ODONTOGENIC FACIAL CELLULITIS: TREATMENT AND COST IMPLICATIONS

A Thesis Presented in Partial Fulfillment

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By

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ABSTRACT

Purpose: The purpose of this study was to assess the cost, hospitalization characteristics, and treatment implications of odontogenic facial cellulitis.

Methods: This study consists of a retrospective chart review of medical and dental records of sixty-three children admitted to Nationwide Children's Hospital due to facial cellulitis of odontogenic origin. Chi-square analysis was used to evaluate categorical variables and t-tests were used to compare continuous means.

Results: The mean age of children included was 8.3 ± 3.8 years. Overall mean length of stay (LOS) was 2.0 ± 0.99 days. The mean cost was $4138 ± 2,376. Females were significantly more likely to have an increased LOS (p=0.0484). There were no significant differences to LOS related to primary or permanent tooth (0.051), maxillary versus mandibular tooth of origin (p=0.914).

Conclusion: With correct diagnosis, antibiotic treatment, and prompt treatment, rapid resolution of the infection is expected.

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BACKGROUND

Facial cellulitis is an acquired condition in children frequently seen in pediatric dentistry. Clinical variability of facial cellulitis results from involvement of multiple anatomic structures, differing sources of infection, and variable management. Making the correct diagnosis and treatment can be challenging and costly due to this variability. Treatment often requires a multidisciplinary approach. Early diagnosis and treatment are critical in the management of pediatric patients because delay can result in spread of infection to vital anatomic structures or worse systemic spread producing sepsis or meningitis requiring hospital admission.[1,2,3]

Facial cellulitis is classified as odontogenic or nonodontogenic based on the source of infection. Odontogenic cellulitis refers to orofacial infections arising or resulting from the dentition and its adjacent supporting periodontal structures. Nonodontogenic cellulitis can arise from trauma, sinus or skin infections, or idiopathic causes.[4,5] In a comparison of odontogenic and nonodontogenic facial cellulitis in a pediatric hospital population, Unkel et al found that odontogenic cellulitis comprised approximately 50% of the total hospital facial infections over a ten-year period.[6] Previous research on odontogenic facial cellulitis has focused on the location of the cellulitis, the source of the cellulitis, its microbiology, differences in disease characteristics over time, and the economics of the disease from admissions to the hospital and visits to the hospital emergency department.

Odontogenic facial cellulitis is a broad term for a condition that migrates into numerous anatomical regions and spaces including periorbital space, buccal space, canine space, retropharyngeal space, submandibular, sublingual, submental, and neck regions. Dodson et al simplified nomenclature by classifying infections by anatomic location: 1) upper face and 2) lower face.[4] Upper-face infections include the orbits and periorbital region, maxillary teeth or sinuses, and buccal region. Lower-face infections include the mandibular dentition, buccal region, and the sublingual, submental, and submandibular regions. Upper-face infections commonly have an unknown source of infection while trauma and odontogenic sources are the most common.[4,7] Lower-face infections are more likely to be diagnosed with a definite source of infection. In children with lower-face infections, the most common source was dental.[4,7]

Dental caries is the single most common chronic disease of childhood, occurring five to eight times as frequently as asthma, the second most common chronic disease in children.[8] Despite reduction in caries in recent years, more than half of all children have experienced caries by the second grade, and, by the time students finish high school, about 80 percent have caries.[9] National data indicate that 80 percent of dental caries in the permanent teeth found in children is concentrated in 25 percent of the child and adolescent population.[10] Dental caries occurs disproportionately in minority, low-income, and disadvantaged children.[11] Over time, as tooth decay remains untreated, infection occurs and disseminates beyond the dentition to produce a dentoalveolar abscess which can spread into surrounding connective tissue. This progression can get worse and

ultimately require more complex and expensive interventions in a hospital emergency department or operating room.[12]

Odontogenic infections are widely considered polymicrobial and bacteria identified from odontogenic infections have changed over the decades.[19] Alpha-hemolytic streptococci are the most frequently isolated bacteria over time in odontogenic infections.[20] Distinct differences in microbiology have been reported between upper-face infections and lower-face infections.[4] Upper-face infections are positive for more/varying microbes with *Staph epidermidis, St Aureus, St pyogenes, St viridans, H influenzae*, and *St pneumoniae* being most common.[4,5,7] *S aureus*, along with other gram positive cocci are raising concern because of growing resistance to most common antibiotics.[20] Lower-face infections are typically less variable with *S Aureus* and *S Pyogenes* being the most commonly seen organisms.[4,5,7] Unkel et al reported that in odontogenic facial infections, the most common organism was alpha streptococcus while in non-odontogenic facial cellulitis, *H influenza* type B prevailed.[6] This infers that facial infections of odontogenic origin may need to be treated differently than facial cellulitis of non-odontogenic origin.

Penicillin remains the antibiotic of choice for mild-to-moderate odontogenic infections in the immunocompetent host.[13,14,15] However, several authors recommend that it should not be used as initial therapy for more serious infections, possibly involving penicillin-resistant anaerobes. Currently, clindamycin is favored over penicillin by infectious disease specialists as a first-line agent for the treatment of odontogenic infections due to the excellent clinical

efficacy against penicillin-resistant oral anaerobes.[13] Addition of β-lactamase inhibitors such as clavulanate and sulbactam to broad-spectrum penicillins has also expanded the antimicrobial spectrum and have been very successful in treating serious odontogenic infections. Amoxicillin/clavulanate was found consistently active against all 87 aerobic and anaerobic pathogens isolated in one recent series of odontogenic abscesses.[14,15] In the United States, parenteral forms of clindamycin and penicillins with β-lactamase inhibitor such as ampicillin/sulbactam (Unasyn) are generally preserved for more severe oral infections seen in patients admitted with odontogenic facial cellulitis.[16,17,18]

Antibiotics given for dental infections only treat the symptoms of dental caries. In addition to treating serious odontogenic facial infections with more aggressive parenteral antibiotics, more definitive treatment needs to be considered at the time of hospital admission (i.e. extraction, pulpectomy, etc.).[21] Providing antibiotics alone is not a definitive cure for dental infections, but many hospitals don not have access to dental services, or choose not to request consultation. Pettinato et al reported that no dental consult was requested 69% of dental ER visits even with pediatric dental residents available.[21] Providing definitive care to carious teeth as soon as possible upon admission might decrease the total hospital length of stay and decrease the overall cost of admission. Ettelbrick et al reported that the mean hospital admission cost with children admitted to five different children's hospitals due to caries in 1997 was $3,223.[22] Costly and invasive procedures such as head computed tomography

(CT) could be decreased if the proper consults were obtained. Currently no studies compare prompt treatment to length of stay and cost of admission.

Several studies examine other important variables in odontogenic facial infections such as age, gender, admission temperature, and length of stay. Dodson et al's study of 113 pediatric patients with facial infections reported a mean age of 4.6 years, 59% male predominance, mean admission temperature of 100.8°F, and an average length of hospitalization of 3.5 days for a pediatric population.[4] However, this population consisted of both odontogenic and nonodontogenic infections. When comparing odontogenic to nonodontogenic facial cellulitis in a pediatric population, Unkel et al reported a mean age of 8.8 years for the odontogenic cellulitis sample compared to 4.4 years for the nonodontogenic population.[6] However, a slight female predominance (53%) was seen in the odontogenic sample compared to a male predominance of 56% for the nonodontogenic sample.[6] Mean admission temperature was almost 1°F lower in the odontogenic facial cellulitis sample compared to the nonodontogenic sample.[6] This could be due to differences in microbiology between odontogenic and nonodontogenic infections. Interestingly, when comparing many of the same variables (i.e. age, gender, race, admission temperature, space involvement, or length of stay), Storoe et al found no clinically significant differences in characteristics of patients hospitalized with odontogenic infections between the 1980s and the 1990s.[20]

Untreated dental caries can lead to abscess and facial cellulitis. Facial cellulitis can be life threatening and is often associated with significant morbidity.

As shown previously, odontogenic cellulitis has been shown to comprise approximately 50% of the total hospital facial infections and will certainly be encountered by hospital emergency staff and dentists alike.[6] The previous research done on facial cellulitis in children describes a condition that is quite variable in origin, location, microbiology, and treatment outcome. This current research project is intended to document these characteristics that might aid in management. Updated data will be used to create a comprehensive picture of the state of facial cellulitis management today. The study will assess and compare cost, length of stay, hospitalization characteristics, and treatment approaches to facial cellulitis used in our hospital with a dental service. Implications of this retrospective study are better management and reduced costs of care as well as policy-related data generation to be used to advocate for children.

MATERIALS AND METHODS

1. Study Approval

This study was approved by the Nationwide Children's Hospital Institutional Review Board.

2. Study Design

A retrospective case-control cohort study was designed to address the research objectives. Approval from the IRB was obtained to evaluate medical records of patients admitted to Nationwide Children's Hospital for management of an odontogenic facial infection. All patients admitted to the hospital for odontogenic infections between January 1, 2000 to December 31, 2006 were included in this study. Inpatient medical and dental charts were recovered for all 64 patients who constitute the study sample.

3. Subject Selection

Pediatric patients 18 years of age or younger who were admitted to Nationwide Children's Hospital for management of an odontogenic facial infection were included in the study. Patients were identified using distinct International Classification of Disease codes (ICD-9) associated with infectious disease and facial infections. This set of codes can be grouped into the following diagnostic categories: facial, orbital, or oral/perioral cellulitis; inflammation of the pulpal, periapical, gingival, or periodontal tissues; jaw or salivary gland inflammation; and facial infection. Patients were eliminated from the study if the cause of the facial cellulitis was determined to be of nonodontogenic origin.

4. Variables Studied

The following study variables were extracted from the patients' medical and dental records: age, sex, distance traveled, admission temperature (°F), month of admission, and length of stay in days (day of admission = day 0). The source of infection was verified to be odontogenic through review of both medical and dental records by a single standardized reviewer. Odontogenic variables included: tooth of origin per Universal notation (1-32; A-T), dentition affected (primary/permanent), tooth of origin location (maxillary, mandibular, both). Treatment variables analyzed during hospital admission included: location of infection (body of mandible, submandibular, crosses midline, loss of nasolabial fold, loss of nasolabial crease), first service consulted (emergency department, infectious disease, pediatric dentistry, oral/maxillofacial surgery, other), additional services consulted, treatment performed (extraction, root canal, extraction/placement of drain, root canal/placement of drain, no treatment), day treatment was performed compared to day of admission (treatment performed same day as admission = day 0), lab culture performed (yes/no), imaging (periapical, PANO, CT, ultrasound, other), and if general anesthesia was deemed necessary by the department of dentistry. Data was collected on the antibiotic used during the entire hospital stay and what antibiotic was given at the time of discharge. Additionally, data was collected on the analgesic used while admitted and what was given at the time of discharge.

With IRB approval, hospital financial records for this group of patients were obtained, and the amount of total hospital charges and the type of

insurance was determined. Total hospital charges for the emergency room, facility, pharmacy, and dental were obtained. Facility charges included total dollar amount for all tests ordered and charges for all nursing care required. Pharmacy charges included medications given at the hospital. Dental charges included treatment performed on the odontogenic source of infection. Physician charges are separate from hospital charges and these records were not able to be obtained.

5. Data/Statistical Analysis

The database was created using Excel (Microsoft Corp) spreadsheet and then analyzed using Excel statistical software. Bivariate statistics (t or χ^2 statistic) were computed to assess the differences between various study variables. Differences were considered to be statistically significant if $p \leq 0.05$. Additionally, a multivariate logisitic regression was performed comparing variables to total cost and length of stay.

RESULTS

1. Sample Demographics

Medical and dental charts for sixty-three patients admitted for facial cellulitis of odontogenic origin over a six-year period (2000-2006) were reviewed for this study. The male-female ratio was 1:1 (n=31 male; n=32 female) and the mean sample age was 8.3 years ± 3.8. The mean tympanic temperature upon admission was 99.6°F± 1.5. Most patients admitted were from low-income families. The payor sources for the 63 patients admitted were: 12 private insurance, 49 Medicaid, 2 were written off by the hospital, and 0 self-pay. Patients traveled a mean distance of 39.4 miles ± 3.8 to receive care at Nationwide Children's Hospital. Twenty-Eight (45%) patients traveled ≤ 10 miles for treatment. Distance traveled did not significantly impact the overall length of stay (p=0.456). Admissions for pediatric odontogenic cellulitis peaked in the spring with April being the highest month of admission (n=11) and spring accounting for 33% of the total reviewed admissions (FIGURE 1).

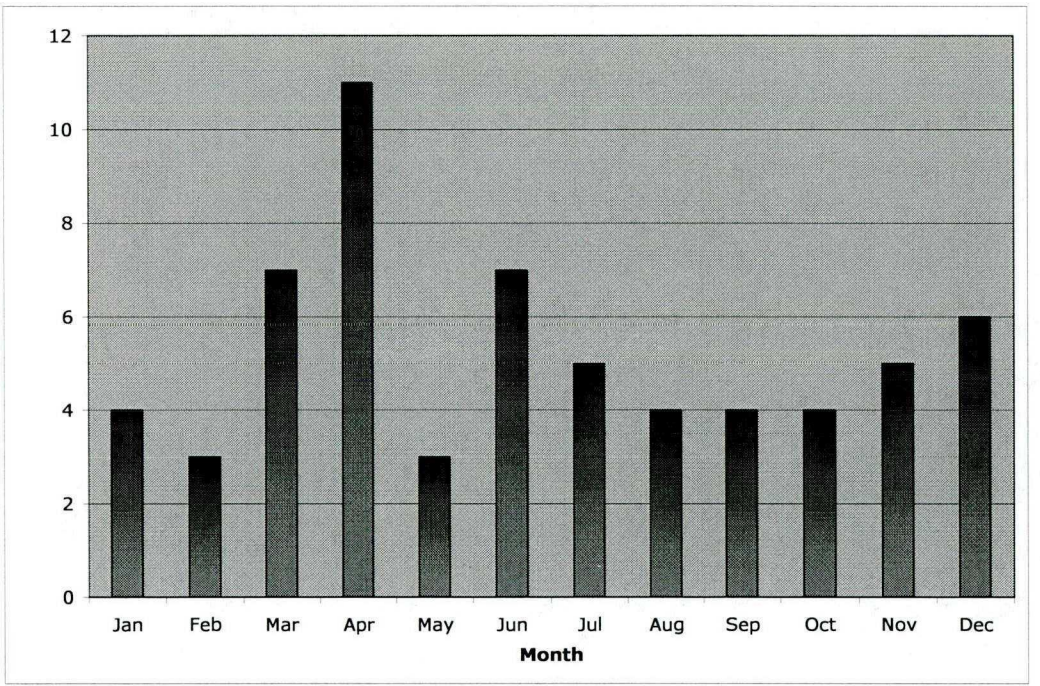

Figure 1: Comparison of the number of admissions per month at Nationwide Children's Hospital due to facial cellulitis of odontogenic origin from the year 2001-2006 (n=63).

2. Cellulitis Characteristics

The majority of facial infections (66%) were located in the upper facial area with 38% unilateral, 18% bilateral, and 10% exhibited both upper and lower facial infections (FIGURE 2). Orbital cellulitis was present in 48% of admitted patients. Maxillary primary and permanent teeth accounted for 57% of odontogenic infections. While mandibular teeth represented 40% and a combination of both maxillary and mandibular tooth infections accounted for 3% of facial cellulitis cases. The most common primary teeth of origin were the

maxillary first primary molars (FIGURE 3). While the mandibular right first molar was the most common permanent tooth of origin (FIGURE 4).

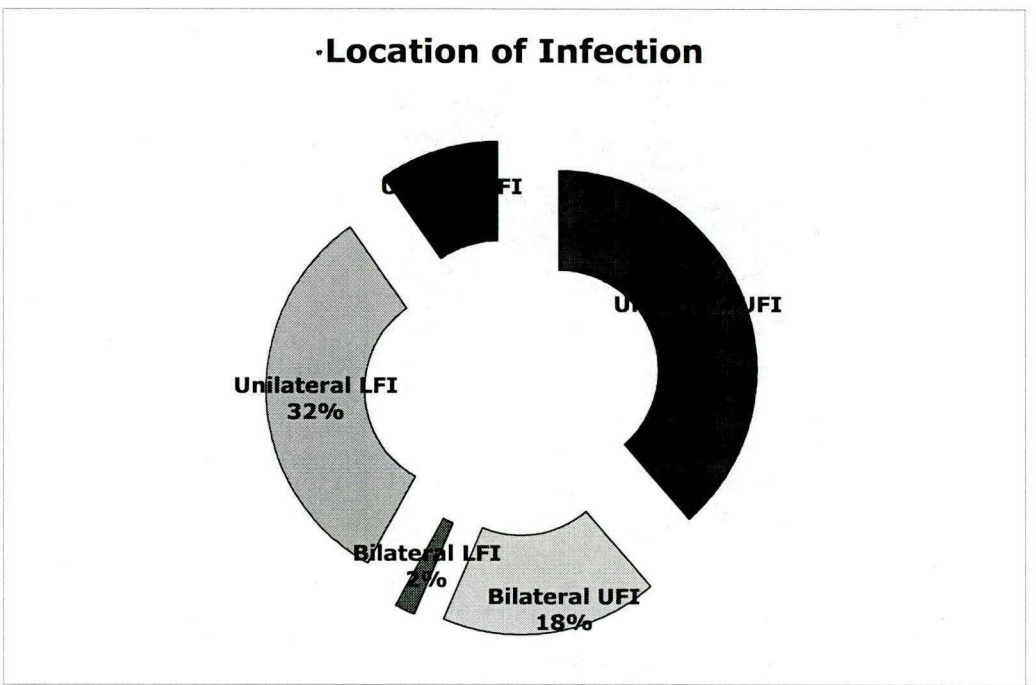

Figure 2: Comparison of the location of the facial infections (n=63). Unilateral upper facial infections (UFI) accounted for 38%, bilateral UFI represented 18%, unilateral lower facial infections (LFI) represented 32%, while a combination of UFI and LFI accounted for 10% of total infections.

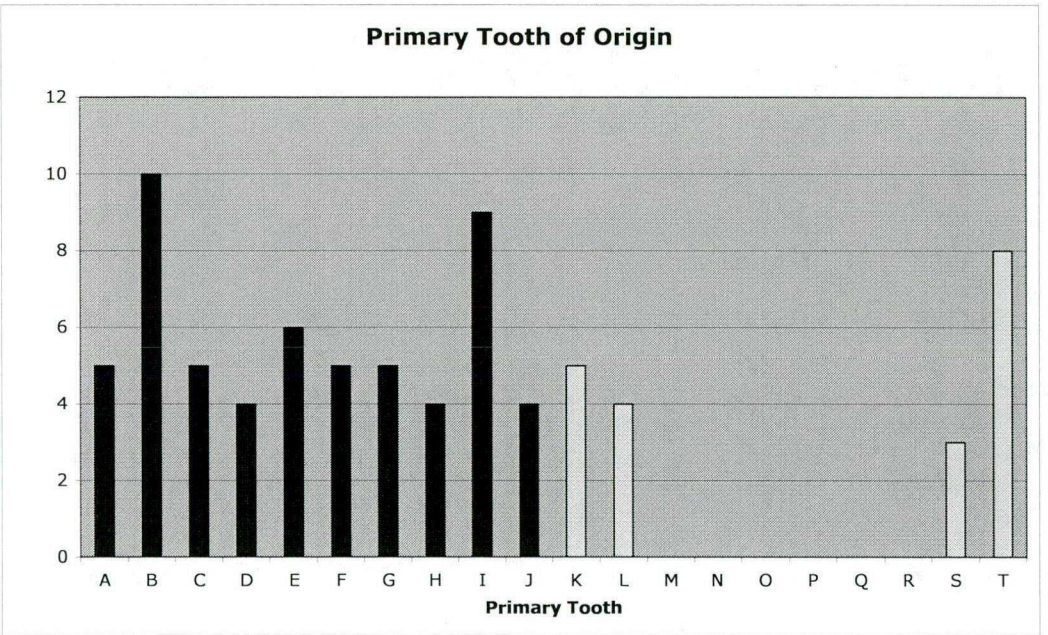

Figure 3: 71% of the primary tooth involvement in our study involved the posterior primary molars with the maxillary first primary molars (#B/#I) being the most common cause of primary tooth odontogenic infections. However, only 29% of primary tooth odontogenic infections were due to primary maxillary incisors (#D, #E, #F, and #G).

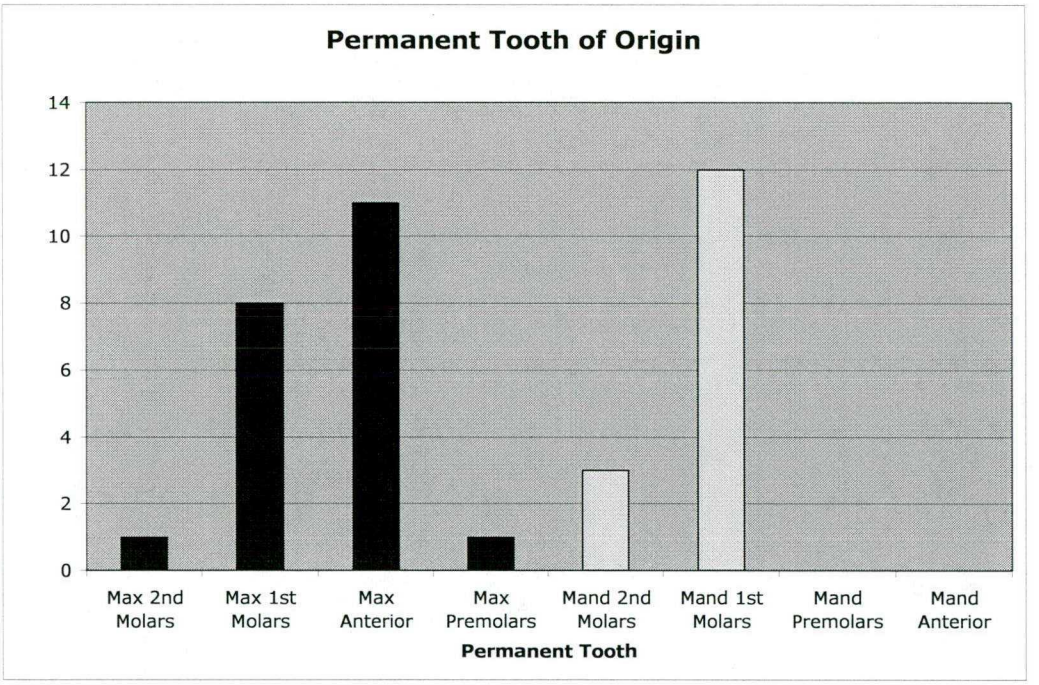

Figure 4: Mandibular molars were most likely to be involved in posterior permanent dentition cases with tooth #30 being the most common (n=6) The permanent dentitions was involved in 44% of cases admitted for facial cellulitis.

3. Management

Pediatric dentistry was consulted in all of the cases reported to have facial cellulitis of odontogenic origin. The pediatric dental department was the first service consulted in 62% of admission cases with the emergency department physician consulted first on 38% of cases. With imaging, 81% of patients received periapical films, 35% panoramic, and 19% received CT scans (FIGURE 5). Patients were significantly more likely (43%) to receive a CT scan when first examined by a emergency department physician when compared to only 5% of the time being first examined by pediatric dentistry (p=0.0004).

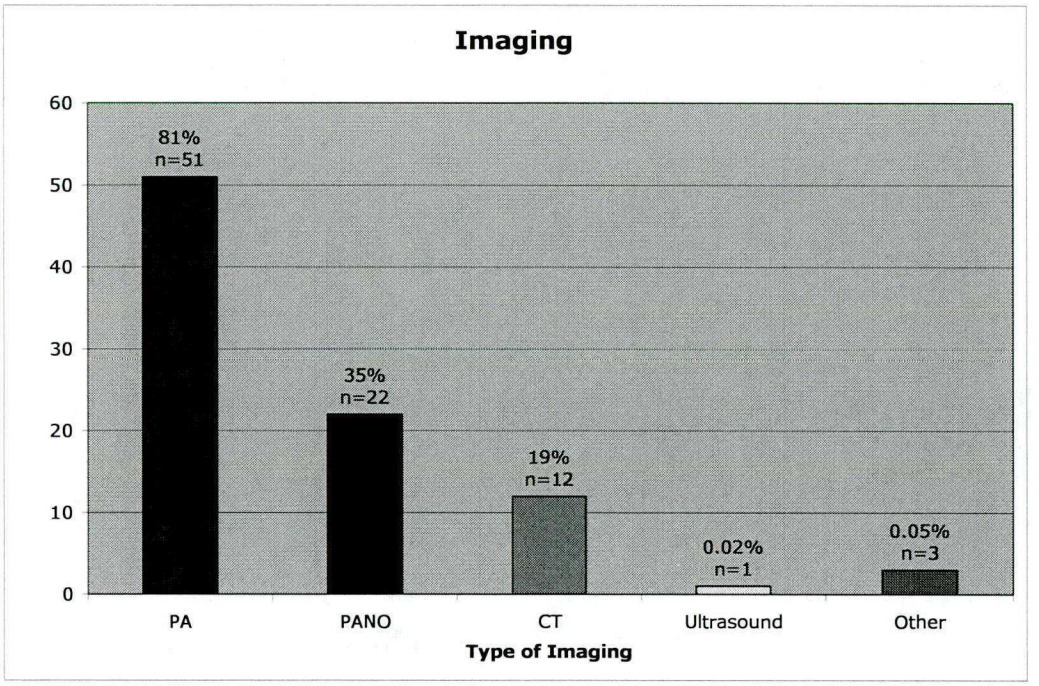

Figure 5: 81% of patients received periapical films, 35% panoramic, and 19% received CT scans. Patients were significantly more likely (43%) to receive a CT scan when first examined by a emergency department physician when compared to only 5% of the time being first examined by pediatric dentistry (p=0.0004).

The majority of patients had surgical or dental interventions within the first two days of admission (81%). 37% of patients received definitive treatment (i.e. extraction, RCT) on the same day of admission. Overall, the most common management was extraction (n=47; 75%) followed by root canal therapy at (n=11; 17%) and no treatment performed (n=5; 8%).

Following admission for facial cellulitis of odontogenic origin, all study patients were placed on IV antibiotics with 59% receiving Cleocin while the remaining 41% received IV Unasyn. Location of cellulitis was not a factor in

antibiotic selection (p=0.785). The majority of patients required additional analgesics (n=59; 94%), with Tylenol being the most likely to be prescribed (n=24; 38%). Upon discharge, 95% of patients were prescribed oral antibiotics with Augmentin (n=36; 60%), Clindamycin (n=21; 35%), Pen V (n=2; 3%), and Amoxicillin (n=2; 2%) being the most likely prescribed by infectious disease physicians respectively. However, only 41% of patients were discarcharged with an analgesic with Tylenol again being the most likely to be prescribed (n=10; 38%).

The total hospital charges for all 63 patient admissions were $258,513 and ranged from a high of $13,112 to a low of $944. The mean charge of admitted patients was $4,138 ± 2,376. It should be noted that annual inflation rates that range between 3-4% were not taken into consideration when tabulating the mean total cost over the six year study period. General anesthesia was needed in 17% of patients (n=11). General anesthesia significantly impacted total cost by an average of $3,083 ± 1,199 (p = 0.0008). However, treatment of all additional caries during general anesthesia did not significantly alter total cost (p=0.9860) when single tooth and full mouth procedures were compared. Treatment of additional teeth and overall access to general anesthesia increased in 2005 with the opening of a dental outpatient surgery center at Nationwide Children's Hospital.

DISCUSSION

In the surgical literature, there are several studies that focus on the epidemiology of odontogenic infections that are relevant to this investigation. Their study designs will be summarized and then comparisons made with the present study. However, there are few if any studies that have looked at the multiple variables involved with facial cellulitis of odontogenic origin and compared definitive treatment performed to length of stay and the overall cost of treatment. The current study focused on the benefits of the involvement of dentistry in patients admitted for facial cellulitis of odontogenic origin and the subsequent decrease in length of stay and total cost.

1. Gender

Previous literature describing the relationship between patient gender and the incidence of odontogenic infection has been contradictory and confounding. Dodson et al found that in 113 pediatric patients with maxillofacial infections of odontogenic or nonodontogenic origin, there was a male predominance with 67 males (59%) and 46 females (41%) ($p=0.008$)[4]. More recently, Lin et al found an equal distribution in the pediatric population with 28 boys and 28 females diagnosed with facial cellulitis of odontogenic origin[7]. In this study, no significant difference ($p=0.8997$) was seen between gender differences in the pediatric population with 32 females (49%) and 31 males (51%). It appears that from our study and others that gender does not play a substantial role in the occurrence of facial cellulitis of odontogenic origin.

2. Age

There have been few reports describing pure odontogenic infections in the pediatric population. This makes it challenging to determine an age in which children are most likely to incur an odontogenic infection requiring hospitalization. Of the 63 patients admitted in this study, the mean age was 8.3 years ± 3.8. Similarly, Unkel et al reported that odontogenic cellulitis generally occurred in older children with a mean age of 8.8 ±4.4 years compared to nonodontogenic infections (4.4 ± 4.7 years)[6]. Lin et al reported an average age of 5.7 ± 2.7 years in an odontogenic infection population while Ettelbrick et al reported a mean age of 7 years[7,22]. In another study which included both odontogenic and nonodontogenic causes of facial cellulitis in the pediatric population, Dodson et al found an average age of 4.55 ± 0.4 years[4]. One would assume that many of the facial infections of odontogenic origin would be due to early childhood caries (ECC), which most likely would affect the upper anterior teeth due to nursing bottle decay. The American Academy of Pediatric Dentistry (AAPD) defines ECC as affecting children <72 months, and therefore this national definition imparts some clinical relevancy to this point[23]. In the present study only 17 patients (27%) were <72 months, with the mean age of those patients being years 4.2 ± 1.1 years.

3. Admission Temperature

Unkel et al reported that when comparing pediatric odontogenic to nonodontogenic infections, nonodontogenic infections had a significantly higher

mean temperature (101.1 ± 2°F) than the odontogenic group (99.5 ± 2°F)[6]. Similarly, we found a mean temperature of 99.6 ± 1.5°F. Temperatures are generally considered to be febrile when the temperature is greater than 97.7°F[6]. It appears that many odontogenic facial infections due not have a dramatic rise in temperature as compared to nonodontogenic facial infections.

Lin et al reported that nonodontogenic infections showed that *H Influenzae* type b was the most commonly present organism whereas in odontogenic infections, *α-Streptococcus* was the most common cause of odontogenic infections[7]. Febrile rectal temperature elevations greater than 101.3°F can be considered diagnostic for nonfacial H. influenza infections.[24] One could hypothesize that the increased presence of *H. influenza* for nonodontogenic facial infections could be responsible for the higher temperatures noted than compared to the lower mean temperatures with odontogenic infections. However, odontogenic infections are rarely cultured due to the difficulty obtaining invasive cultures in children and the unnecessary added hospital expense if an offending tooth is recognized.

4. Distance Traveled

Nationwide Children's Hospital serves a large underserved population in central Ohio and the surrounding states. Intuitively, it was hypothesized that due to approximately a quarter (22%) of our sample size traveling greater than 50 miles to receive care that there could be a bias to longer periods of hospitalization to monitor greater recovery. However, distance traveled did not

significantly impact the overall length of stay (p=0.456). Additionally, it should be noted that the majority of patients (62%) lived less than 20 miles from the hospital. Although recall and follow-up may become more difficult with increased distance traveled, it does not appear that distance traveled affected treatment or outcome of admitted patients. No previous studies have monitored distance traveled and it appears that it does not play a substantial role in treatment, length of stay, or overall total cost if treatment is performed during the hospital stay. However, if definitive treatment was not performed during hospital admission, distance traveled may prove to increase recurrent hospital admissions due to decreased access or follow-up care.

5. Season of Admission

The greatest number of cases occurred in the spring, between March and May with April having the highest incidence of admissions (n=11). Our findings are consistent with previous literature, which observed a peak in facial cellulitis during the spring season.[6,7,28] It has been proposed that this is caused by seasonal shifts, which make children more susceptible to infection by bacteria such as H Influenzae. However, facial cellulitis is difficult to culture, especially in children. It remains unclear why seasonal changes and a peak in odontogenic infections in the pediatric population would also increase in the spring.

6. Location of Infection

It has been reported that orofacial odontogenic infections travel into the anatomic spaces of least resistance.[26] Our study found that the majority of

odontogenic cases were located in the upper face with 56% located purely in the upper face and additional 10% located in both the upper and lower face. These findings are consistent with previous literature, which similarly found that upper face infections outnumbered lower facial infections[6,7,20]. However, contrary to previous literature which reported an increased length of stay and morbidity in lower face infections, we found no significant difference in the overall length of stay and treatment between upper and lower facial infections (p=0.914).

7. Tooth of Origin

Our study found that the majority of odontogenic cases were located in the upper face, and that the source of the infection was more often from deciduous posterior teeth (43%) than deciduous anterior teeth (17%) or all permanent teeth (40%). Lin et al reported that 75% of teeth involved in primary tooth odontogenic infections were posterior primary molars.[7] However, it was not reported specifically what teeth were seen to be the most frequently the source of the infection.[7] Similarly, we found that 71% of the primary tooth involvement in our study involved the posterior primary molars with the maxillary first primary molars being the most common cause of primary tooth odontogenic infections. This may be associated with ECC/S-ECC, which occurs most often in the maxillary anterior primary teeth and molars. However, only 29% of primary tooth odontogenic infections were due to anterior primary teeth. This may suggest that ECC is more likely to cause a more serious odontogenic infection requiring admission in the posterior primary teeth while affecting the anterior primary teeth with greater frequency.

The majority of research involving tooth involvement in odontogenic infections has been completed in the adult population focusing on the permanent dentition. It has been shown that mandibular molars are the most common source of infection in the permanent dentition of an adult population.[20,25,26] Specifically, the mandibular third molar has been shown to be the most common source of infection in the adult permanent dentition.[20] Our findings in the pediatric population supported this finding with 81% of the permanent molar involvement being mandibular molars with tooth #30 being the most common.

8. Day of Treatment

According to the protocol used in treating all odontogenic infections requiring admission, we treated the offending tooth/teeth as soon as possible with definitive treatment, which included extraction or pulp therapy along with intravenous antibiotics. No significant differences were seen when treating the tooth on the day of admission versus later in the hospital stay when compared to length of stay. However, control samples treating only with antibiotics were not available due the retrospective nature of this study. This is the only current pediatric manuscript describing early treatment and elimination of the source of the infection at the time of admission or as soon thereafter as possible. Traditionally, it has been suggested that the standard is to treat with aggressive antibiotics during the hospital stay and treat the offending teeth following discharge. This can lead to decreased follow-up and elimination of the offending source of the infection with possible recurrence.

9. Length of Stay

Although no significant differences were seen between treating the offending odontogenic source of infection upon admission versus later during the hospital stay, it can be noted that the mean length of stay for this study was 2.03 days ± 0.99. This mean length of stay is substantially lower when compared to previous reports that range from 4.4 to 8.9 days[7,27,29]. Dodson reported an average length of stay of 3.5 days for a pediatric population.[4] However, Dodson et al's study included both odontogenic and nonodontogenic pediatric samples and only one of twenty-two odontogenic cellulitis patients had a length of stay shorter than 4 days.[4] The majority of studies include mixed odontogenic and nonodontogenic samples. We propose that the dramatic decrease in the overall length of stay in our study is due to the aggressive, definitive treatment given at the time of admission or soon thereafter followed by intravenous antibiotics. This eliminates the primary source of the infection allowing antibiotics to work at a faster rate of resolution.

10. Analgesic

Pediatric pain control for odontogenic infections is dramatically under researched and unknown. Much of this has to do with the ability of the child to express accurate pain levels and the practitioner balancing safety with overall need to control pain in the pediatric population. There are currently no studies that have focused on pain control in the pediatric population for odontogenic infections requiring hospital admission. Our study found that the vast majority of

patients required or were given an analgesic 94% of the time. Acetaminophen alone was needed in 38% of the cases followed by ibuprofen (16%) and a combination of acetaminophen and ibuprofen (16%). Overall, 70% of patients admitted for facial cellulitis were able to be comfortable with acetaminophen and ibuprofen or a combination of the two. Interestingly, only 41% of patients were discharged with pain medicine. No significant difference was seen between discharging children with pain that were less that 6 years old compared to children greater than 6 years old (p=1.000). This could be representative of pain resolution due to antibiotics and definitive treatment or underprescribing due to the inability of children to accurately describe pain levels. During admission and upon discharge, the patient's pain is assessed using a FACES scale that ranges from 1 (smiling with no pain) to 10 (crying, uncontrollable pain).

11. Antibiotics

In clinical odontogenic infections requiring hospital admission, the consequences of inadequate antibiotic coverage may be both serious in nature and rapid in onset and hence it is essential that the possibility of the responsible organisms being resistant to the chosen antibiotic is minimized.[30] Although penicillin remains the antibiotic of choice for mild to moderate odontogenic infections in the immunocompetent host,[14,15] several authors recommend that it should not be used as initial therapy for more serious infections possibly involving penicillin-resistant oral anaerobes.[16,30] As reported previously, upper face infections have more varying microbial flora when compared to lower face infections[4,5,7]. Both intravenous clindamycin (Cleocin) and ampicillin/sulbactam

(Unasyn) are indicated for treatment of serious odontogenic infections[16]. No significant difference was seen in the overall length of stay when comparing Cleocin to Unasyn (p=0.785) in both upper face infections and lower face infections.

Overall, 95%of patients of were discharged with oral antibiotics. Interestingly, 60% of patients were discharged with Augmentin instead of the preferred discharge antibiotic being oral clindamycin, penicillin, or amoxicillin/clavulanate. This is most likely due to a study bias where the hospital infectious disease department discharged the patient instead of the pediatric dental department.

12. Imaging

When evaluating pediatric odontogenic facial infections it is important to balance the need for accurate diagnostic and informative radiographic imaging with need and efficacy of overexposure of the developing child. In this study, 81% of patients received periapical radiographs, 35% received a panoramic radiograph, and 19% received a CT scan. Overall, no significant difference was seen when comparing overall length of stay when comparing the minimal radiographic exposure of a periapical radiograph to the more aggressive CT scan (p=0.895).

Nationwide Children's Hospital is one of the few pediatric hospitals that has a full time presence of dentistry in the emergency department. Thus, many of the facial cellulitis patients that would typically be examined by ED physicians are first triaged and consulted by dentistry first at Nationwide Children's Hospital.

Pediatric dentistry was the first service consulted in 62% of patients with odontogenic facial cellulitis with the emergency department physician being the first service consulted in the remaining 38% of patients. However, patients triaged for facial cellulitis of odontogenic origin were significantly more likely to get a CT 43% of the time when first consulted by an emergency department physician compared to only 5% of the time when consulted by dentistry (p=0.0004). With no observed benefit in all of our study patients, substantial overall total cost increase, and the additional risk of radiographic exposure that a CT scan presents to the growing child, the physician/dentist should consider less aggressive radiographic exposure.

13. Total Cost

As reported previously, the mean length of stay was 2.03 days ± 0.99. The overall mean total cost to treat patients admitted of odontogenic facial cellulitis was $4,138 ± 2,376. This cost is higher than previously reported $3,223 by Ettelbrick et al in 2000[22]. Inflation and rising health care costs could account for the majority of the discrepancy. However, if general anesthesia was needed to treat patients due to cooperation or morbidity, a significant cost increase of $3,083 ± 1,199 was required (p=0.0008). Interestingly, treatment of all additional caries in addition to the offending tooth did not significantly increase the overall cost of treatment (p=0.9860). Thus, in cases where general anesthesia is

required, it should be the gold standard to treat all additional caries and improve overall health and decrease future incidence of hospital admission for facial cellulitis.

CONCLUSION

Retrospective studies provide baseline data for further investigation and treatment recommendations. However, they have limitations. Limitations in our study include interpretation from multiple medical and dental practitioners, differences in treatment protocol if consulted by medical prior to dental, poor preadmission history of symptoms and medications, and the development of a control protocol versus an experimental protocol that could determine the efficacy of the treatment protocol used in this study.

When dealing with odontogenic infections that require hospital admission in the pediatric population, early diagnosis and treatment are critical. Aggressive management of cellulitis through the use of antibiotics and definitive treatment as rapidly as possible will help decrease systemic symptoms and overall morbidity. With proper diagnosis, antibiotic treatment, and aggressive surgical/dental interventions all cases in this study were cured with minimal morbidity.

Both medical and dental clinicians alike can use the data in this study to better evaluate and treat pediatric facial infections. Odontogenic facial infections should be considered as a differential diagnosis in all cases of facial cellulitis. According to the results of this study, a pediatric patient with odontogenic facial cellulitis would most likely: 1) occur in children with caries or trauma to the mixed dentition irrespective of gender 2 have an admission temperature less than 100°F 3) occur in the spring 4) afflict the upper facial region with more frequency 5) benefit from definitive treatment as early as possible following hospital admission 6) receive aggressive intravenous antibiotics. Overall, fast and

aggressive treatment of odontogenic infections appears to shorten the length of stay, decrease morbidity, and decrease the financial burden.

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