Management of Caries-Related Visits to a Pediatric Hospital Emergency Department

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Abstract

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Purpose: The purposes of this study were to: (1) identify characteristics of patients visiting a pediatric emergency department (ED) for dental caries and infection, (2) describe the medical and dental services provided to these patients, (3) quantify and compare treatment and wait times in the ED for dental caries and infection emergencies, and (4) examine the relationship between wait times in the ED and triage acuity scores, pain scores, and National Emergency Department Overcrowding Scale (NEDOCS).

Methods: This is a descriptive study of data collected from a retrospective, cross-sectional, chart review of all after-hours patients receiving emergency dental treatment for dental caries and infection at Seattle Children's Hospital from January 1, 2008

through December 31, 2010. Demographics, triage acuity, pain scores, and medical/dental treatment and times were analyzed.

Results: A total of 155 patients (99 males and 56 females) with dental caries and infection presented to the ED during the study period. Demographics and dental treatments were similar to previous studies. Mid-level triage scores were assigned to most patients (79%). Pain scores were moderate to severe for 40% of patients. The most frequently provided medical services were writing prescriptions (70%) and administration of medications in the ED (68%). There was a significant association between pain score and pain management; as pain scores increased, there was an increase in both administration and prescription of non-narcotic analgesics ($p=0.043$ and $p=0.046$, respectively) and narcotics ($p=0.007$ and $p<0.001$, respectively). The mean times were 77 minutes waiting for an ED physician, 55 minutes for dental treatment, and 238 minutes for overall length of stay (LOS). Dental consultation and treatment averaged 23% of time spent at the hospital. Higher pain levels resulted in increased overall LOS. On average, administration of medications in the ED significantly increased LOS by 73 minutes ($p<0.001$), and writing a prescription significantly increased LOS by 54 minutes ($p<0.001$). Twenty-one percent of patients needed hospital admission, and the mean admit length of stay for these patients was 40 hours.

Conclusion: Dental treatment provided in a hospital ED is inefficient and time-consuming with significant healthcare resource utilization. Dental treatment accounted for only 23% of total time spent in the ED, and most patients required no advanced medical intervention. The economic implications of managing dental caries and infection

in an ED are unfavorable for patients, hospitals, and third party payers. An outpatient dental clinic could provide treatment for most of these pediatric dental emergencies at significantly reduced cost in patient time and healthcare resources.

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DEDICATION

I would like to dedicate this project to my family and friends. To my fellow residents for an unforgettable two years of residency - thank you for being the ones that made me smile when things were down and for sharing in the joys when things were good. To my mom and Pete for your unwavering confidence in me and for your love and guidance. To my big brother, Brian, for teaching me how to thrive in my own skin and for being an amazing example of whom I strive to be. To my family in Seattle for feeding me, for taking such good care of me, and for allowing me to be a fourth child in their family. And lastly, in loving honour and memory of my father, who continues to be an inspiration, who provides me strength, and who continues to be a part of every aspect of my life. All of you have taught me the values and the skills necessary to be who I am and to achieve everything that I have. I believe in myself because you believe in me. Thank you, and I love you all. I would like to close off with a few words from Tony Robbins,

"Life is a gift, and it offers us the privilege, opportunity,
and responsibility to give something back by becoming more."

INTRODUCTION

Dental caries, plaque-induced demineralization of enamel or dentin, is a common and complex disease. It has been identified as the most prevalent unmet chronic health need in children in the United States and subsequently, dental caries is considered the most prevalent disease in children in the U.S. (Vargas, Crall, & Schneider, 1998). This is a concern considering that dental caries and its sequela, infection, are preventable conditions for the majority of children.

The American Academy of Pediatric Dentistry (AAPD) adopted a policy supporting the concept of a dental home in 2001 (AAPD Policy on the Dental Home, 2013a). The dental home establishes a relationship between a child and his/her family and the dentist to provide comprehensive oral care including individualized dental education, preventative services, and emergency dental treatments. In theory, a dental home would reduce the incidence of a preventable condition escalating where hospital emergency services are needed. The dental home should also be the first point of contact for any acute dental emergency needs.

Dental caries emergencies have been the subject of multiple investigations (Cohen, Manski, & Hooper, 1996; Davis, Deinard, & Maïga, 2010; Dorfman, Kastner, & Vinci, 2001; Ettelbrick, Webb, & Seale, 2000; Graham, Webb, & Seale, 2000; Ladrillo, Hobdell, & Caviness, 2006; Rowley, Sheller, Williams, & Mancl, 2006; Sheller, Williams, & Lombardi, 1997; Vargas et al., 1998; Wilson, Smith, Preisch, & Casamassimo, 1997; Zeng, Sheller, & Milgrom, 1994). Reasons for presenting to emergency departments

(EDs) with caries emergencies include: lack of dental insurance coverage, lack of awareness about how and where to find appropriate care, and lack of after-hours dental care provided by dentists (Dorfman et al., 2001; Pettinato, Webb, & Seale, 2000; Rowley et al., 2006; Von Kaenel, Vitangeli, Casamassimo, Wilson, & Preisch, 2001).

Treatment of dental caries in the ED is costly and inefficient (Ettelbrick et al., 2000; Pettinato et al., 2000). Services provided for dental care in the ED are more expensive, time-consuming for patient, and incomplete compared to the services provided in a dental clinic for the same condition (Ettelbrick et al., 2000; Pettinato et al., 2000). Dental treatments provided in the ED setting are usually not definitive and still require follow-up with a regular dentist (Graham et al., 2000). The inefficiencies and costs compound the problem especially when a patient has visited two separate emergency departments for the same problem (in the case where one ED refers to another ED) (Rowley et al., 2006; Sheller et al., 1997). The cost of providing dental care in the ED setting is a burden to a health care system that already has limited resources.

The medical services provided to patients with dental caries emergencies have not been described. A recent study of dental trauma emergencies at a pediatric hospital ED found that the most frequently provided medical services were administration of analgesics and writing prescriptions (Mitchell, Sheller, Velan, Caglar, & Scott, 2014). The mean overall hospital time was 176 minutes with time for dental consultation and treatment averaging 32% of time spent at the hospital. Patients spent most of the time waiting for physicians and receiving non-dental services. For nearly all patients, services could have been provided at an outpatient dental clinic.

PURPOSE

The aims of this study were to: (1) identify characteristics of patients visiting a pediatric ED for dental caries and infection, (2) describe the medical and dental services provided to these patients, (3) quantify and compare treatment and wait times in the ED for dental caries and infection emergencies, and (4) examine the relationship between wait times in the ED and triage acuity scores, pain scores, and National Emergency Department Overcrowding Scale (NEDOCS).

METHODS

This is a descriptive study of data collected from a retrospective, cross-sectional, chart review. The records of 151 patients with 155 after-hours patient encounters receiving emergency dental treatment for dental caries and infection at Seattle Children's Hospital (SCH) from January 1, 2008 through December 31, 2010, were analyzed in this Institutional Review Board-approved study. There were two separate emergency visit encounters reported for 4 of the 152 patients; their second visit involved a different dental emergency issue than their first encounter, and each encounter was considered a separate observation. For ease of reporting results, the results will be based on and referred to as "155 patients".

SCH is a tertiary-level pediatric teaching hospital containing 245 beds in Seattle, Washington (King County). Care is provided for pediatric patients up to age 21 years. After-hours emergency calls occur during weekdays (5:00pm to 8:00am), weekends, and holidays.

Upon arrival to the ED, patients initially see a pediatric nurse practitioner who determines that the patient's complaint relates to a dental problem, records a pain score, and assigns an Emergency Screening Index (ESI) triage score. The triage score reflects the urgency and complexity of a patient's problem(s) and ranges from 1 to 5, with lower numbers representing a more emergent or complex problem (Appendix A). Pain is scored from 0 to 10 with higher numbers representing more severe pain. Following initial assessment, patients are evaluated by a medical resident or nurse practitioner followed by an ED attending. Medications are administered in the ED as

indicated. The length of time between a patient's initial triage assessment and their evaluation by a medical resident and attending depends on many factors in the ED at any particular time. The National Emergency Department Overcrowding Scale (NEDOCS) is a linear regression model that is used to indicate the activity level of the ED at a particular moment in time (Weiss et al., 2004). NEDOCS is recorded every 4 hours and scored from 0 to 200 with higher numbers representing a more crowded ED (Appendix B).

If it has been determined by the medical team that the patient requires dental consultation and/or treatment, the patient is referred to dental residents on call. The dental residents escort the patient to the dental clinic for a problem-focused dental examination and needed treatment(s). All emergency patients are treated by pediatric dental residents with an attending pediatric dentist available as needed. At the completion of dental treatment, the patients returned to the ED where the medical team determines disposition, writes prescriptions, and discharges patients from the ED. The overall length of stay (LOS) is the time from patient registration until discharge from the ED to home or to hospital admission. A patient's flow through the ED is depicted in Figure 1.

A decision may be made by the medical team to admit certain patients. Reasons to admit a patient include: trismus indicating possible masticator space involvement, severe facial cellulitis, deep space infection, rapid progression of infection, risk of airway compromise, fever and malaise, or a medically fragile patient. Rarely, a patient may be

admitted in conjunction with child protective services due to social concerns involving neglect or non-accidental trauma.

Data for this study was collected from multiple sources: electronic medical record (Computerized Information System (CIS)™), Epic Hyperspace™, FirstNet™, Invision Database, ED Sharepoint, physical medical chart, and an electronic SCH Department of Dentistry After-Hours Patient Log. Data was entered into an Excel™ spreadsheet by a single dentist examiner trained in record abstraction during a pretest. Fifteen records were randomly selected for re-examination and data entry by two other investigators and found no differences from the primary examiners' records. Categories of variables collected were:

1. Sociodemographic
2. Signs and symptoms
3. Medical management
4. Dental management
5. Hospital admissions
6. Emergency department operations and logistics

All variables recorded for this study are listed in Appendix C.

All data was analyzed with Stata™ version 12.0 (College Station, TX). Descriptive statistics, including means and standard deviations for quantitative measures and counts and percentages for categorical variables were calculated. Mean age and wait times were compared between patient statuses (admitted or discharged to home), medical services provided (medications administered in the ED and prescriptions

written), patient groups, and pain scores using 2 sample t-tests and ANOVA. Chi-square and Fisher's exact tests of association were used to compare group frequencies. The significance level was set *a priori* to 0.05.

This study was conducted under committee guidance as a partial requirement for the Master's of Science in Dentistry Degree at the University of Washington.

RESULTS

Sociodemographic

A total of 155 patients with dental caries and infection (129 involving primary teeth and 26 involving permanent teeth) presented during the study period. Mean patient age was 7.3 years (standard deviation (SD) = 3.8), and males presented more than females (63.9% vs. 36.1%). Patients were 44.5% Caucasian, 16.8% African American, 11.0% Asian, and 10.3% Hispanic. Fifteen percent required a medical interpreter. Most frequent payers were Medicaid (54.8%) and private insurance (32.3%). The majority of patients were self-referred (64.5%), and 10.3% were referred from other hospital EDs. Ninety-four percent of patients came from the immediately neighboring counties. (Table 1)

The majority of patients had a dental home (61.9%). Of the 59 patients without a dental home, the mean age was 6.8 years (SD=3.9). Seventy-three percent of those without a dental home were self-referred. Those without a dental home had similar demographics compared to the entire sample (Table 2).

Signs and symptoms

Pain scores reports by the 155 patients were: 53.6% low pain scores (0-3), 27.1% moderate pain scores (4-6), and 12.9% severe pain scores (7-10). Eighteen percent of patients reported no pain upon presentation to the ED. Most patients (85.9%) reported a history of pain. Other patient signs and symptoms included: extraoral swelling (72.9%), decreased oral intake (48.4%), localized fistula or abscess (41.9%), intraoral vestibular

swelling (39.3%), and fever over 37.7°C (10.3%). Of the 43 patients with a history of fever, 81.4% had a fever of 3 days or less. Of the 135 patients with a history of swelling, 85.2% had a swelling of 3 days or less. The most frequent location for swelling was cheek (57.4%), periorbital (20.0%), submandibular (14.2%), lip (10.3%), and sublingual (2.6%). Table 3 summarizes signs and symptoms for all patients and the groups of patients discharged to home versus admitted to the hospital. These findings will be further discussed when describing results for admitted patients.

Of the 155 patients, 69.7% involved one tooth compared to 27.7% involving multiple teeth. The most commonly affected primary teeth were first molars (51.3%). Forty-eight percent of patients had a previous dental visit for the same problem that brought them to the ED. Of the 67 patients (43.2%) with previous dental treatment involving the affected tooth, composite restorations were the most frequent treatment (50.7%). Seventy-nine percent of patients had radiographic pathology reported following examination of dental radiographs. Thirty-nine percent of patients had severe early childhood cares (S-ECC) as defined by the AAPD (AAPD Policy on Early Childhood Caries, 2013b). Table 4 summarizes dental signs and symptoms for all patients and the groups of patients discharged to home versus admitted to the hospital.

Medical management

One-hundred and six (68.4%) of the patients had at least one medication administered in the ED visit. Of the 155 patients, 39.4% received antibiotics, 35.5% received narcotics, and 33.6% received non-narcotic analgesics. Adjunct services were 21.3% intravenous line for administration of medications, 20.7% hospital admission, 16.8%

laboratory services, 5.8% sedation, and 4.5% CT imaging. One patient received imaging for an unrelated orthopedic complaint. Prescriptions were written for 70.3% of patients: antibiotics (60.0%), narcotics (19.4%), and non-narcotic analgesics (16.1%). (Table 5).

There was a significant association between pain score and pain management. As pain scores increased, there was an increase in both administration and prescription of non-narcotic analgesics ($p=0.043$ and $p=0.046$, respectively) and narcotics ($p=0.007$ and $p<0.001$, respectively). (Table 6)

Dental management

Dental treatments for primary teeth were most often extractions (83.7%) but also included referral to oral surgery services (4.7%), drainage (0.8%), and sedative restorations (0.8%). Conversely, dental treatments for permanent teeth were most often referred to oral surgery services (46.2%), but also included extractions (15.4%), drainage (15.4%), pulpectomy (11.5%), and sedative restoration (11.5%). Behavior management support included nitrous oxide anxiolysis (32.9%) and a protective immobilization wrap (29.0%). (Table 7)

Hospital admissions

Thirty-two patients (20.7%) were admitted to the hospital. Overall, they had a mean age of 7.9 years (SD=3.3) and primarily had a private practice dental home (59.4%). Half of the patients were self-referred (50.0%) and 34.4% were referred from another ED. The

majority of teeth involved were primary teeth (75.0%), maxillary teeth (59.4%), and posterior teeth (71.9%). (Table 8)

Signs and symptoms that were significantly associated with admit status included: history of fever ($p=0.007$), localized fistula or abscess ($p=0.029$), vestibular intraoral swelling ($p=0.003$), and swelling location ($p<0.001$). Those patients with swelling located in the cheek, periorbital, submandibular, and sublingual regions were more likely to be admitted than those with lip swelling. All four patients with sublingual swelling were admitted. (Table 3)

The mean admit length of stay was 40.3 hours (SD=35.3). Services provided to the admitted patients during their hospital stay included: antibiotics (93.8%), placement and/or maintenance of an intravenous line (87.6%), consultations (56.3%), non-narcotic analgesics (50.0%), narcotic analgesics (40.6%), dental treatment under general anesthesia (40.6%), and laboratory services (18.8%). (Table 8)

Emergency department operations and logistics

Time was spent waiting for providers and receiving medical and dental services. The mean overall length of stay (LOS) in the ED was 238.0 minutes (SD=98.8), nearly 4 hours. Although patients admitted to the hospital did not differ from patients discharged to home in wait times until triage, wait times for physicians, or dental treatment times, their overall LOS was significantly longer (316.8 minutes vs. 217.3 minutes, $p<0.001$). (Table 9)

On average, physician wait times (77.2 minutes, SD=63.7) were significantly longer than dental treatment times (54.8 minutes, SD=26.3) ($p<0.001$) (Table 10). Twenty-three percent of time in the ED was spent receiving dental treatment for all patients presenting with caries and infection (Figure 2).

Triage scores were recorded for all patients. Mid-level triage scores of 3 and 4 were assigned to 78.7% of patients compared to 21.4% of patients who were triaged at a higher acuity level (triage 1 or 2). For non-admitted patients, as triage acuity increased (triage 1 or 2), indicative of more severe illness, there was an increase in physician wait time, a decrease in dental treatment time, and an increase in overall LOS. This contrasted with patients admitted to the hospital; as triage acuity increased (triage 1 or 2), there was a decrease in physician wait time, an increase in dental treatment time, and a decrease in overall LOS. (Table 11)

Pain scores (low, moderate, or severe) were recorded for 145 patients. Patient gender was not associated with pain scores. Pain scores were significantly associated with age ($p<0.001$); patients reporting severe pain were older than those reporting low and moderate pain. Although not significant, as pain level increased from low to moderate/severe, there was a trend towards increased analgesic and antibiotic administration in the ED as well as analgesic and antibiotic prescription. As pain level increased, the overall LOS in the ED also increased; there was a difference in overall LOS of 36.8 minutes for low vs. moderate pain and a difference of 48.1 minutes for low vs. severe pain. There was no relationship between pain scores and wait times for physician or dental treatment times. (Table 12)

On average, administration of medications in the ED significantly increased length of stay (261 minutes vs. 188 minutes, $p< 0.001$). On average, writing a prescription significantly increased length of stay (254 vs. 200 minutes, $p<0.001$). However, specific administration of non-narcotic analgesics in the ED and writing a prescription for either non-narcotic or narcotic analgesics were not found to be significant. (Table 13)

NEDOCS was recorded for 98 of the 155 patients. As NEDOCS increased, indicative of a more severely crowded ED, there was a decrease in physician wait times and in dental treatment time but a general increase in overall LOS. The exception to this is the one patient that presented to the ED at a time when the ED was severely over-crowded (NEDOCS of 144) but had the shortest overall LOS (145.0 minutes). (Table 14)

DISCUSSION

The results of this study are interesting from multiple perspectives: patients and families, ED resource management, and the healthcare system.

All of the parents seeking care for their child at the ED had perceived some acuity in their child's condition (e.g. swelling, fever, loss of appetite, pain). With such concerning symptoms, it is understandable that parents sought emergent care. The ED is the after-hours dental home for patients of SCH Dental Clinic and its community partners, accounting for 11% of the patients in this study. Reasons to come to the ED for the remaining 89% could have included: private dentist was unavailable after-hours, advised to come by patient's physician, and referred from another ED without dental services.

It would be interesting to know what families expect when bringing their child to the ED for a dental problem. It can be assumed that most families are naïve to the ED process. Because there are many layers involved in the ED process, patients spent more time waiting than they did receiving services. An excellent example found in our study was patients receiving ibuprofen or acetaminophen in the ED. This seemingly straightforward service added, on average, 73 minutes to the length of stay. Medications given in the ED must be ordered by a provider, retrieved from a secured area, and administered by a nurse with appropriate documentation. Writing a prescription added, on average, 54 minutes to the length of stay, and this did not include receiving medication from the pharmacy. If parents had been aware that their

ED stay would take 4 hours, some may have managed pain and fever with over-the-counter medications and sought care at a dental clinic the following day.

Dental caries emergencies are rarely life threatening, consistent with the triage scores assigned to patients in this study. Since patient acuity was low, we expected the busyness of the ED to affect their length of stay. Even when the NEDOCS showed that the ED was not busy, the average length of stay was considerable, exceeding 4 hours. There is a limit to how fast the ED patient process can move; only one patient presented when the ED was severely over-crowded (NEDOCS 141-180). That patient's overall LOS exceeded 2 hours, despite receiving no dental treatment beyond examination and waiting less than half an hour for the physician.

The majority of patients did not require advanced medical services. For the 53 patients requiring IV antibiotics and/or hospital admission, the ED was the optimal venue for managing their dental caries emergency. It can be argued that the 66% of patients in our study that did not receive IV antibiotics or admission could have been more efficiently, cost-effectively, and definitively managed in a dental clinic setting. The ED resources used to manage non life-threatening dental problems are diverted from those patients with truly emergent conditions, increasing the burden on ED facility and staff.

The cost of providing care in the ED is high. This does not deter patients from seeking care in the ED because nearly all patients in this study had some form of insurance. Payers wishing to decrease costs associated with dental emergencies could provide encouragement to dentists to manage after-hours patients through financial incentives.

A medical code or dental code unique to after-hours care resulting in a significant payment to providers may lead to clinics offering after-hours services and also offer the patient a more efficient and convenient alternative to the ED.

Limitations

This study includes only patients presenting to the ED and seen by the dental team. Patients evaluated and discharged by the ED team without dental involvement were not included. This undercounts the number of lower acuity caries emergencies during the study. Other limitations are differences in the quality of record keeping among multiple providers, subjectivity of pain scores and triage scores, and missing data.

CONCLUSION

Dental treatment provided in a hospital ED is inefficient and time-consuming with significant healthcare resource utilization. Dental treatment accounted for only 23% of total time spent in the ED, and most patients required no advanced medical intervention. The economic implications of managing dental caries and infection in an ED are unfavorable for patients, hospitals, and third party payers. An outpatient dental clinic could provide treatment for most of these pediatric dental emergencies at significantly reduced cost in patient time and healthcare resources.

FIGURES

Figure 1. Patient flow in ED for pediatric dental emergencies (Mitchell et al., 2014)

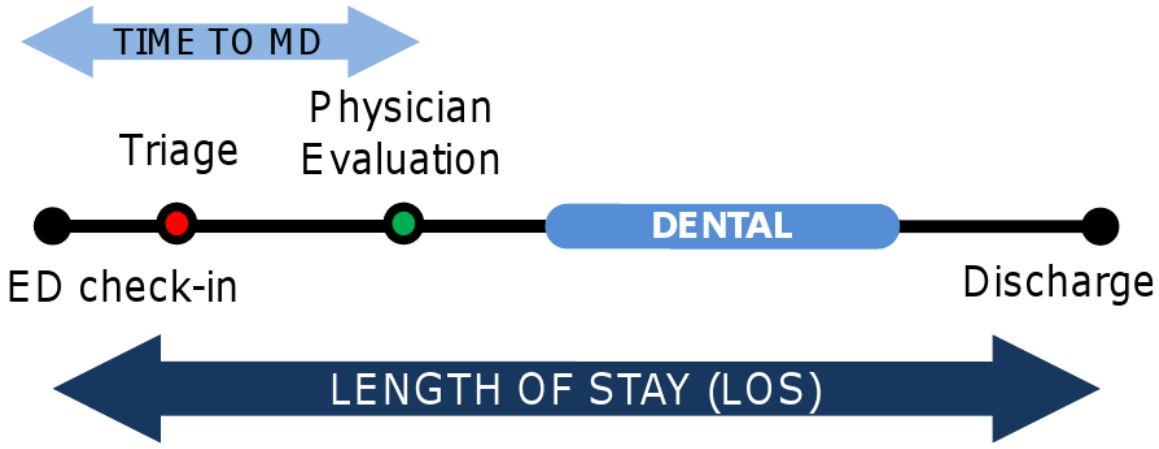


Figure 2. Wait and treatment times for dental caries and infection patients presenting to a hospital ED

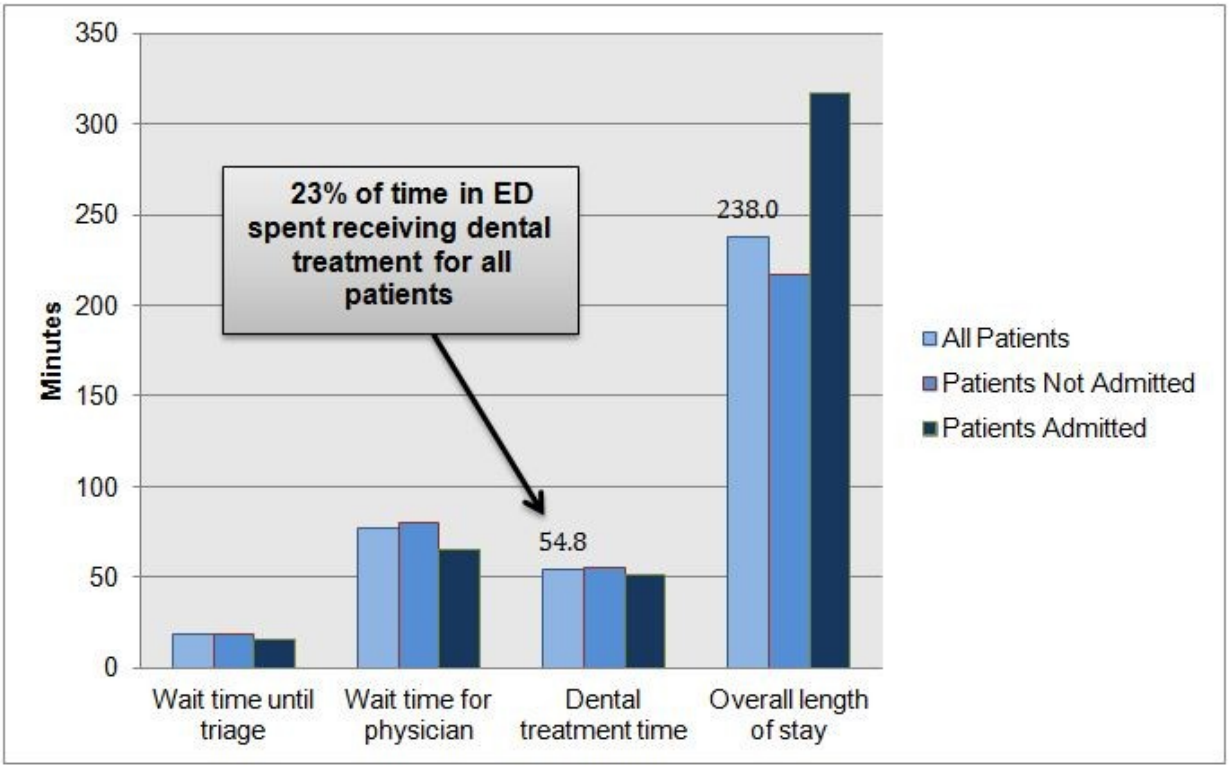
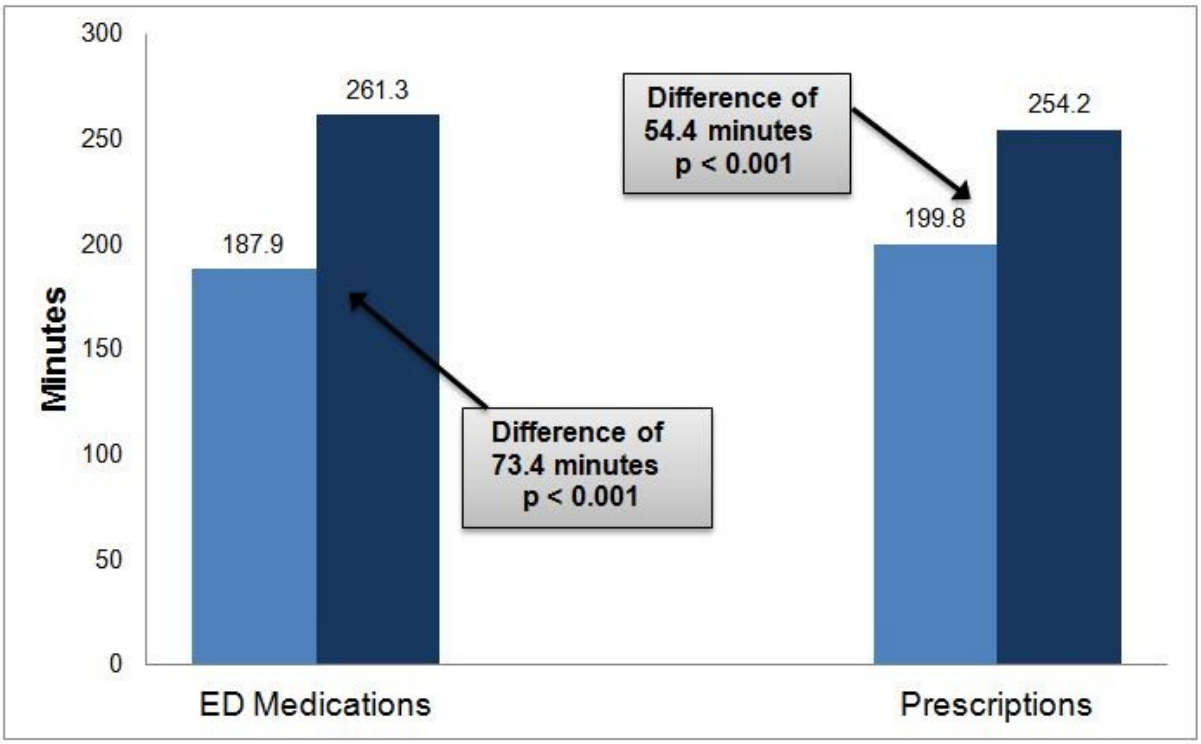


Figure 3. Impact of medications or prescriptions on overall length of stay in the ED



TABLES

Table 1: Demographics of patients presenting with dental caries and infection to a pediatric emergency department				
		All Patients N = 155	**Primary Dentition N = 129**	**Permanent Dentition N = 26**
Age (years)	Mean ± (SD)	7.3 ± (3.8)	6.0 ± 2.3	13.5 ± (3.7)
	Median, Range	6.1, 1.2-21.1	5.8, 1.2-12.6	13.9, 7.9-21.1
		N (%)	**N (%)**	**N (%)**
Gender	Male	99 (63.9)	88 (68.2)	11 (42.3)
	Female	56 (36.1)	41 (31.8)	15 (57.7)
Race/Ethnicity	Caucasian	69 (44.5)	57 (44.2)	12 (46.2)
	African American	26 (16.8)	20 (15.5)	6 (23.1)
	Other	23 (14.8)	19 (14.7)	4 (15.4)
	Asian	17 (11.0)	16 (12.4)	1 (3.9)
	Hispanic	16 (10.3)	14 (10.9)	2 (7.7)
	Unknown	4 (2.6)	3 (2.3)	1 (3.9)
Interpreter Status	No	131 (84.5)	108 (83.7)	23 (88.5)
	Yes	24 (15.5)	21 (16.3)	3 (11.5)
Payer Status	Medicaid	85 (54.8)	69 (53.5)	16 (61.5)
	Private	50 (32.3)	43 (33.3)	7 (26.9)
	Medicaid + Private	11 (7.1)	9 (7.0)	2 (7.7)
	Self-Pay	7 (4.5)	6 (4.7)	1 (3.9)
	Charity	2 (1.3)	2 (1.6)	0 (0.0)
Referral Source	Self-referral	100 (64.5)	86 (66.7)	15 (53.9)
	Physician	20 (12.9)	18 (14.0)	2 (7.7)
	Dentist	19 (12.3)	14 (10.9)	5 (19.2)
	Hospital	16 (10.3)	11 (8.5)	5 (19.2)
County	King	98 (63.2)	80 (62.0)	18 (69.2)
	Snohomish	39 (25.2)	35 (27.1)	4 (15.4)
	Pierce	9 (5.8)	7 (5.4)	2 (7.7)
	Other	9 (5.8)	7 (5.4)	2 (7.7)

Table 2: Demographics of patients with no dental home presenting with dental caries and infection to a pediatric emergency department				
		All Patients N = 155	**Primary Dentition N = 129**	**Permanent Dentition N = 26**
Dental Home Status	Private	66 (42.6)	53 (41.1)	13 (50.0)
	None	**59 (38.1)**	52 (40.3)	7 (26.9)
	SCH and Partners	17 (10.9)	15 (11.6)	2 (7.7)
	Community Clinic	13 (8.4)	9 (7.0)	4 (15.4)
		All Patients N = 59	**Primary Dentition N = 52**	**Permanent Dentition N = 7**
Age (years)	Mean ± (SD)	6.8 ± (3.9)	5.6 ± (2.2)	15.7 ± (1.7)
	Median, Range	5.6, 1.2-18.7	5.4, 1.2-12.0	15.4, 13.5-18.7
		N (%)	**N (%)**	**N (%)**
Gender	Male	40 (67.8)	37 (71.2)	3 (42.9)
	Female	19 (32.2)	15 (28.8)	4 (57.1)
Race/Ethnicity	Caucasian	20 (33.9)	17 (32.7)	3 (42.9)
	African American	12 (20.3)	10 (19.2)	2 (28.6)
	Asian	9 (15.3)	9 (17.3)	0 (0.0)
	Other	9 (15.3)	9 (17.3)	0 (0.0)
	Hispanic	8 (13.6)	7 (13.5)	1 (14.3)
	Unknown	1 (1.7)	0 (0.0)	1 (14.3)
Interpreter Status	No	50 (84.8)	43 (82.7)	7 (100.0)
	Yes	9 (15.2)	9 (17.3)	0 (0.0)
Payer Status	Medicaid	32 (54.2)	27 (51.9)	5 (71.4)
	Private	17 (28.8)	16 (30.8)	1 (14.3)
	Self-Pay	5 (8.5)	4 (7.7)	1 (14.3)
	Medicaid + Private	5 (8.5)	5 (9.6)	0 (0.0)
	Charity	0 (0.0)	0 (0.0)	0 (0.0)
Referral Source	Self-referral	43 (72.9)	37 (71.1)	6 (85.7)
	Physician	9 (15.3)	8 (15.4)	1 (14.3)
	Hospital	5 (8.5)	5 (9.6)	0 (0.0)
	Dentist	2 (3.4)	2 (3.8)	0 (0.0)
County	King	31 (52.5)	28 (53.8)	3 (42.9)
	Snohomish	23 (39.0)	20 (38.5)	3 (42.9)
	Other	4 (6.8)	3 (5.8)	1 (14.3)
	Pierce	1 (1.7)	1 (1.9)	0 (0.0)

Table 3: Clinical signs and symptoms for patients presenting to a pediatric ED with dental caries and infections				
	All Patients N = 155	**Patients Not Admitted N = 123**	**Patients Admitted N = 32**	**p-value**
	N (%)	**N (%)**	**N (%)**	
Clinical Signs and Symptoms				
Pain				
Low (0-3)	83 (53.6)	68 (55.3)	15 (46.9)	
None (0)	*28 (18.1)*	*24 (19.5)*	*4 (12.5)*	
Moderate (4-6)	43 (27.1)	31 (25.2)	11 (34.4)	
Severe (7-10)	20 (12.9)	15 (12.2)	5 (15.6)	
Missing data	10 (6.4)	9 (7.3)	1 (3.1)	
Pain duration				
< 1 day	39 (25.2)	31 (25.2)	8 (25.0)	
1-3 days	42 (27.1)	32 (26.0)	10 (31.3)	
> 3 days	52 (33.6)	41 (33.3)	11 (34.4)	
Not applicable	14 (9.0)	12 (9.8)	2 (6.3)	
Missing	8 (5.2)	7 (5.7)	1 (3.1)	
Decrease in PO intake				
Yes	75 (48.4)	56 (45.5)	19 (59.4)	
No	76 (49.0)	64 (52.0)	12 (37.5)	0.147*
Missing data	4 (2.6)	3 (2.4)	1 (3.1)	
Temperature				
Normal (36.5 – 37.7°C)	138 (89.0)	113 (91.9)	25 (78.1)	
Fever (> 37.7°C)	16 (10.3)	10 (8.1)	6 (18.8)	0.067*
Missing	1 (0.7)	0 (0.0)	1 (3.1)	
History of fever				
Yes	43 (27.7)	28 (22.8)	15 (46.9)	0.007*
No	112 (72.3)	95 (77.2)	17 (53.1)	
Fever duration				
< 1 day	12 (7.7)	8 (6.5)	4 (12.5)	
1-3 days	23 (14.8)	16 (13.0)	7 (21.9)	
> 3 days	4 (2.6)	3 (2.4)	1 (3.1)	1.000**
Not applicable	108 (69.7)	92 (74.8)	16 (50.0)	
Missing data	8 (5.2)	4 (3.3)	4 (12.5)	
Localized fistula or abscess				
Yes	65 (41.9)	57 (46.3)	8 (25.0)	0.029*
No	90 (58.1)	66 (53.7)	24 (75.0)	
Vestibular intraoral swelling				
Yes	61 (39.3)	41 (33.3)	20 (62.5)	0.003*
No	94 (60.7)	82 (66.7)	12 (37.5)	
Extraoral swelling (facial cellulitis)				
Yes	113 (72.9)	82 (66.7)	31 (96.9)	<0.001**
No	42 (27.1)	41 (33.3)	1 (3.1)	
Swelling duration				
< 1 day	49 (31.6)	39 (31.7)	10 (31.3)	
1-3 days	66 (42.6)	48 (39.0)	18 (56.3)	0.750**
> 3 days	12 (7.7)	9 (7.3)	3 (9.4)	
Not applicable	20 (12.9)	19 (15.5)	1 (3,1)	

Missing data	8 (5.2)	8 (6.5)	0 (0.0)	
Swelling location				
Cheek	89 (57.4)	66 (53.7)	23 (71.9)	
Periorbital	31 (20.0)	15 (12.2)	16 (50.0)	
Submandibular	22 (14.2)	12 (9.8)	10 (31.3)	0.001**
Lip	16 (10.3)	14 (11.4)	2 (6.3)	
Sublingual	4 (2.6)	0 (0.0)	4 (12.5)	

* p-value calculated from using a chi-square test

** p-value calculated from using a Fisher's exact test

Table 4: Dentition signs and symptoms for patients presenting to a pediatric ED with dental caries and infections			
	All Patients N = 155	Patients Not Admitted N = 123	Patients Admitted N = 32
	N (%)	N (%)	N (%)
Dentition Signs and Symptoms			
Number of teeth involved			
1 tooth	108 (69.7)	86 (69.9)	22 (68.8)
2 teeth	31 (20.0)	24 (19.5)	7 (21.9)
> 2 teeth	12 (7.7)	10 (8.1)	2 (6.3)
Missing data	4 (2.6)	3 (2.4)	1 (3.1)
Type of teeth			
Primary teeth	129 (83.2)	106 (85.4)	24 (75.)
Permanent teeth	26 (16.8)	18 (14.6)	8 (25.0)
Arch location of teeth			
Maxillary teeth	84 (54.2)	65 (52.9)	19 (59.4)
Mandibular teeth	69 (44.5)	57 (46.3)	12 (37.5)
Both maxillary/mandibular teeth	2 (1.3)	1 (0.8)	1 (3.1)
Location of teeth			
Anterior teeth	30 (19.4)	25 (20.3)	5 (15.6)
Posterior teeth	116 (74.8)	93 (75.6)	23 (71.9)
Both ant/post teeth	9 (5.8)	5 (4.1)	4 (12.5)
Specific primary tooth involved			
Primary maxillary first molar	43 (27.7)	32 (26.0)	11 (34.4)
Primary mandibular first molar	37 (23.9)	27 (22.0)	10 (31.3)
Primary maxillary second molar	20 (12.9)	15 (12.2)	5 (15.6)
Primary mandibular second molar	32 (20.7)	25 (20.3)	7 (21.9)
Primary maxillary incisors	28 (18.1)	22 (17.9)	6 (18.8)
Primary mandibular incisors	3 (1.9)	3 (2.4)	0 (0.0)
History of previous treatment			
No	88 (56.8)	75 (61.0)	13 (40.6)
Yes	67 (43.2)	48 (39.0)	19 (59.4)
Type of previous treatment			
None	88 (56.8)	75 (61.0)	13 (40.6)
Composite restoration	34 (21.9)	25 (20.3)	9 (28.1)
Pulp therapy + restoration	10 (6.4)	8 (6.5)	2 (6.3)
SSC restoration	7 (4.5)	4 (3.2)	3 (9.4)
Sedative restoration	6 (3.9)	5 (4.1)	1 (3.1)
Amalgam restoration	4 (2.6)	4 (3.2)	0 (0.0)
Attempted Treatment	3 (1.9)	2 (1.6)	1 (3.1)
Extraction	2 (1.3)	0 (0.0)	2 (6.3)
Incision and drainage	1 (0.7)	0 (0.0)	1 (3.1)
History of previous dental visit			
Yes	74 (47.7)	56 (45.5)	18 (56.3)
No	81 (52.3)	67 (54.5)	14 (43.8)
Time since last dental visit			
< 1 day	19 (12.3)	14 (11.4)	5 (15.6)
1-3 days	24 (15.5)	17 (13.8)	7 (21.9)

4-7 days	5 (3.2)	3 (2.4)	2 (6.3)
> 7 days	24 (15.5)	20 (16.3)	4 (12.5)
Not applicable	81 (52.3)	67 (54.5)	14 (43.8)
Missing data	2 (1.3)	2 (1.6)	0 (0.0)
Radiographic pathology			
Yes	122 (78.7)	100 (81.3)	22 (68.8)
No	13 (8.4)	10 (8.1)	3 (9.4)
Not applicable	13 (8.4)	7 (5.7)	6 (18.8)
Missing data	7 (4.5)	6 (4.9)	1 (3.1)
Severe ECC			
Yes	61 (39.3)	50 (40.7)	11 (34.4)
No	94 (60.7)	73 (59.3)	21 (65.6)

Table 5: Medical services provided to patients presenting to a pediatric ED for dental caries and infection			
	All Patients N = 155	**Primary Dentition N = 129**	**Permanent Dentition N = 26**
	N (%)	**N (%)**	**N (%)**
Medications Administered			
At Least 1 Medication	106 (68.4)	84 (65.1)	22 (84.6)
Antibiotic	61 (39.4)	45 (34.9)	16 (61.5)
Narcotic	55 (35.5)	41 (31.8)	14 (53.9)
Non-narcotic analgesics	52 (33.6)	41 (31.8)	11 (42.3)
Other	24 (15.5)	17 (13.2)	7 (26.9)
Route of Medication			
PO Only	55 (35.3)	48 (37.2)	7 (26.9)
IV Only	33 (21.3)	21 (16.3)	12 (46.2)
Both	16 (10.3)	13 (10.1)	3 (11.5)
Adjunct Services			
Overnight admission	32 (20.7)	24 (18.6)	8 (30.8)
Laboratory services	26 (16.8)	15 (11.6)	11 (42.3)
Sedation	9 (5.8)	8 (6.2)	1 (3.9)
CT Imaging	7 (4.5)	2 (1.6)	5 (19.2)
Other	4 (2.6)	2 (1.6)	2 (7.7)
Medical Radiology	1 (0.7)	0 (0.0)	1 (3.9)
Prescriptions			
At Least 1 Prescription	109 (70.3)	86 (66.7)	23 (88.5)
Antibiotic	93 (60.0)	72 (55.8)	21 (80.8)
Narcotic	30 (19.4)	18 (14.0)	12 (46.2)
Non-narcotic analgesics	25 (16.1)	19 (14.7)	6 (23.1)
Other	12 (7.7)	8 (6.2)	4 (15.4)

Table 6: Relationship between pain score and analgesic administration and prescription in the ED				
	Pain Score			
	Low (0-3) N = 83	Moderate (4-6) N = 42	Severe (7-10) N = 20	p-value
	N (%)	N (%)	N (%)	
ED Non-narcotic				
Yes	25 (30.1)	10 (23.8)	11 (55.0)	0.043*
No	58 (69.9)	32 (76.2)	9 (45.0)	
ED Narcotic				
Yes	20 (24.1)	19 (45.2)	11 (55.0)	0.007*
No	63 (75.9)	23 (54.8)	9 (45.0)	
Prescription Non-narcotic				
Yes	10 (12.1)	7 (16.8)	7 (35.0)	0.046*
No	73 (88.0)	35 (83.3)	13 (65.0)	
Prescription Narcotic				
Yes	10 (12.1)	7 (16.8)	10 (50.0)	<0.001*
No	73 (88.0)	35 (83.3)	10 (50.0)	

* p-value calculated from using a chi-square test

Table 7: Dental services provided to patients presenting to a pediatric ED with dental caries and infection			
	All Patients N = 155	**Primary Dentition N = 129**	**Permanent Dentition N = 26**
	N (%)	**N (%)**	**N (%)**
Dental Services			
Intraoral radiographs	132 (85.2)	113 (87.6)	19 (73.1)
Extraction	112 (72.3)	108 (83.7)	4 (15.4)
Oral surgery consultation	18 (11.6)	6 (4.7)	12 (46.2)
Exam only	13 (8.4)	13 (10.1)	0 (0.0)
Drainage	5 (3.2)	1 (0.8)	4 (15.4)
Sedative restoration	4 (2.6)	1 (0.8)	3 (11.5)
Pulpectomy	3 (1.9)	0 (0.0)	3 (11.5)
Behavior Adjuncts			
Nitrous oxide	51 (32.9)	49 (38.0)	2 (7.7)
Protective immobilization wrap	45 (29.0)	45 (34.9)	0 (0.0)

Table 8: Patient characteristics and treatment provided during hospital admission		
PATIENT CHARACTERISTICS		**All Patients N = 32**
		N (%)
Age (years)	Mean ± (SD)	7.9 ± (3.3)
	Median, Range	7.2, 3.2-16.1
Dental Home Status	Private	19 (59.4)
	None	5 (15.6)
	SCH and Partners	4 (12.5)
	Community Clinic	4 (12.5)
Referral Source	Self-referral	16 (50.0)
	Hospital	11 (34.4)
	Physician	3 (9.4)
	Dentist	2 (6.3)
Type of teeth	Primary	24 (75.0)
	Permanent	8 (25.0)
Arch location of teeth	Maxillary	19 (59.4)
	Mandibular	12 (37.5)
	Both	1 (3.1)
Location of teeth	Anterior	5 (15.6)
	Posterior	23 (71.9)
	Both	4 (12.5)
TREATMENT PROVIDED		**All Patients N = 32**
Admit Overall Length of Stay, hours Mean ± (SD)		40.3 ± (35.3) n = 30
		N (%)
Admit Overall Length of Stay	0-12 Hours	5 (15.6)
	13-24 Hours	7 (21.9)
	25-36 Hours	3 (9.3)
	37-48 Hours	7 (21.9)
	49-60 Hours	2 (6.2)
	>60 Hours	6(18.8)
	Missing data	2 (6.2)
Medications Administered	Antibiotic	30 (93.8)
	Non-narcotic analgesics	16 (50.0)
	Narcotic	13 (40.6)
	Other	11 (34.4)
Route of Medication	PO Only	1 (3.1)
	IV Only	14 (43.8)
	Both	14 (43.8)
Adjunct Services	Hydration	32 (100.0)
	Consultations	18 (56.3)
	Dental tx under general anesthesia	13 (40.6)
	Laboratory services	6 (18.8)
Prescriptions	Antibiotic	22 (68.8)
	Non-narcotic analgesics	6 (18.8)
	Narcotic	5 (15.6)
	Other	11 (34.4)

Table 9: Wait and treatment times for patients discharge to home compared to patients admitted when presenting to a pediatric ED with dental caries and infections				
	All Patients	Patients Not Admitted	Patients Admitted	
	Mean ± (SD) Median, Range N	Mean ± (SD) Median, Range N	Mean ± (SD) Median, Range N	p-value
Wait time until triage, (minutes)	18.3 ± (13.8) 13.0, 1.0-89.0 n = 155	18.9 ± (14.4) 13.0, 1.0-89.0 n = 123	15.8 ± (11.2) 12.5, 3.0-53.0 n = 32	0.20[+]
Wait time for physician, (minutes)	77.2 ± (63.7) 68.5, 9.0-296.0 n = 154	80.3 ± (68.5) 70.5, 9.0-296.0 n = 122	65.3 ± (39.3) 58.0, 10.0-173.0 n = 32	0.11[+]
Dental treatment time, (minutes)	54.8 ± (26.3) 53.0, 0.0-155.0 n = 105	55.7 ± (25.8) 52.0, 0.0-155.0 n = 81	51.8 ± (28.3) 55.5, 0.0-110.0 n = 24	0.55[+]
Overall length of stay, (minutes)	238.0 ± (98.8) 213.5, 71.0-620.0 n = 154	217.3 ± (84.3) 199.0, 71.0-620.0 n = 122	316.8 ± (111.0) 313.0, 151.0-608.0 n = 32	<0.001[+]

[+] p-value calculated using a 2 sample t-test

Table 10: Wait and treatment times for patients presenting to a pediatric ED with dental caries and infections		
	Mean ± (SD), N	**p-value**
Wait time for physician, (minutes)	77.2 ± (63.7) n = 154	<0.001[+]
Dental treatment time, (minutes)	54.8 ± (26.3) n = 105	

[+] p-value calculated using a 2 sample t-test

Table 11: Triage acuity scores and wait times, dental treatment times, and overall length of stay									
	All Patients			Patients Discharged to Home			Patients Admitted		
	Time to Physician, (minutes)	Dental Treatment Time, (minutes)	Overall Length of Stay (LOS), (minutes)	Time to Physician, (minutes)	Dental Treatment Time, (minutes)	Overall Length of Stay (LOS), (minutes)	Time to Physician, (minutes)	Dental Treatment Time, (minutes)	Overall Length of Stay (LOS), (minutes)
	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N
Triage Score									
1 or 2	75.6 ± (32.1) n = 35	62.4 ± (28.8) n = 25	262.7 ± (96.3) n = 35	82.7 ± (28.8) n = 25	62.8 ± (27.7) n = 18	251.9 ± (103.5) n = 25	57.8 ± (34.4) n = 10	61.3 ± (33.8) n = 7	289.8 ± (73.1) n = 10
3	82.1 ± (77.3) n = 87	52.3 ± (6.5) n = 61	232.6 ± (98.1) n = 88	85.8 ± (83.1) n = 70	53.3 ± (27.5) n = 47	211.4 ± (79.9) n = 71	66.6 ± (45.6) n = 17	48.9 ± (23.7) n = 14	320.9 ± (118.8) n = 17
4	65.6 ± (45.9) n = 32	52.9 ± (20.6) n = 19	225.3 ± (101.7) n = 31	63.8 ± (48.8) n = 27	54.7 ± (16.5) n = 16	199.9 ± (67.6) n = 26	75.6 ± (26.6) n = 5	43.3 ± (40.4) n = 3	357.0 ± (152.0) n = 5

Table 12: Relationship of pain scores to treatment times and medical interventions for patients presenting to a pediatric ED with dental caries and infection					
	Pain Score				
	All Patients N = 145	Low (0-3) N = 83	Moderate (4-6) N = 42	Severe (7-10) N = 20	p-value
Age (years)					
Mean ± (SD)	7.0 ± (3.6)	6.2 ± (3.3)	7.0 ± (2.5)	10.2 ± (5.0)	<0.001++
Median, Range	6.0, 1.2-18.9	5.8, 1.2-18.9	6.6, 2.4-13.9	9.5, 2.3-18.7	
	N (%)	N (%)	N (%)	N (%)	
Gender					
Male	95 (65.5)	54 (65.1)	29 (69.0)	12 (60.0)	0.775*
Female	50 (34.5)	29 (34.9)	13 (31.0)	8 (40.0)	
Triage Score					
1 or 2	31 (21.4)	15 (18.1)	14 (33.3)	2 (10.0)	
3	82 (56.6)	51 (61.5)	20 (47.6)	11 (55.0)	0.147**
4	32 (22.1)	17 (20.5)	8 (19.1)	7 (35.0)	
Medications in ED					
Antibiotics	58 (40.0)	25 (30.1)	22 (52.4)	11 (55.0)	
Non-narcotic	46 (31.7)	25 (30.1)	10 (23.8)	11 (55.0)	0.627**
Narcotic	50 (34.5)	20 (24.1)	19 (45.2)	11 (55.0)	
Other	23 (15.9)	11 (13.3)	8 (19.1)	4 (20.0)	
Prescriptions					
Antibiotics	89 (61.4)	47 (56.6)	27 (64.3)	15 (75.0)	
Non-narcotic	24 (16.6)	10 (12.1)	7 (16.7)	7 (35.0)	0.374**
Narcotic	27 (18.6)	10 (12.1)	7 (16.7)	10 (50.0)	
Other	12 (8.3)	5 (6.0)	5 (11.9)	2 (10.0)	
Wait and treatment times in ED, (minutes) Mean ± (SD), N					
Wait time for physician	77.2 ± (63.7) n = 154	78.1 ± (78.0) n = 82	79.5 ± (43.0) n = 42	79.1 ± (45.7) n = 20	0.994++
Dental treatment time	54.8 ± (26.3) n = 105	53.3 ± (24.8) n = 51	60.5 ± (29.1) n = 33	50.8 ± (29.5) n = 14	0.391++
Overall length of stay	238.0 ± (98.8) n = 154	223.4 ± (86.9) n = 82	260.2 ± (95.6) n = 42	271.5 ±(145.0) n = 20	0.052++

* p-value calculated from using a chi-square test

** p-value calculated from using a Fisher's exact test

++ p-value calculated from using ANOVA

Table 13: Impact of administration of medications and prescriptions on overall length of stay in the ED for dental caries and infection								
	All Medications, (minutes)	p-value	Antibiotics, (minutes)	p-value	Non-narcotic Analgesics, (minutes)	p-value	Narcotic Analgesics, (minutes)	p-value
	Mean ± (SD) N		Mean ± (SD) N		Mean ± (SD) N		Mean ± (SD) N	
ED MEDICATION								
Yes	261.3 ± (106.0) N = 105	<0.001+	296.0 ± (98.0) N = 60	<0.001+	249.9 ± (116.8) N = 52	0.148+	281.0 ± (119.7) N = 54	0.002+
No	187.9 ± (54.7) N = 49		200.9 ± (80.0) N = 94		231.9 ± (88.2) N = 102		214.7 ± (76.5) N = 100	
PRESCRIPTION								
Yes	254.2 ± (102.6) N = 108	<0.001+	262.8 ± (104.4) N = 92	<0.001+	247.7 ± (97.4) N = 25	0.3031+	255.7 ± (102.8) N = 29	0.158+
No	199.8 ± (77.4) N = 46		201.1 ± (76.7) N = 62		236.1 ± (99.3) N = 129		233.8 ± (97.8) N = 125	

+ p-value calculated using a 2 sample t-test

Table 14: Relationship of NEDOCS scores to wait and treatment times in a pediatric ED			
	Time to Physician, (minutes)	Dental Treatment Time, (minutes)	Overall Length of Stay (LOS), (minutes)
	Mean ± (SD), N	Mean ± (SD), N	Mean ± (SD), N
NEDOCS Score			
0-20	73.2 ± (54.2) n = 14	64.1 ± (24.7) n = 11	254.0 ± (120.9) n = 14
21-60	78.0 ± (86.5) n = 55	59.4 ± (27.6) n = 39	235.8 ± 86.6 n = 54
61-100	76.4 ± (38.0) n = 25	49.4 ± (17.6) n = 15	258.7 ± 105.6 n = 25
100-140	65.0 ± (24.8) n = 3	22.5 ± (31.8) n = 2	374.3 ± 213.0 n = 3
141-180	26.0 ± (0.0) n = 1	0.0 ± (0.0) n = 0	145.0 ± (0.0) n = 1

Note: Missing 57 data values for NEDOCS score.

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APPENDIX

Appendix A. ED triage acuity score.

1 – Immediate/Life-threatening
2 – Emergency
3 – Urgent
4 – Non-urgent
5 – Minor

Appendix B. National Emergency Department Over-Crowding Scale (NEDOCS).

00-20 – Not busy
21-60 – Busy
61-100 – Extremely busy but not over-crowded
101-140 – Over-crowded
141-180 – Severely over-crowded
181-200 – Dangerously over-crowded

Appendix C. Data recorded from each patient and emergency record.

Sociodemographic

- Medical record number
- Date of birth
- Gender
- Ethnicity
- Interpreter status
- Insurance payer status
- Dental home status
- Zip code
- Referral source

Signs and symptoms

- Home medications
- Presence and duration of pain and pain score (0-10)
- Presence and duration of fever and temperature in the ED
- Presence, location, and duration of swelling
- PO intake status
- Presence of caries and severe early childhood caries
- Radiographic pathology
- Tooth numbers of teeth involved
- Previous dental treatment and dental history
- Special health care needs

Medical and dental management

- Radiography
- CT imaging
- Laboratory tests
- Sedation
- Medications given in the ED
- Prescriptions
- Consultations
- Disposition and admission status
- Dental treatment provided

Hospital admissions

- Date and time of admission and discharge
- Discharge temperature
- Medications
- Hydration status
- Lab tests
- Consultations
- Need for operating room/general anesthesia

Emergency department operations and logistics

- Date and service
- Arrival time at ED
- Triage time in ED
- Time to physician examination
- Dental treatment time
- Discharge time
- ED triage acuity score (1-5)
- NEDOCS (0-200)