



ORIGINAL ARTICLE

# Assessment of predictors of treatment outcome among patients with bacterial odontogenic infection



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## 1. Introduction

Odontogenic infections are pathologic states of the head, neck or other areas of the body resulting from pathogenic organisms whose primary source is the tooth and/or tooth supporting structures (Uluibau et al., 2005). These infections have the potential to spread extremely rapidly from localised infections to cause airway embarrassment, requiring prompt and aggressive intervention. In their most severe forms, odontogenic infections can result in acute airway obstruction, multiple organ failure and ultimately death of the patient (Uluibau et al., 2005, Green et al., 2001).

In most reports, the incidence of these infections has decreased over the past few decades, but Seppanen et al. (2009), reported that despite the medical advancement of the post antibiotic era, the incidence of odontogenic infections has continued to increase.

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The clinical manifestation of odontogenic infections is a spectrum depending on the location of the space involved, virulence of the aetiologic organisms and other co-morbidities of the patients. The organisms involved consist of both aerobes and anaerobes which reflect the oral flora (Paul et al., 2010). Complications of odontogenic infections include descending mediastinitis, septic shock, upper airway obstruction, jugular vein thrombosis, venous septic embolus, carotid artery pseudoaneurysm or rupture, pleural empyema, pericarditis and disseminated intravascular coagulopathy (Paul et al., 2010; Karkos et al., 2007; Flynn et al., 2006a). These conditions are life threatening and increase the mortality rate to about 50% especially in cases of descending mediastinitis (Mihos et al., 2006).

Despite the increased availability of antimicrobial therapy and healthcare services, odontogenic orofacial infections remain a cause of admission and patient mortality. This was a prospective study to assess the presentation, predisposing factors, management outcome and the predictors of poor prognosis in odontogenic infections.

## 2. Material and method

This study was carried on subjects who presented with odontogenic orofacial space infections at the Lagos University Teaching Hospital (LUTH) between January 2014 and April 2015 after approval from the Research and Ethics Committee of the hospital was obtained.

#### Inclusion Criteria:

1. Patients with odontogenic infections of the head and/or neck region, including diagnoses of dento-alveolar abscess, deep fascial space infections and any localized pus collection.

#### Exclusion Criteria:

1. Subjects with non-bacterial infections like viral and fungal infection.
2. Subjects with odontogenic infections such as dental caries and periodontitis without dentoalveolar abscess; infected cysts or neoplasms, cervicofacial abscess of unknown cause.
3. Pregnant women
4. Those who refused consent to the study were excluded.

Data collected from patient preoperatively included age, sex, ethnic group and occupation. The patient's name and other confidential information was known only to the main researcher. Preoperative clinical data included causative tooth/teeth involved, fascial spaces involved, the maximum inter-incisal distance and absence/presence of respiratory distress. For the fascial space involved, this was divided into abscess, cellulitis, Ludwig's angina and Necrotizing fasciitis. Cellulitis was for cases which the spread is unilateral while Ludwig's angina was specifically for cases with bilateral submandibular, sublingual and submental cellulitis. The causative tooth involved was assessed both clinically and radiographically while the fascial space involved was assessed clinically. The maximum inter-incisal distance in millimetres (mm) was measured by the distance between the upper and lower central incisors. Presence of respiratory distress characterised by stridor, flaring of the alar of the nose, sweating and subjects assuming a sniffing position were also noted.

Intraoperative data recorded included the anatomic space drained which was assessed clinically, empirical antibiotic administered, type of anaesthesia (local or general) and method of securing of airway in general anaesthesia (endotracheal or tracheostomy) were recorded.

Post-operative data: Postoperative data collected included number of out-patient visits in patients not hospitalized, length of hospital stays (for patients on admission), number of days for complete resolution of symptoms, and complications including progression of infections, therapeutic failure and death.

The causative organisms and antibiotic sensitivity were determined by the following steps:

1. Aspiration of pus done with needle/Sample of pus or exudate collected using sterile swab if aspiration was unsuccessful.
2. Specimen were placed in transport media (thioglycolate broth) and sent immediately to microbiology laboratory for culture of organisms and antibiotic sensitivity.

#### 2.1. Evaluation of treatment outcome

The treatment outcome was divided into successful without complications, successful with complications and unsuccessful as follows:

1. Successful without complications: when there was complete resolution of presenting condition after treatment without any form of complication or progression of infection. For this study, this included subjects (on admission or not) who had complete resolution of symptoms before 7 days (< 7days).
2. Successful with complications: complete resolution of condition after treatment though there were complications but they were effectively managed. This included subjects who had therapeutic failure (failure of empirical antibiotics), progression of infections, complications such as contracture, facial nerve injury and osteomyelitis. This also included subjects with complete resolution on or after 7 days (> or = 7 days).
3. Unsuccessful: mortality of the subject or patient discharged against medical advice while there was no resolution of disease.

#### 2.2. Ethical consideration and informed consent

Approval for this study was obtained from the Health Research and Ethics Committee (HREC) of the Lagos University Teaching Hospital and consent was obtained from all subjects involved after thorough explanation of the study to them.

#### 2.3. Data analysis

Data was analysed using SPSS for windows (version 20.0; SPSS mc, Chicago, IL, USA). For all comparisons,  $p \leq 0.05$  was adopted as the criterion for establishing a statistical significance.

### 3. Results

A total of 55 subjects who presented with odontogenic orofacial space infections who met the inclusion criteria in a period extending from January 2014 and April 2015 participated in the study. There were 30 males (54.5%) and 25 females (45.5%) with a male-to-female ratio of 1.2:1. The median age was 39 years (range, 8 months – 94 years). Subjects in the 4th decade of life (31–40 years) had the highest incidence (20%), followed by those in 3rd decade of life (18.2%) (Table 1).

**Table 1** Frequency of occurrence of odontogenic orofacial infections in different age groups.

Age groups	Frequency (%)
0–10	2 (3.6)
Nov-20	5 (9.1)
21–30	10 (18.2)
31–40	11 (20)
41–50	9 (16.4)
51–60	6 (10.9)
61–70	8 (14.5)
> 70	4 (7.3)
TOTAL	55 (100)

### 3.1. Odontogenic orofacial space infections

Of 55 cases seen, majority of cases 39(71%), presented with abscess this was followed by Ludwig's angina with 7 cases (12.7%) (Table 2). The most common potential spaces frequently involved were submandibular space, 18 (28%) followed by submental space 12 (19%) while least was temporal space 3 (5%) (Table 3). Fifty-four (87.1%) of the teeth involved were lower teeth. The most common teeth implicated in odontogenic infections were the lower 3rd molars ( $n = 26$ ; 41.9%), followed by the lower 2nd molars ( $n = 13$ ; 21%).

### 3.2. Causative organisms and antibiotic sensitivity

Forty-two (76.4%) samples of the 55 taken for bacteriology yielded positive culture for bacteria. A total number of 21 bacteria species were identified from the positive cultures. Gram negative aerobes 25 (50%) were the most common bacteria isolated followed by Gram positive aerobes 17 (34%) and the least isolated were anaerobes 8 (16%). Overall, 52% of isolated organisms were sensitive to Amoxicillin-clavulanate, 70% were sensitive to Ceftriaxone while 24% were resistant to both antibiotics. Ceftriaxone was statistically significantly more potent in inhibiting bacteria growth than Amoxicillin-clavulanate ( $P = 0.009$ ) (Table 4).

### 3.3. Evaluation of treatment outcome

Multiple linear regression analysis was used to determine the effect of independent variables (age, BMI, haemoglobin level, WBC count, random blood sugar and number of spaces involved) on the outcome variable (treatment outcome) (Table 4). Age ( $P = 0.7$ ), BMI ( $P = 0.86$ ), WBC count ( $P = 0.795$ ) and random blood sugar ( $P = 0.078$ ) were not significant predictors of outcome but haemoglobin level ( $P = 0.041$ ) and number of spaces involved ( $P < 0.001$ ) were significant predictors of outcome. The most significant predictor of outcome was the number of spaces involved.

**Table 3** Frequency of involvement of anatomic spaces in odontogenic infections.

Anatomic space involved	Frequency of occurrence	Percentage %
Submandibular	18	28
Submental	12	19
Sublingual	7	11
Submasseteric	9	14
Buccal	11	17
Temporal	3	5
Lateral pharyngeal	4	6
<b>Total</b>	<b>64</b>	<b>100</b>

**Table 4** Multiple linear regression analysis on predictors of outcome.

	Standard coefficients (Beta)	T	Significance (P value)
Outcome (constant)		2.93	0.006
Age	0.046	0.389	0.7
BMI	0.023	0.178	0.86
Haemoglobin level	-0.262	-2.127	0.041
WBC count	0.034	0.262	0.795
Random blood sugar	0.226	1.818	0.078
Number of spaces involved	0.486	3.882	< 0.001

## 4. Discussion

Odontogenic infections remain a cause of morbidity and mortality in Oral and Maxillofacial surgery. Its acute presentation makes it a cause for urgent attention and treatment (Jun-Kai and Shun-Cheng, 2011; Flynn et al., 2006b). The age range and peak age of occurrence of subjects who presented with odontogenic bacterial infections in this study was similar to what has been reported by many studies which reported the

**Table 2** Clinical diagnosis at presentation and the anatomical spaces involved.

Anatomic space involved	Clinical abscess	Diagnosis cellulitis	NF	Ludwig's angina	Total (%)
Dentoalveolar	23	0	0	0	23 (41.8%)
Buccal	3	0	1	0	4 (7.3%)
Submandibular	1	1	0	0	2(3.6%)
Submasseteric	3	0	0	0	3 (5.5%)
Lateral pharyngeal	1	0	0	0	1 (1.8%)
Submandibular and lateral pharyngeal	1	0	1	0	2 (3.6%)
Submandibular, submental and sublingual	0	0	0	7	7 (12.7%)
Submandibular, submental and lateral pharyngeal	0	0	1	0	1 (1.8%)
Temporal, submasseteric and buccal space	1	0	1	0	2 (3.6%)
Temporal and submasseteric	1	0	0	0	1 (1.8%)
Buccal and submasseteric	3	0	0	0	3 (5.5%)
Submandibular and submental	1	3	0	0	4 (7.3%)
Buccal and submandibular	1	0	1	0	2 (3.6%)
<b>Total (%)</b>	<b>39 (70.9%)</b>	<b>4 (7.3%)</b>	<b>5 (9.1%)</b>	<b>7 (12.7%)</b>	<b>55 (100%)</b>

NF = Necrotising fasciitis.

fourth decade of life as most common period of occurrence (Saito, 2011).

There have been different reports on the presentation of odontogenic orofacial infections due to the diverse structures of the head and neck. In this study, the dentoalveolar abscess is the most common bacterial odontogenic infection accounting for 41.8% of cases seen corroborating the findings of previous studies (Akinbami et al., 2010; Rahman et al., 2005; Larawin et al., 2006).

Most authors however, differ in the most frequent potential space infection (Rahman et al., 2005; Larawin et al., 2006) reported that Ludwig's angina was the most common clinical presentation of odontogenic fascial space infection with the submandibular space as the most common space involved which is similar to the findings of this study. Other previous studies including those of Akinbami et al. (2010) reported sub-masseteric and buccal spaces as the most commonly affected spaces respectively.

These varying reports show the diverse clinical presentations of odontogenic orofacial space infections. This diversity can be explained by the fact that the spread of odontogenic infections is affected by many factors including the tooth involved, virulence of causative organisms, anatomic barriers and host immunity which varies with different individuals (Koichi et al., 1998).

Bacteria involved in odontogenic orofacial space infections are generally reported to be of mixed aerobic-anaerobic infection (Al-Qamachi et al., 2010). Eighty-four per cent of organisms isolated in this study were aerobes while 16% were anaerobes. This is in contrast with studies carried out on bacteriology of orofacial infections by Ndukwe et al. (2004) and Osazuwa et al. (2010) who registered that anaerobes are the most predominant organisms in orofacial infections and gram positive aerobes had minimal role to play. This may be because they considered both odontogenic and non-odontogenic infections unlike this study where only odontogenic infections were considered.

The first choice of empirical antibiotic in many reports on antibiotics management of odontogenic orofacial infections are beta-lactam penicillin (Karkos et al., 2007; Flynn et al., 2006a) though Kuriyama et al. (2000) reported a high resistance of bacteria to beta lactam penicillins in patients who had received antibiotics prior to sampling. The percentage of organisms' sensitive to amoxicillin-clavulanate especially in cases of necrotizing fasciitis and Ludwig's angina was low supporting the view of Kuriyama et al. (2000) and Flynn and Halpern (2003). This may be explained by the fact that most subjects who presented at our clinic with severe space infections were referred from other centres who had prescribed medications during early phase of the infection. Due to inadequate or inappropriate dosage and incomplete treatment, there is tendency to develop resistance to the antibiotics used and also to similar antibiotics (Flynn and Halpern, 2003).

The outcome of treatment of odontogenic infections differs due to the diverse types and presentations of infections and treatment modalities employed by different surgeons. Majority of subjects who presented with abscess and cellulitis had a successful outcome without complications. There was no mortality recorded in subjects with abscess and cellulitis. Most of the abscesses were dentoalveolar abscess which rarely progresses or cause hospital admission. Successful

treatment outcome with complications was similar in both necrotising fasciitis and Ludwig's angina (60% and 57% respectively). In addition, the mortality rate of necrotizing fasciitis and Ludwig's angina of 20% and 14% respectively were higher when compared to that of previous studies (Frazee et al., 2008).

There have been many attempts to determine various patient factors that serve as prognostic indicators/predictors of outcome in odontogenic orofacial infections. In previous studies of orofacial infections, several clinically useful predictors of outcome have been identified, including admission WBC and temperature, lower face infection, and medical or immune system compromise (Flynn et al., 2006), (Paul et al., 2010). Multiple linear regressions showed that haemoglobin level at presentation and number of spaces involved (anatomic extent of the infection) significantly predicted treatment outcome. This finding is at variance with the findings of Dodson et al. (1991) who reported that admission temperature and admission WBC could predict outcome. The difference in the two studies may be due to the fact that Dodson et al. (1991) studied children who commonly develop high fevers, which complicates their management and contributes to poor outcome. Also age was not a significant predictor of outcome in the present study, in contrast to the findings of Osunde et al. (2012) who reported a statistically significant association between age and treatment outcome. It may however, be difficult to compare the complication rate/treatment outcome in the present study with other studies because of differences in study design, patient population, cause of infection, and the lack of a common method of calibrating severity of infections observed.

## 5. Conclusion

Dentoalveolar abscess was the most prevalent odontogenic bacterial infection in orofacial region but the submandibular space was the most affected potential tissue space. Subjects with clinical diagnosis of abscess or cellulitis were more likely to have a successful outcome than those with necrotising fasciitis or Ludwig's angina. Haemoglobin level and number of spaces involved were the only significant predictors of outcome.

## Declaration of interest

The authors have no competing interest to declare and there is no conflicting interest between authors.

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