third molar and lower central incisors did not cause any of the infections in this study.

Seventy-six percent of those studied had involvement of a single fascial space on admission, compared to 24% who had involvement of multiple spaces. The most common fascial spaces involved were the submandibular (39%) and buccal (39%) spaces, followed by the sublingual space (9%).

IMD data for two patients was not available. The remaining 98 had a mean IMD decile of 7.01 – two decile points less deprived compared to the national average.

The most common complication was airway obstruction (6%). Ludwig's angina occurred in 4%, and was always accompanied by airway obstruction. No patients suffered from necrotising fasciitis or mediastinitis, and there were no patient deaths.

LOS appeared to have a skewed distribution, ranging from zero to thirteen nights, with a peak at two nights. Mean LOS was 2.38 nights, with a range of 0–13. The mode LOS was two nights. Only five-percent of patients had a LOS greater than five nights. Within this subset of patients, the two with the greatest LOS (eight and 13 nights) both presented with Ludwig's angina with airway obstruction.

Further statistical analysis (Table 3) showed significant associations between LOS and male gender (p = 0.009969), age (p = 0.00466), the number of involved fascial spaces (p = 0.00193) and the presence of complications (p = 0.000012).

Temperature on admission, IMD, smoking, diabetes and treatment prior to admission had no significant association with LOS (p >0.1).

Discussion

The highest rate of admission for odontogenic infection in this study was amongst 25–29 year olds, which is similar to previous studies.[11,12] This finding may be due to comparatively greater rates of untreated caries in this group.[13] The association between age and LOS has already been established in the literature.[6]

Males formed a majority (54%) of patients in this study, consistent with previous studies.[6,14] The significantly greater LOS compared to females may be due to poorer oral hygiene,[15,16] hesitance in accessing health services[17] and a tendency to present at later stages of illness.[18] The highest rate of admission in females was between 50–54 years of age. The reason for this finding is unclear.

Most patients (57%) were referred from the A&E department. Only nine percent were referred from primary care. This suggests a study demographic of patients unwilling, or unable to access a dentist. There is evidence that dental emergency patients are irregular attenders.[19] Further research into the dental attendance pattern of those admitted for the management of odontogenic infection may be useful to target dental care at high risk groups.

Seventy-three percent of patients were apyrexial on admission. Possible reasons include local spread of infection, without systemic involvement or the undocumented effect of analgesics on body temperature. The lack of association with LOS contrasts with previous studies.[20]

Sixty-two percent of patients were prescribed antibiotics prior to admission, which corroborates with other studies.[21] This finding contrasts with 18% who were managed surgically and may be due to non-attendance in primary care, or reflect a preference for antibiotic prescription over surgical management by GDPs. The 29% who did not receive any treatment prior to admission may contain those who are dental non-attenders, have difficulty with dental access or have quickly progressing infections. Treatment prior to admission did not significantly affect LOS.

Lower posterior teeth were by far the most common source of infection, accounting for 77.9% of all causative teeth. Lower molar infections are more likely to be severe, due to spread into the sublingual and submandibular spaces. This contrasts with the tendency of upper molar infections to spread intraorally or into the buccal space. The buccal and submandibular spaces were the most frequently involved fascial spaces in the study. This is unsurprising, considering the frequency of lower molar involvement. Those with multiple space infections had a significantly greater LOS than those with single space infections. Again this is unsurprising, as only the most severe infections will be able to spread across multiple fascial spaces.

Most patients in this study resided in the hospital's catchment area of Surrey, Hampshire and southwest London. These areas are relatively less deprived than the rest of the UK, explaining the mean IMD score of 7.01. There is an established link between low socioeconomic (SES) status and higher rates of disease, lower expected lifespans, and poorer health outcomes.[22] However, there was no significant association between level of deprivation and LOS in this study. This effect may not be as apparent in an area of relatively high socioeconomic status, served by a public health system.

Mean LOS for patients in this study (2.38 nights) was lower than the range reported in the literature, of 2.7 to 8.27 days.[8,23] The Royal Surrey County hospital has an established protocol for managing odontogenic infection, including early extraction, incision and drainage alongside antimicrobial chemotherapy. Once stable, patients are discharged on oral antibiotics and encouraged to visit a general dentist for review.

The average cost per night for a bed in an NHS hospital is £400.[24] A total of 238 nights were spent in hospital by the patients in this study. This represents an estimated £95,200 spent by the hospital on bed costs alone for

Box 1 The typical patient

25–29 year old

Male

Previously treated with antibiotics alone

Has walked into A&E without referral

Source of infection is the lower 2nd molar

Single space involvement of either the buccal or submandibular space

Apyrexic on admission

Twice as likely to smoke than the general population

Stayed in hospital for two nights

Leaves without complications

Treated with IV antibiotics, extraction of tooth, intraoral incision and drainage

these patients, ignoring any cost of treatment, investigations and prescriptions.

The average cost per hour to run an NHS operating theatre is £1200.[25] Thirty-two patients required extraoral incision and drainage in theatre. Assuming an operating theatre time of one hour (including anaesthetic induction and recovery time), produces an estimated cost of £38,400 to the NHS.

Assuming a minimum wage of £5.30 in 2015[26] for 18–20 year olds, and seven hours of work lost per night stayed in hospital, one can estimate a total loss of earnings of £8829 for patients in this study. This is just an estimate, and does not take into account differences in wage, recovery time post-discharge from hospital and childcare. The true economic costs are likely to be much greater.

We can gain a picture of the typical patient in this study, shown in Box 1.

Conclusions

The oral & maxillofacial surgery unit at the Royal Surrey County Hospital manages complex odontogenic infection with short hospital admissions and minimal complications.

The evidence presented by this study suggests a significant health inequality between young males and the rest of the population, as well as a difficulty or unwillingness in accessing primary dental services by patients. The evidence suggests that aggressive management

of odontogenic infections for older, male patients with multiple space involvement is an important consideration.

This study found no significant association of treatment prior to admission, smoking and IMD with LOS. This may be due to the small sample size, and further investigation may be warranted.

The NHS spent at least £133,600 managing patients in this study. The true costs are likely to be greater. Odontogenic infection may be prevented with regular dental attendance, and it is therefore imperative to identify at-risk groups to allow targeted intervention.

1. Gams K, Shewale J, Demian N, Khalil K, Banki F. Characteristics, length of stay, and hospital bills associated with severe odontogenic infections in Houston TX. *J Am Dent Assoc* 2017; **148:** 221–229.
2. Farmahan S, Tuopar D, Ameerally P, Kotecha R, Sisodia B. Microbiological examination and antibiotic sensitivity of infections in the head and neck. Has anything changed? *Br J Oral Maxillofac Surg* 2014; **52:** 632–635.
3. UK Parliament. Political challenges relating to an aging population: Key issues for the 2015 Parliament. 2015 Available at https://www.parliament.uk/business/publications/research/key-issues-parliament-2015/social-change/ageing-population/ (accessed November 2017).
4. Robertson R, Wenzel L, Thompson J, Charles A. Understanding NHS financial pressures. The King's Fund, 2017.
5. Krishnan V, Johnson J, Helfrick J. Management of maxillofacial infections: A review of 50 cases. *J Oral Maxillofac Surg* 1993; **51:** 868–873.
6. Wang J, Ahani A, Pogrel M. A five-year retrospective study of odontogenic maxillofacial infections in a large urban public hospital. *Int J Oral Maxillofac Surg* 2005; **34:** 646–649.
7. 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:** 116–122.
8. Stathopoulos P, Igoumenakis D, Shuttleworth J, Smith W, Ameerally P. Predictive factors of hospital stay in patients with odontogenic maxillofacial infections: the role of C-reactive protein. *Br J Oral Maxillofac Surg* 2017; **55:** 367–370.
9. Department for Communities and Local Government. The English Indices of Deprivation 2015. 2015. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464597/English_Indices_of_Deprivation_2015_-_Research_Report.pdf (accessed May 2018).
10. English Indices of Deprivation 2015: Postcode Lookup. Imd-by-postcode.opendatacommunities.org. 2015. Available at http://Imd-by-postcode.opendatacommunities.org (accessed November 2017).
11. Verma S, Chambers I. Dental emergencies presenting to a general hospital emergency department in Hobart, Australia. *Aust Dent J* 2014; **59:** 329–333.
12. Uluibau I, Jaunay T, Goss A. Severe odontogenic infections. *Aust Dent J* 2005; **50(4 Suppl 2):** S74–S81.
13. Office for National Statistics. Social Survey Division, Information Centre for Health and Social Care. Adult Dental Health Survey, 2009.Second Edition. UK Data Service, 2012.
14. Hwang T, Antoun J, Lee K. Features of odontogenic infections in hospitalised and non-hospitalised settings. *Emerg Med J* 2011; **28:** 766–769.
15. Veiga N, Pereira C, Ferreira P, Correia I. Oral Health Behaviors in a Sample of Portuguese Adolescents: An Educational Issue. *Health Promot Perspect* 2014; **4:** 35–45.
16. Östberg A, Jarkman K, Lindblad U, Halling A. Adolescents' perceptions of oral health and influencing factors: a qualitative study. *Acta Odontol Scand* 2002; **60:** 167–173.
17. Banks I. No man's land: men, illness, and the NHS. *BMJ* 2001; **323:** 1058–1060.
18. Malcher G. The state of men's health in Europe. *BMJ* 2011; **343:** d7054.
19. Nayee S, Kutty S, Akintola D. Patient attendance at a UK dental hospital emergency clinic. *Br Dent J* 2015; **219:** 485–488.
20. Peters E, Fong B, Wormuth D, Sonis S. Risk factors affecting hospital length of stay in patients with odontogenic maxillofacial infections. *J Oral Maxillofac Surg* 1996; **54:** 1386–1391.
21. Sanchez R, Mirada E, Arias J, Pano J, Burgueno M. Severe odontogenic infections. Epidemiological, microbiological and therapeutic factors. *Med Oral Patol Oral Cir Bucal* 2011; **16:** e670–e676.
22. Feinstein J. The Relationship between Socioeconomic Status and Health: A Review of the Literature. *Milbank Q* 1993; **71:** 279–322.
23. Gronholm L. Severe Odontogenic Infections. Academic Dissertation. University of Helsinki; 2012.
24. NHS. NHS Hospital Stay. Data.gov.uk. 2015. Available at https://data.gov.uk/data-request/nhs-hospital-stay (accessed November 2017).
25. Fletcher D, Edwards D, Tolchard S, Baker R, Berstock J. Improving theatre turnaround time. *BMJ Quality Improvement Reports* 2017; **6:** u219831.w8131.
26. UK Government. National Minimum Wage and National Living Wage rates – GOV.UK. 2017. Available at https://www.gov.uk/national-minimum-wage-rates (accessed November 2017).