Trends in Utilization of a Children’s Hospital Emergency Department for Caries-related Complaints

By

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A thesis submitted in conformity with the requirements for the degree Master of Science Graduate Department of Pediatric Dentistry University of Toronto

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ABSTRACT

PURPOSE: To determine trends in caries-related visits to a children’s hospital emergency department and associated costs.

METHODS: A review of health records of all children who presented to the ED at The Hospital for Sick Children, Toronto, with caries-related complaints from January 1, 2003 to December 31, 2012 was completed. Institutional costs for the episodes of care were calculated using encounter level costing. A Poisson model examined trends over time. A log-linear model examined the impact of sex, age, comorbidity, and socioeconomic status.

RESULTS: Over the study period, the numbers of visits for caries-related complaints increased by 48 percent (p=0.001). Characteristics of the children were being male, under 5 years old, low socioeconomic status and no co-morbidity. The mean cost per visit was $575.17 CDN.

CONCLUSIONS: With an increasing volume and mean visit cost of almost $600 CDN, children’s hospital EDs caries-related visits to children’s hospital EDs are not insignificant.
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TABLE OF CONTENTS

ABSTRACT ii
ACKNOWLEDGEMENTS iii

CHAPTER 1: INTRODUCTION 1

SECTION 1.1 RATIONALE 3
SECTION 1.2 RESEARCH GOALS 4
SECTION 1.3 RESEARCH OBJECTIVES 4
SECTION 1.4 THESIS OUTLINE 4

CHAPTER 2: LITERATURE REVIEW 6

SECTION 2.1 DENTAL EMERGENCY TRENDS 6
SECTION 2.2 MOTIVATIONS & PATIENT CHARACTERISTICS 8
SECTION 2.3 CARIES-RELATED COMPLAINTS 14
SECTION 2.4 TREATMENT PROVIDED IN THE ED 18
SECTION 2.5 COST OF CARE FOR CARIES-RELATED COMPLAINTS IN THE ED 20
SECTION 2.6 SUMMARY OF LITERATURE REVIEW 22

CHAPTER 3: METHODS 23

SECTION 3.1 DESIGN OVERVIEW 23
SECTION 3.2 STUDY POPULATION 23
SECTION 3.3 DATA COLLECTION 24
SECTION 3.4 STUDY VARIABLES 26
SECTION 3.5 DATA ANALYSIS 27

CHAPTER 4: VISITS TO A CHILDREN’S EMERGENCY DEPARTMENT FOR CARIES-RELATED COMPLAINTS: TEN-YEAR UTILIZATION TRENDS 29

SECTION 4.1 ABSTRACT 30
SECTION 4.2 INTRODUCTION 31
SECTION 4.3 METHODS 32
SECTION 4.4 RESULTS 35
SECTION 4.5 INTERPRETATION 40
SECTION 4.6 ACKNOWLEDGEMENTS 44
SECTION 4.7 REFERENCES 45
CHAPTER 1: INTRODUCTION

Hospital emergency departments (EDs) provide care for acute injuries and illnesses as well as exacerbations of chronic conditions that require urgent medical attention (Chan et al., 2001). In recent years, North American EDs have reported sizeable increases in patient volumes. For example, the number of visits to EDs in the United States increased by 23.1 percent, from 94.9 million to 116.8 million visits for the period 1997-2007 (Tang, Stein, Hsia, Maselli, & Gonzales, 2010). This increase was almost double what would be expected from population growth alone during the years assessed (US Census Bureau, 2001).

Similar to the increasing trend for overall medical emergencies, hospital EDs have also become an important source of care for people with oral complaints (Quiñonez, 2011, Lewis et al., 2003). In the United States, approximately 1 to 2 percent of visits to general hospital EDs annually are for oral complaints (McCormick et al., 2013), and there is evidence that this volume is increasing across all age groups (Wall et al., 2012, Lee et al., 2012, Hong et al., 2011). Within Canada it has been estimated that 5.4 percent of the adult population has presented to an ED for oral complaints (Quiñonez, 2011).

While the majority of research has focused on general hospital EDs that serve all age groups, studies have shown an even more pronounced increase in oral complaint visits to children’s hospital EDs (Ladrillo, Hobdell, & Caviness, 2006; Rowley, Sheller, Williams, & Mancl, 2006). For instance, Texas Children’s Hospital experienced a 121 percent increase in dental complaint visits over a five-year period, compared to a 28 percent increase in non-dental complaint visits over the same time period (Ladrillo et al., 2006). Although there is limited data on hospital visits for children in Canada, from 2003 to 2006, Ontario had 24,336 ED visits for dental complaints unrelated to trauma in patients under the age of 20 years.
Children with dental complaints may present to a hospital for treatment of traumatic injuries, the sequelae of dental caries, oral mucosal conditions and other issues. Importantly, the number of visits related to dental caries appears to be increasing (Rowley et al., 2006; Zeng, Sheller, & Milgrom, 1994). Caries-related complaints include dental decay and associated pain, diseases of the pulp and periapical tissues, dental abscesses and cellulitis of odontogenic origin. A review at Seattle Children’s Hospital and Regional Medical Center from 1982 to 1991 described 1,482 after hours dental emergency visits. The proportion of caries-related visits increased over the study period, while those for traumatic injury decreased (Zeng et al., 1994). A more recent follow-up study at Seattle Children’s Hospital and Regional Medical Center from 1995 to 2003 revealed that this trend continued with an increased number of dental visits to the ED primarily due to more caries-related complaints (Rowley et al., 2006). Based on the percentage of total dental ED visits, the number of caries-related visits increased by 17 percent over the 8.5 years studied (Rowley et al., 2006). In the American literature, the proportion of dental ED visits for caries-related complaints in the pediatric population varies from 32 to 48 percent (Ladrillo et al., 2006; Oh, Leonard, Walsh, & Fuller, 2012; Rowley et al., 2006; Von Kaenel, Vitangeli, Casamassimo, Wilson, & Preisch, 2001). In Canada, most studies have looked at a single year to determine prevalence, types, and treatment of caries-related children’s ED visits (Oliva, Kenny, & Ratnapalan, 2008). Ultimately, there is little to no data on temporal trends in children’s hospital emergency visits for caries-related dental complaints within Canada.

The costs of these ED visits are also concerning. In the United States in 2006, the total hospital charges for caries-related ED visits by children was estimated at $14.3 million USD with a mean charge of $667.48 USD (Nalliah, Allareddy, Elangovan, Karimbux, & Allareddy, 2010). This study did not include more advanced sequelae of dental caries such as abscess or
cellulitis that more heavily impact hospital resources. In Canada, provincial health insurance covers most of the costs of hospital and physician treatment, while dental treatment is charged to the patient. The exception is surgical dental treatment delivered in-hospital, which can include dental-related hospital ED visits. Yet to date there are no studies examining the hospital-incurred costs of treating caries-related ED visits specifically. Ultimately, ED use for caries-related complaints is a topic of ongoing interest for policy makers, especially as it is thought to occur as a result of poor access to dental care.

SECTION 1.1 RATIONALE

The Hospital for Sick Children (SickKids) in Toronto, Canada is an urban academic health sciences center that offers twenty-four hour emergency pediatric dental care through the Department of Dentistry outpatient clinic and after hours staffing of the Division of Paediatric Emergency Medicine. Patients may present directly to the Department of Dentistry during clinic hours or through the ED. Consistent with other children’s hospitals, the experience at SickKids has been that caries-related complaints comprise a large proportion of the emergency dental visits (Oliva et al., 2008). Further knowledge regarding the demographics of the population would allow public health workers to better target at risk communities. Hospital administrators would benefit from information concerning the types of caries-related emergency complaints, treatments required, overall trends and seasonal variation in order to develop better staffing and treatment strategies. Policy makers would also benefit from information concerning charges associated with hospital-based care for dental needs.
SECTION 1.3 RESEARCH OBJECTIVES

PRIMARY

To determine the annual frequency of children 0-17 years of age who presented to a tertiary care children’s hospital with a caries-related emergency complaint over a ten-year period.

SECONDARY

In the aforementioned population, this study will also determine the following:

1. The demographic characteristics of the families that presented for caries-related emergency complaints over a ten-year period.
2. The types of caries-related emergency complaints that presented and the treatment provided over a ten-year period.
3. The costs associated with providing treatment for caries-related emergency complaints over a five-year period.

SECTION 1.4 THESIS OUTLINE

This thesis is organized as follows: Chapter 2 provides a literature review on the reported trends in caries-related ED visits, identified motivating factors of the presenting families, treatment and costs of providing care. Chapter 3 describes general methods, data collection protocols and statistical analyses. Chapter 4 addresses the primary objective and the secondary objective related to patient demographics and presents methods, results, and the policy implications of the ten-year trends in caries-related ED visits. Chapter 5 addresses the secondary objective related to the diagnosis and management of caries-related ED visits, and presents methods, results, and the policy implications of diagnoses and treatment provided over a ten-year
period. Chapter 6 addresses the secondary objective related to the costs associated with providing care at a hospital ED and presents methods, results, and the policy implications of a cost analysis of the last five years of the study period. Finally, Chapter 7 presents the main conclusions of this research, and describes directions for future research.
CHAPTER 2: LITERATURE REVIEW

SECTION 2.1 DENTAL EMERGENCY TRENDS

Hospital emergency departments (EDs) and dental clinics have become an increasingly important point of care for people seeking treatment for oral complaints (Lewis, Lynch, & Johnston, 2003; Quiñonez, 2011). Oral complaints are reported to account for a small proportion of total ED complaints, ranging from less than one percent to 4.3 percent of all ED visits, yet the incidence of ED visits for oral complaints is also reported to have increased at a faster rate than that of other ED complaints (Allareddy, Rampa, Lee, Allareddy, & Nalliah, 2014; Anderson, Cheralal, Traore, & Martin, 2011; Lewis et al., 2003; McCormick, Abubaker, Laskin, Gonzales, & Garland, 2013). To be sure, in the United States from 2001 to 2008, the number of ED visits for oral complaints increased by 41 percent compared with a 13 percent increase for all other complaints (Lee, Lewis, Saltzman, & Starks, 2012).

Patients with oral complaints may present to a hospital for treatment of traumatic injuries, the sequelae of dental caries, oral mucosal conditions and other oro-facial complaints. Caries-related complaints include pain associated with dental decay, diseases of the dental pulp and periapical tissues, dental abscesses and cellulitis of odontogenic origin. While caries-related emergency complaints, primarily dental pain and abscesses, have been reported to represent as much as 73 percent of all oral emergencies (Wilson, Smith, Preisch, & Casamassimo, 1997), most reports place the estimates at 38 to 56 percent (Fleming, Gregg, & Saunders, 1991; Graham, Webb, & Seale, 2000; Lewis et al., 2003; Rowley, Sheller, Williams, & Mancl, 2006). ED visits for oral complaints not related to injury accounted for 1.7 percent of all US ED visits in 2007 (Okunseri, Okunseri, Thorpe, Xiang, & Szabo, 2012). From 1997 through 2007, there was a 4 percent annual increase in ED dental complaint visits not related to oral injury (Okunseri et
al., 2012). In New Hampshire between 2001 and 2007, there was a 14 percent increase in total ED visits overall and a 47 percent increase in caries-related visits (Anderson et al., 2011). Despite the broad range among estimates, there appears to be an increasing trend of caries-related ED visits for the general population in the US (Hong et al., 2011).

Within Canada it has been estimated that 5.4 percent of the adult population has presented to an ED for oral complaints (Quiñonez, 2011). Between 2004 and 2013, the incidence of oral related ED visits in Ontario increased by 20 percent (Ministry of Health and Long-Term Care, 2014). A recent study found that about one percent of all ED visits in Ontario were for oral complaints unrelated to injury (Quiñonez, Gibson, Jokovic, & Locker, 2009). In absolute numbers, this translates to a total of 141,365 ED visits by 116,357 unique patients for oral complaints unrelated to injury over a three-year period. In the period 2004 to 2013, more visits were made for dental caries-related complaints than for diabetes or hypertension-related diseases (Quiñonez, Gibson, Jokovic, & Locker, 2009).

While the majority of research has focused on general hospital EDs that serve all age groups, studies looking specifically at children’s hospital EDs showed an even more pronounced increase in visits for oral complaints (Ladrillo, Hobdell, & Caviness, 2006; Rowley et al., 2006). Texas Children’s Hospital experienced a 121 percent increase in oral complaint visits over five years, compared to a 28 percent increase in all other emergency visits over the same time period. Inpatient admissions resulting from the ED oral complaint visits also increased during the five-year study period with more than two-thirds of these admissions the result of untreated dental caries and subsequent abscesses or cellulitis (Ladrillo et al., 2006). Seattle Children’s Hospital and Regional Medical Center from 1982 to 1991 reported 1,482 after hours oral complaint visits. The proportion of caries-related visits increased over the study period, while those for traumatic
injury decreased (Zeng, Sheller, & Milgrom, 1994). A more recent follow up study at Seattle Children’s Hospital and Regional Medical Center from 1995 to 2003 confirmed this trend (Rowley et al., 2006). However, US national estimates from 2001 to 2008 found that visit rates among the pediatric population at general hospital EDs for oral complaints remained relatively stable throughout the study period (Lee et al., 2012).

Although there is limited data on oral complaint hospital visits for children in Canada, it was reported that in Ontario from 2003 to 2006, there were 24,336 ED visits for oral complaints unrelated to trauma in patients under the age of 20 years (Quiñonez et al., 2009). Most studies carried out in Canada have looked at a single year to determine prevalence, etiologies and treatment of caries-related children’s ED visits (Oliva, Kenny, & Ratnapalan, 2008). The Hospital for Sick Children (SickKids) in Toronto, reported that caries-related complaints comprised 0.5 percent of total emergency visits (Oliva et al., 2008). The North Bay Parry Sound District Health Unit (Ontario) reported an 87 percent increase in the incidence of oral complaint ED visits to general hospitals by children for the years of 2004 to 2013 (Ministry of Health and Long-Term Care, 2014). The North Bay Parry Sound District Health Unit excluded trauma-related visits, but included acute/chronic gingivitis, tempomandibular joint disorders, diseases of salivary glands and impacted teeth. Importantly, there is little data on temporal trends in children’s hospital emergency visits for caries-related dental complaints within Canada.

**SECTION 2.2 MOTIVATIONS & PATIENT CHARACTERISTICS**

Parents have reported a variety of reasons for seeking treatment in a hospital ED for caries-related dental complaints. Reasons for seeking treatment in a hospital ED include: referral from a pediatrician, no prior dentist visits, not knowing that the problem was dental in nature and
financial limitations (Quinby, Sheller, Williams, & Grembowski, 2004). Interviews of American families who presented with caries-related dental complaints revealed that hospital treatment was sought when the families’ dental offices were closed or they did not have a primary care dentist (Von Kaenel, Vitangeli, Casamassimo, Wilson, & Preisch, 2001). Patients who had contacted or presented to the hospital dental clinic with an emergency revealed that 50.2 percent of them had inquired elsewhere before contacting the hospital dental service. Of the group that had previously sought out treatment, 50 percent were referred from the university dental school, 30 percent were referred by friends or family, eight percent by private dental offices or other hospitals without dental services and 12 percent by a medical clinic (Gibson, Blasberg, & Hill, 1993). Importantly, few studies have focused on the associated demographic and motivating factors of families utilizing a children’s hospital ED for caries-related complaints.

The Andersen Behavioral Model of predisposing, enabling and need factors is often used to describe patient motivation for seeking health care (Andersen, 1995). This model provides a framework to consider characteristics and motivating factors that influence a family’s decision to seek care at a children’s ED for caries-related complaints. Predisposing factors are demographic variables such as socio-economic status (SES), age, pre-existing medical conditions and education level that influence the likelihood of using health services. Enabling factors are variables that influence one’s ability to access care such as insurance status, ability to attend appointments during regular working hours, transportation issues and primary language spoken. Need factors include both the perceived need of the patient or caregiver and need as evaluated by a health care provider (Anderson et al., 2011).

Among the predisposing factors, SES is the most widely studied in the context of ED visits for caries-related dental complaints. It has been argued that families seeking care in the ED
for oral complaints are primarily from a socioeconomically disadvantaged background (Dorfman, Kastner, & Vinci, 2001; Rowley et al., 2006; Von Kaenel et al., 2001). A 2011 study by Hong et al., on oral complaint (injury and caries-related) ED visits at 11 different hospitals in Kansas for all age groups found the rate of ED visits for dental care from residents in ZIP codes with a mean annual family income less than $40,000 USD was 11.3 per 1,000 population. The corresponding visit rate was 0.5 per 1,000 population for residents in ZIP codes with a mean annual family income greater than $80,000 USD. Similarly, another US study has estimated that approximately 70 percent of ED visits by children for caries-related complaints are made by those from regions with a median household income below $49,000 USD (Allareddy, Nalliah, et al., 2014). In England, it was found that children living in more affluent areas were less likely to present for emergency dental care than those living in more deprived areas (Moles & Ashley, 2009). In short, EDs provide an important access point to manage the emergency sequelae of dental caries for children of families with low SES.

It has also been noted that younger children are more likely to present to the ED for caries-related complaints. In one American study, patients with caries-related complaints were younger than those presenting with non-dental emergencies (Rowley et al., 2006). At SickKids, 59 percent of patients presenting to the ED with caries-related complaints were younger than five years of age (Oliva et al., 2008). Within the cohort was an especially high prevalence of infection in the pre-school group that comprised 42 percent of all caries-related visits made. This is consistent with US studies wherein 61 percent of patients with caries-related complaints were age six and younger with one-quarter being under age three. Many of these children presented with severe early childhood caries (S-ECC) in addition to the cavity or cavities that provoked the trip to the ED (Nagarkar, Kumar, & Moss, 2012). S-ECC is any sign of smooth-surface decay in
children younger than three years old, or one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of greater than or equal to four (age three), greater than or equal to five (age four), or greater than or equal to six (age five) (Drury et al., 1999). In one American study, children with S-ECC comprised 22 percent of ED oral complaint visits (Rowley et al., 2006). The average age of those presenting with S-ECC was three years old.

There is one study that reported a slightly different pattern of presentation when it came to age. In a national US sample reported approximately double the number of visits for caries-related complaints in the six to ten year old age range compared to the age groups directly before and after (Allareddy, Nalliah, et al., 2014). However, the study focused on hospitals that serve all age groups and may show different patient characteristics than hospitals that only serve the pediatric population.

Patients with medical co-morbidities often face barriers to receiving primary dental care and it could be assumed that this group access hospital ED for caries-related complaints at a higher rate than the general population. However, in the US more than 92 percent of children with oral complaints had no medical comorbidity (Allareddy, Nalliah, et al., 2014). These results suggest that the majority of children utilizing hospital EDs for caries related complaints are otherwise healthy.

Among enabling factors, the lack of dental insurance was found to be a significant predictor of ED utilization for caries-related complaints. An evaluation of self-reported ED visits for oral complaints in the adult population of Canada demonstrated that access to dental insurance or publicly funded care was associated with reduced utilization of the ED for oral complaints (Quiñonez, 2011). In the US, patients covered by Medicaid or those without dental
insurance present to the ED disproportionately more than those with private dental coverage (Quinby et al., 2004). Children presenting to EDs with dental pain were six times as likely to be uninsured than children in the surrounding county. Seattle Children’s Hospital and Regional Medical Center reported that Medicaid patients were twice as likely to present outside of clinic hours with caries-related complaints compared to patients with private insurance (Zeng et al., 1994). Interestingly, in the US most children are eligible for Medicaid and should be able to seek care in a dental office rather than an ED. However, low dentist participation rates in Medicaid, may leave otherwise eligible children reliant on the ED for management of caries-related complaints (Allareddy, Nalliah, et al., 2014).

The lack of dental coverage leading to ED use for caries-related emergencies is not isolated to the US and Canada. A 2009 study at two London, England hospitals explored reasons for attending an after-hours hospital dental emergency service. When patients were asked why they attended a hospital clinic, 42 percent reported that they were unable access care at other emergency dental services that did not accept National Health Service (government funded) patients. A further seven percent of respondents reported that their dentists no longer accepted National Health Service patients (Austin, Jones, Wright, Donaldson, & Gallagher, 2009). In Canada, multiple government-funded programs that cover children for dental care exist, tend to have a lower reimbursement scale than private coverage (50 to 60 percent of Ontario Dental Association fee guide rates). One American study showed that the lower reimbursement rate of public programs lead to public patients not being accepted as readily by all dentists (Bisgaier, Cutts, Edelstein, & Rhodes, 2011). This leaves patients either without a source of care or forced to pay out of pocket for dental care. A study in Vancouver, Canada evaluating patients’ motivation for contacting hospital dental services for emergencies found that a common reason
cited was the perception that the cost would be less than attending a private dental office (Gibson et al., 1993).

Multiple studies report that not having a primary dental provider is associated with emergency visits (Dorfman et al., 2001; Sheller, Williams, & Lombardi, 1997; Zeng et al., 1994). For the pre-school age group in particular, an emergency visit was the first contact with a dental professional for 52 percent of children under age three (Thuku, Carulli, Costello & Goodman., 2012). A study evaluating care-seeking behaviors of caregivers of children presenting to the ED with caries-related complaints found that 25 percent had visited the hospital dental clinic within the 36 months prior to the ED visit for either a dental consult or another oral emergency, but not for primary care (Von Kaenel et al., 2001).

In contrast to medical ED visits in the US, oral complaint visits have been shown to increase on weekends and evenings (Manski, Cohen, & Hooper, 1998). Another study found that a statistically significant greater number of US patients present to the ED for oral complaints outside regular business hours than other patients (Wall, 2014). In Canada, Quiñonez et al. (2009) found that ED visits for oral complaints peaked on weekends and during the weekday in the morning and again in the early evening. This suggests that dentist availability or the ability to miss work influenced the decision to use a hospital ED for caries-related complaints rather than a dental office.

Other studies that focused specifically on children’s EDs found a slightly different trend in that visits were more evenly spread out throughout the day and week. One US study found that the largest number of visits occurred during the day and not the evening (Graham et al., 2000). At SickKids, 45 percent of children presented to the ED during office hours and 62 percent presented during the working week (Oliva et al., 2008). In one US study, the most frequent
reason given for using the ED during regular working hours was not having a primary care
provider (Rowley et al., 2006).

Need factors are thought to be the most immediate determinant of care seeking behavior. Yet medical providers and patients often differ in what they perceive as an emergency (Kubicek et al., 2012). What a health care provider may consider to be non-urgent or relatively minor may be perceived as very serious by worried patients and families. A parent may perceive pain from carious infection that interferes with normal activities such as eating and sleeping as requiring immediate care. Chart reviews of ED visits for caries-related complaints reveal that descriptions of the patients often include fever, dehydration, malaise and sleep loss (Graham et al., 2000). Systemic symptoms of the infective process may help explain why families seek care in the ED. Furthermore, Dorfman et al. (2001) found that 9 percent of patients thought the problem that brought them to the ED was medical and not dental in nature.

**SECTION 2.3 CARIES-RELATED COMPLAINTS**

Dental caries and associated sequelae can negatively impact the functional, developmental and social aspects of a child’s overall wellbeing. The pain associated with dental caries can lead to reduced eating, interrupted sleep, behavioral issues, poor learning and lower self esteem (Low, Tan, & Schwartz, 1999). Dental conditions are generally not self-limiting and, when left untreated they commonly become progressively worse.

Dental caries starts as a localized bacterial infection within the enamel and dentin of teeth. Without treatment, a lesion will often progress deeper into dentin, eventually nearing the dental pulp. In response, the pulp initially undergoes a mild inflammatory reaction known as reversible pulpitis. A typical symptom of this condition is pain triggered by hot, cold and sweet
stimuli that lasts for a few seconds and then resolves. If treatment is not rendered at the reversible pulpitis stage, the condition will advance to irreversible pulpitis, a more severe inflammation of the pulp. Pain can become intense, spontaneous and persistent. An irreversibly inflamed pulp will undergo necrosis and the resultant inflammation can spread to the hard and soft tissues adjacent to the tooth resulting in a periapical periodontitis that often produces pain and/or swelling. If the swelling remains localized it is termed an apical abscess and may present clinically as a fluctuant alveolar swelling, with or without a draining fistula. If drainage has been established, the associated discomfort is typically less severe. If the inflammation spreads into the adjacent tissues a cellulitis may develop. This is associated with diffuse, firm and painful swelling of the affected area. Regional lymphadenopathy and fever may be present as well (Douglass & Douglass, 2003).

A variety of disease classification systems were used to categorize caries-related complaints presenting to hospital EDs. Some studies used US national and state specific discharge databases to identify cases (Nagarkar et al., 2012; Oh, Leonard, Walsh, & Fuller, 2012). Many institutions used their own emergency records and completed a chart review to identify cases to be included in their studies (Rowley et al., 2006; Sheller et al., 1997; Von Kaenel et al., 2001; Wilson et al., 1997). Some studies used generic terms such as “non-traumatic” dental conditions and included gingivitis, stomatitis, loose teeth and toothache (Dorfman et al., 2001; Ladrillo et al., 2006; Oliva et al., 2008). Other studies utilized International Classification of Disease (ICD-9 and ICD-10) codes specific to diseases of the jaw and salivary glands (Graham et al., 2000; Oliva et al., 2008). The ICD system has the added benefit of being standard in Canada and the US in most clinical settings, including the ED (Canadian Institute of Health Information, 2012; World Health Organization, 2010). In this
classification system the codes pertaining to diseases of the oral cavity are varied and specific. Examination of the accuracy of the ICD-10-CA classification system in an ED setting in Canada found that although there were discrepancies between the assigned ICD-10-CA code and the diagnosis made by a dentist conducting a chart review, the codes can be used to accurately identify caries-related complaints (Figueiredo, Singhal, Dempster, Hwang, & Quiñonez, 2015).

Chart reviews of identified caries-related ED visits found that patients consistently present with similar chief complaints. Battenhouse et al. (Battenhouse, Nazif, & Zullo, 1988) reported that non-traumatic events were responsible for 54 percent of the 1,456 children’s oral emergencies presenting to the ED at Children’s Hospital of Pittsburgh, PA during a calendar year. Specifically, dental caries and abscess formation were the most common chief complaint representing a combined 45 percent of visits. At Columbus Children’s Hospital in Ohio, Wilson et al. (1997) described the types of non-traumatic oral complaint emergencies presenting to the ED during a one-year period. Caries was the primary diagnosis in 73 percent of the cases, with abscess present in 33 percent of patients and ECC accounting for 18 percent of all cases with a diagnosis of caries. In a study by Sheller et al. (1997) the most frequent primary tooth diagnoses were abscess with sinus tract (44 percent), caries with spontaneous pain (23 percent), caries with provoked pain (12 percent), caries with no symptoms (nine percent) and cellulitis (nine percent).

Oral pain was consistently the most frequently reported chief complaint on presentation to the ED at North American hospitals (Dorfman et al., 2001; Rowley et al., 2006). At SickKids in Toronto, pain was the presenting complaint in most patients (53 percent), followed by facial swelling (26 percent), fever (six percent) and others such as gum bleeding, gum swelling and sores (15 percent) (Oliva et al., 2008). At Boston Children’s Hospital, 92 percent of patients presented with a chief complaint of dental pain. Seventy percent of patients were subsequently
diagnosed with caries or abscess secondary to caries. Of those presenting with pain, 56 percent reported being in discomfort for 72 hours or less and 26 percent had visited a dentist for the same issue that led to their visit to the ED (Dorfman et al., 2001).

Primary molars appear to be the most likely teeth to provoke a caries-related ED visit. At Seattle Children’s Hospital and Regional Medical Center 84 percent of oral complaint emergency visits involved primary teeth, 15 percent permanent teeth and one percent with both primary and permanent teeth (Rowley et al., 2006). The presentations involving primary teeth were 36 percent extra oral swelling, 31 percent carious lesions with symptoms; 31 percent carious lesions with localized swelling or sinus tract; and two percent caries lesions with no symptoms. When permanent teeth were involved, 51 percent had carious lesions with symptoms, 32 percent extra-oral swelling, 16 percent carious lesions with localized swelling or sinus tract and one percent with no symptoms. Primary teeth most associated with inpatient admission were the maxillary first molars and mandibular second molars. Mandibular first molars were the permanent teeth most associated with inpatient admission. In a 1991 study in Belfast, abscesses were more frequently associated with carious primary first molars than with carious primary second molars (Fleming et al., 1991). A retrospective chart review of children seen in the ED at Columbus Children’s Hospital during 1998 for a chief complaint of dental pain that was caries-related found the lower left second primary molar was the most commonly affected tooth, followed by the lower right second primary molar (Von Kaenel et al., 2001).
SECTION 2.4 TREATMENT PROVIDED IN THE ED

Families presenting to the ED are usually first seen by an ED physician who will either manage the complaint themselves, or if a hospital offers dental services will determine if the concern requires immediate attention from a dentist. However, not all EDs provide a dental consulting service. Pennycook, Makower, Brewer, Moulton, & Crawford (1993) described the oral complaints presenting to a general ED and a dentist’s review of their management by physicians. Among the caries-related complaints, a specific diagnosis or identification of the offending tooth was rarely made and the majority of patients were managed based on presenting signs and symptoms. While the treatment provided was considered to be safe, the authors concluded it to be sub-optimal. EDs often provided only temporary relief of pain and infection with a dental appointment indicated to definitively manage the cause.

Most patients with caries-related complaints do not receive dental treatment in the ED (Graham et al., 2000; Pettinato, Webb, & Seale, 2000). The majority of caries-related complaints are managed pharmacologically with analgesics and/or antibiotics (McCormick et al., 2013). Estimates of oral complaint visits in the US report only ten percent of oral complaints as having had surgical intervention compared with 42 percent of all other ED complaints. Specifically, caries-related complaints were significantly more likely to receive an antibiotic and/or analgesic prescription relative to all other ED complaints (Lewis et al., 2003). In Ontario from 2003 to 2006, the majority of caries-related complaints including a diagnosis of periapical abscess, toothache and dental caries, received no intervention, interventions were not coded or they received pharmacotherapy or other non-dental services (Quiñonez et al., 2009). Interviews with UK patients following an ED visit for oral complaints, revealed that 79 percent of respondents would prefer future dental emergencies to be managed by a dentist (Austin et al., 2009).
At children’s hospitals it was similarly found that patients who presented to an ED with a caries-related complaint are prescribed a course of oral antibiotics and a recommendation for follow up care with a dentist (Oliva et al., 2008; Sheller et al., 1997). Oral antibiotics were prescribed for most patients with intramuscular and intravenous antibiotics administered in a minority of cases. The type and route of administration of the antibiotics was based largely on the presence of accompanying symptoms such as fever or dehydration, as well as the treating physician’s personal preference. ER physicians referred 40 percent of patients to the hospital dental clinic, 48 percent to an outside dental clinic or private practitioner and 11 percent were not given a dental referral (Graham et al., 2000).

In hospitals that have dental service such as an on-call dentist for emergencies, children still rarely receive definitive dental treatment. At Columbus Children’s Hospital despite being seen by dental personnel, only 18 percent had extraction while 37 percent were prescribed antibiotics and 38 percent were prescribed analgesics (Von Kaenel et al., 2001). At Children’s Medical Center of Dallas despite having an on-call dentist available outside of clinic hours, they were only consulted for six out of 159 caries-related visits over a two-year period (Graham et al., 2000). At SickKids in 2005, the ED physician saw 209 of the 247 children that were triaged for a non-trauma related emergency, close to 70 percent were discharged from the ED on a course of oral antibiotics and/or analgesics (Oliva et al., 2008). Those diagnosed as having toothaches or less serious infections were provided a referral to a community dentist or dental public health clinic. Eight percent of children were admitted to the hospital for intravenous antibiotics followed by extraction in the hospital dental clinic. A follow-up examination at the hospital dental clinic the next day was recommended for 57 percent of patients and the rest who did not receive definitive care were advised to follow up with their primary care dental provider.
SECTION 2.5 COST OF CARE FOR CARIES-RELATED COMPLAINTS

Dental conditions are generally not self-limiting and when left untreated become progressively worse, requiring more extensive and costly care. In the US in 2006, the total hospital charges for dental caries ED visits by children were estimated at $14.3 million USD with a mean per charge of $667.48 USD (Nalliah, Allareddy, Elangovan, Karimbux, & Allareddy, 2010). More advanced sequelae of dental caries such as abscess or cellulitis that more heavily impact hospital resources were not included in the study. In New Hampshire, ED charges associated with oral conditions increased from $1.8 million USD in 2001 to $5.9 million USD in 2007 (Anderson et al., 2011). A 2006 study by Hong et al. (Hong et al., 2011) found that hospital ED visits for oral complaints resulted in a mean hospital charge of $360.21 USD. They also found that, over the six-year period of the investigation, there was a statistically significant increase in the mean charges associated with oral complaint ED visits. A study by Nagarkar et al. (2012) evaluated visits for ECC in New York State from 2004 to 2008 and reported an average ED visit cost of $526 USD. However, details of the visit including the associated teeth, final diagnosis and treatment provided were not examined. Also, they did not include inpatient hospitalizations for caries and associated costs, which raise the overall costs of managing the caries-related complaint.

In these studies, the wide range of hospital charges associated with oral complaint visits was explained by the varying presentations of patients and the variation in tests ordered to evaluate the child. Although most patients needed limited or minimal interventions, some required more resource-intensive care. Families who incurred greater costs were generally those who needed more care to manage swelling, dehydration, fever or who required IV antibiotics.
The types of interventions at each visit varied widely by to patient and institution, but consistently greater than 50 percent of visits resulted in no definitive care. Such visits generally included patient assessment, a prescription of antibiotics and a dental referral at a mean cost of $112-667 USD (Graham et al., 2000; Nalliah et al., 2010).

In Canada, provincial health insurance covers most of the costs of hospital and physician treatment, while dental treatment is largely not supported. The exception is some surgical-dental treatment delivered in hospital for eligible patients, including treatment of dental-related hospital ED visits. In Ontario for 2006-2007 the approximately 28,000 ED visits for oral complaints cost a mean of $575.03 CAD to resolve the issue (Quiñonez, Ieraci, & Guttmann, 2011). Another analysis conducted at St. Michael’s Hospital in Ontario estimated a cost of $513 CAD per visit in 2012 (Association of Ontario Health Centres, 2012). To date, there are no studies examining the hospital costs of treating caries-related ED visits at a Canadian children’s hospital.
SECTION 2.6 SUMMARY OF LITERATURE REVIEW

ED visits increased by over twenty percent in the US for the years 1997 to 2007. In addition, more patients were using the ED to address oral complaints than previously. Many of these complaints were caries-related, an increasing trend that was especially pronounced amongst children. In Canada, studies of oral complaint emergencies in children have assessed a single year of ED activity and there have been few studies specifically examining caries-related complaints. Patient age and SES were factors predictive for use of the hospital ED for management of caries-related complaints. Patients who accessed the ED for oral complaints were otherwise healthy but often had no source of primary dental care. While most dental complaints presented during the evenings and on weekends, caries-related complaints also presented during the workday. Most ED care at children’s hospitals did not constitute definitive treatment for caries-related complaints. Trends in, and the cost of managing, caries-related complaints in Canadian children’s hospitals are unknown.
CHAPTER 3: METHODS

SECTION 3.1 DESIGN OVERVIEW

The study consisted of a retrospective review of the health records of all children who presented to SickKids with caries-related emergency complaints from January 1, 2003 to December 31, 2012 inclusive. In this population, emergency and dental records were reviewed and data were abstracted on the following: patient demographics, presenting complaints, comorbidity, dental imaging, dental treatments, final diagnosis and patient disposition. Those seen from January 1, 2007 to December 31, 2012 within the Division of Paediatric Emergency Medicine (DPEM) had additional data provided by the Decision Support Services department at SickKids including and direct and indirect costs associated with care. The information provided by the Decision Support Services department only dates back to 2007 due to the implementation of a new costing methodology at that time. The cost of dental treatment performed in the DPEM was abstracted from the Department of Dentistry OHIP billing submissions.

SECTION 3.2 STUDY POPULATION

The subject population for this study was all children 0-17 years of age who were seen in SickKids DPEM for emergency caries-related dental complaints between January 1, 2003 and December 31, 2012. A caries-related emergency complaint was defined as a chief complaint of pain or swelling due to the sequelae of dental decay including reversible pulpitis, irreversible pulpitis, abscess or cellulitis as recorded in the chart by either the treating physician or dentist.
**Inclusion criteria:** All children who presented to the SickKids DPEM with caries-related emergency complaints from January 1, 2003 to December 31, 2012 (inclusive).

**Exclusion criteria:** Visits related to trauma, salivary glands, TMJ, teething and gingival stomatitis and missing charts.

**Sample Size Considerations:** The decision to include all patients who were seen at SickKids for a caries-related ED visit over a ten-year period was based on precedents set by previous studies that examined similar populations. These studies found that a substantial change in visits for dental complaints in the ED can be detected over a five to eight-year period (Anderson, Cherala, Traore, & Martin, 2011; Ladrillo et al., 2006).

**Section 3.3 Data Collection**

**Identification of cases:** A visit for an emergency dental complaint seen within the DPEM was identified as a registration where the principal diagnosis at discharge was coded using the International Classification of Disease (ICD-10) block code equal to K00-K14 (diseases of oral cavity, salivary glands and jaws). The medical records department then populated a list of patients seen within the specified dates with the applicable ICD-10 codes. Once the patients were identified, eligibility was determined by reviewing the corresponding health records in the electronic patient chart.

**Clinical and demographic data collection:** Clinical information recorded included time of registration, chief complaint, existing medical co-morbidities, diagnoses and treatments
provided. Patient demographic information collected included age, sex and postal code. The collected postal codes were converted using Statistics Canada’s postal code conversion file (PCCF+) version 2006 (Statistics Canada, 2009) to identify the dissemination area (DA). A DA is a small, relatively stable geographic unit that is the smallest standard geographic area for which census data is collected within Canada. The identified DA was then linked to the Ontario Marginalization Index (ON-MARG), a measure that linked factors such as residential instability and material deprivation within DA. The material deprivation score was calculated using the proportion of the population that was over 20 years of age without a high-school diploma, those who were single parent families, those receiving government transfer payments, those over 15 years of age who were unemployed, the proportion of population considered low income and the proportion of households living in dwellings in need of major repair. Quintiles were created by sorting the marginalization data into five groups, ranked from one (least marginalized) to five (most marginalized). The index served as a proxy for socioeconomic status (SES).

**Costing Analysis:** Decision Support Services provided a break down of the cost of care for treatments provided. Children that required hospital admissions had costs calculated for their entire episode of care. The institutional costs for the episodes of emergency care were tabulated using case costing at the encounter level in order to determine an average cost and total cost of emergency care for the population. Decision Support Services used case costing at the encounter level in order to determine an average cost and total cost of emergency care for the population. Case costing, or service recipient costing, is an activity-based costing model that tracks and costs service delivery to individual service recipients by service date. Case costing uses actual dollars, reflected in the hospital finance general ledger, to distribute the direct or indirect costs to the
patient level. Direct costs are the costs directly associated with providing patient care including nursing, lab tests, diagnostic imaging, pharmacy and food. Indirect costs include relevant overhead costs such as administration, finance and human resources. Distribution of these costs are based on nursing workload hours, actual inventory cost of supplies, pharmacy costs and standard workload hours for diagnostic imaging departments. An allocation calculation is performed for indirect costs taking into account the reciprocal utilization of overhead functions. The dental costs were tabulated using the treatment codes submitted to OHIP and associated fees according to the 2006 version of the Schedule of Benefits for Dental Services under the Health Insurance Act (Ministry of Health and Long Term Care, 2006). Costs were reported in Canadian dollars.

**SECTION 3.4 STUDY VARIABLES**

*Primary:* Annual frequency of caries-related emergency complaints seen at SickKids.

*Secondary:*

1. Patient information including date and month of birth, sex, medical co-morbidities and postal code.
2. The diagnosis made by the treating physician or dentist, treatment provided and patient disposition as documented in the chart.
3. The costs associated with care including hospital related direct and indirect costs of care and dental treatment fees.
**SECTION 3.5 DATA ANALYSIS**

The data were entered into a File Maker Pro/Server 12 (2012)® that was password protected and backed up remotely. Each patient was assigned a unique study number and a password protected code-breaking file was stored separately from the database. Elements of the File Maker Pro/Server 12 (2012)® dataset were exported to R Statistics Software version 3.03 for model development and to SPSS 23 (2012)® for data analysis.

*Primary Analysis:* The trend of the data with respect to time was explored by plotting a LOESS curve over the observed data using monthly intervals. Additionally, a Poisson model, using calendar time as the exposure of interest was used to examine whether the rate of caries-related visits changed over time. The final analysis carried out used a log linear analysis to examine the impact of age, sex, comorbidity, weekday/weekend, time and SES and the association with visit counts for caries-related ED visits. Time was categorized into quarters due to sparsity of the data that occurred when using monthly intervals and age was categorized as aged 5 years and below or above 5 years of age. The log linear analysis included all main effects as well as all two-way interactions with time. A two-sided significance level of 0.05 was used for hypothesis testing.

*Secondary Analysis:*

1. Descriptive statistics were calculated, including the mean and standard deviation for quantitative measures such as age, neighborhood income quintile and deprivation index quintile. Frequency and percent were calculated for categorical variables such as sex and existing co-morbidities. Following the development of the time series model, a log linear model for contingency tables was used to examine the impact of age, sex, comorbidity and SES and the association with visit counts for caries-related ED visits.
2. Frequencies of chief complaints, diagnoses, and treatments rendered were calculated.

3. Mean, median and range of cost of treatment were calculated and compared by department.
CHAPTER 4:

Visits to a children's emergency department for caries-related complaints: Ten-year utilization trends

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SECTION 4.1 ABSTRACT

BACKGROUND: There is little data on temporal trends in children’s hospital emergency department visits for caries-related complaints within Canada. This study’s primary aim was to determine the annual frequency of caries-related visits to a children’s hospital emergency department (ED) over a ten-year period. The secondary aim was to describe characteristics of the children.

METHODS: A retrospective review of health records of all children who presented to the ED at The Hospital for Sick Children, Toronto, Canada with caries-related complaints from January 1, 2003 to December 31, 2012 was completed. A caries-related complaint was defined as a chief complaint of pain and/ or swelling due to the sequelae of dental decay (reversible pulpitis, irreversible pulpitis, abscess or cellulitis) as recorded in the chart by the treating physician or dentist. Data were abstracted on age, sex, comorbidity and postal code. A Poisson model examined trends over time. A log-linear model for contingency table was used to examine the impact of sex, age, comorbidity and deprivation index and time.

RESULTS: During the ten-year period, 2,032 caries-related visits to the ED were recorded. Over the study period, the numbers of visits for caries-related complaints increased by 48 percent (p = 0.001). Characteristics of the children were being male, under 5 years old, low socioeconomic status and no co-morbidity.

INTERPRETATION: There was a statistically significant increase in caries-related visits to this children’s hospital ED. EDs are an increasingly important site for children with caries-related complaints, particularly those of pre-school age and low socioeconomic status.
SECTION 4.2 INTRODUCTION

Hospital emergency departments (EDs) have become increasingly important sites of care for people seeking treatment for dental complaints.\(^1,2\) In the United States (US), approximately one to two percent of visits to general hospital EDs annually are for dental complaints\(^3\) and there is evidence that this proportion is increasing across all age groups.\(^4-6\) Within Canada, it has been reported that 5.4 percent of the adult population have presented to an ED for dental complaints.\(^1\)

While the majority of research in the US and Canada has focused on general hospital EDs, studies have shown an even more pronounced increase in dental complaint visits to children’s hospital EDs.\(^7,8\) For example, Texas Children’s Hospital experienced a 121 percent increase in dental complaint visits over a five-year period, compared to a 28 percent increase in non-dental complaint visits over the same time period.\(^7\) Although there is limited data on ED use for dental complaints by children in Canada, in Ontario, the country’s most populated province, from 2003 to 2006 there were 24,336 ED visits for dental complaints unrelated to trauma by patients under the age of 20 years.\(^9\)

Children with dental complaints may present to a hospital for treatment of traumatic injuries, the sequelae of dental caries, oral mucosal conditions and other issues. In the US, it has been reported that the number of ED visits related to dental caries has increased.\(^8,10\) Caries-related complaints include pain associated with dental decay, diseases of the dental pulp and periapical tissues, dental abscesses and cellulitis of odontogenic origin. A ten-year (1982-1991) review at Seattle Children’s Hospital and Regional Medical Center described 1,482 after-hours dental emergency visits, in which the proportion of caries-related visits increased over time, while those for traumatic dental injury decreased.\(^10\) A more recent follow up at Seattle Children’s
Hospital and Regional Medical Center from 1995 to 2003 revealed a continuation of this trend with increased numbers of ED dental visits primarily due to caries-related complaints.\textsuperscript{8}

Most studies carried out in Canada have looked at a single year to determine prevalence, etiologies and treatment of children making caries-related children’s ED visits.\textsuperscript{13} Importantly, there is little to no data on temporal trends in children’s hospital emergency visits for caries-related dental complaints within Canada. The primary purpose of this study was to determine the annual frequency of caries-related visits to a children’s hospital ED over a ten-year period. The secondary objective of this study was to describe the characteristics of the children that presented to the ED.

\textbf{SECTION 4.3 METHODS}

\textbf{Study design}

The study consisted of a retrospective review of the health records of all children who presented to The Hospital for Sick Children (SickKids) ED with caries-related complaints from January 1, 2003 to December 31, 2012 inclusive. A caries-related complaint was defined as a chief complaint of pain or swelling due to the sequelae of dental decay including reversible pulpitis, irreversible pulpitis, abscess or cellulitis as recorded in the chart by either the treating physician or dentist. A visit for a dental complaint seen within the ED was identified as a registration where the principal diagnosis at discharge was coded using the International Classification of Disease (ICD-10) block code equal to K00-K14 (diseases of oral cavity, salivary glands and jaws). The discharge codes were assigned by the attending emergency physician. A list of patients seen within the specified dates with the applicable ICD-10 codes was generated. Once the patients were identified, eligibility was determined by reviewing the
corresponding health records in the electronic patient chart. Final eligibility was determined using the written diagnosis as recorded in the chart by either the treating emergency physician or when consulted, the on-call dentist. Complaints related to trauma, salivary glands, cysts and tumors of the jaws, temporomandibular joint, teething, gingival stomatitis or undetermined etiology were excluded from the study. Also excluded were records with incomplete chart entries.

**Outcomes**

Patient demographic information collected included age, sex and postal code. The collected postal codes were converted using Statistics Canada’s postal code conversion file (PCCF+) version 2006¹⁶ to identify dissemination areas (DA). A DA is a small, relatively stable geographic unit and is the smallest standard geographic area for which census data is collected. The identified DA was then linked to the Ontario Marginalization Index (ON-MARG), a measure that linked factors such as residential instability and material deprivation within DA. The material deprivation score was calculated using the proportion of the population that was over 20 years of age without a high-school diploma, those who were single parent families, those receiving government transfer payments, those over 15 years of age who were unemployed, the proportion of population considered low income and the proportion of households living in dwellings in need of major repair. Quintiles were created by sorting the marginalization data into five groups, ranked from one (least marginalized) to five (most marginalized). The index served as a proxy for socioeconomic status (SES).

**Statistical analysis**

The data were entered into a File Maker Pro/Server 12 (2012)® database. Elements of the File Maker Pro/Server 12 (2012)® dataset were exported to R Statistics Software version 3.03
and to SPSS 23 (2012)® for data analysis. The trend of the data with respect to time was explored by plotting a LOESS curve over the observed data using monthly intervals. Additionally, a Poisson model, using calendar time as the exposure of interest was used to examine whether the rate of caries-related visits changed over time. The final analysis carried out used a log linear analysis to examine the impact of age, sex, comorbidity, weekday/weekend, time and SES and the association with visit counts for caries-related ED visits. Time was categorized into quarters due to sparsity of the data that occurred when using monthly intervals and age was categorized as aged 5 years and below or above 5 years of age. The log linear analysis included all main effects as well as all two-way interactions with time. A two-sided significance level of 0.05 was used for hypothesis testing. Descriptive statistics were calculated using the mean and standard deviation for quantitative and frequencies and percentages for categorical variables.

**Ethical approval**

This study was approved by the Research Ethics Board at SickKids (REB Approval # 1000039465). Data were secured in accordance with Research Ethics Board requirements.
SECTION 4.4 RESULTS

From January 1, 2003 to December 31, 2012, there were 2,032 caries-related ED visits by 1,901 children to the SickKids ED. Caries-related visits accounted for 0.5 percent of all ED visits. Six percent of the sample utilized the ED for a caries-related complaint more than once. A Poisson model was applied to assess the change in visits over time (Figure 1). A statistically significant increase in the number of visits with a rate ratio of 1.004 (95 percent confidence interval: 1.0027-1.0053, p < 0.001) indicating a rate of increase of 0.4 percent month over month was determined. This corresponds to, on average, a cumulative increase in the number of visits of 48 percent over the ten-year period.

Figure 1: Trends in number of caries-related complaints to the ED from 2003-2012

Of the 2,032 visits studied, 42.9 percent occurred on the weekend (defined as Friday after 4 pm to Monday at 8 am) with almost equal distribution on the weekdays (Figure 2). Clinic hours were defined as 8 am to 4 pm and anything outside of that window was categorized as after hours. The majority of visits, 65.1 percent, occurred outside clinic hours.
Patients ranged in age from 9 months to 17 years of age, with a mean age of 6 years (95 percent confidence interval of 5.90 to 6.18) and a standard deviation of 3.2 years (Figure 3). Male children comprised 58.5 percent of visits and females 41.5 percent of visits.
Figure 3: Histogram of distribution of visits by patient age from 2003-2012

The majority of children (81.5 percent) had no associated medical comorbidity (Table 1). Of the 1,901 patients that presented, 351 had a medical comorbidity, 28 of which had multiple conditions for a total of 379 distinct comorbid diagnoses. The most common condition reported was asthma with a prevalence in the sample of 7.2 percent. A central nervous system (CNS) diagnosis including seizure disorders, developmental delays and cerebral palsy was second most common with a prevalence of 3.9 percent. Autism was included as a separate diagnosis and had a prevalence of 2.7 percent. The remaining diagnoses included cardiac conditions, history of cancer, bleeding disorders, gastrointestinal ailments and musculoskeletal disorders.
Table 1: Frequency of comorbidities among children presenting with ED caries-related complaints

<table>
<thead>
<tr>
<th>Diagnoses</th>
<th>Number</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>136</td>
<td>7.2</td>
</tr>
<tr>
<td>CNS condition</td>
<td>75</td>
<td>3.9</td>
</tr>
<tr>
<td>Autism</td>
<td>51</td>
<td>2.7</td>
</tr>
<tr>
<td>CVS condition</td>
<td>39</td>
<td>2.1</td>
</tr>
<tr>
<td>Oncological</td>
<td>13</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>65</td>
<td>3.4</td>
</tr>
<tr>
<td>None</td>
<td>1550</td>
<td>81.5</td>
</tr>
<tr>
<td><strong>Total diagnoses</strong></td>
<td><strong>1929</strong></td>
<td><strong>101.6</strong>*</td>
</tr>
</tbody>
</table>

* >100 as some children had multiple diagnoses

ON-MARG deprivation index (DI) quintiles were available for 1,662 of 1,901 patients. Some DAs were not assigned quintiles due to missing data, such as unreported income levels, within the census. The median DI quintile was 4.0, equating to an appreciable level of deprivation (Table 2). One third of families resided in the most deprived quintile in Ontario and almost half in the two most deprived quintiles. In addition, sixty-one percent of families lived within 10 km of the hospital.

Table 2: Proportion of families in ON-MARG DI quintiles

<table>
<thead>
<tr>
<th>DI Quintile</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>230</td>
<td>13.8</td>
</tr>
<tr>
<td>2.0</td>
<td>242</td>
<td>14.6</td>
</tr>
<tr>
<td>3.0</td>
<td>283</td>
<td>17.0</td>
</tr>
<tr>
<td>4.0</td>
<td>325</td>
<td>19.6</td>
</tr>
<tr>
<td>5.0</td>
<td>582</td>
<td>35.0</td>
</tr>
<tr>
<td>Total</td>
<td>1662</td>
<td>100.00</td>
</tr>
</tbody>
</table>

A log linear model for contingency tables was used to examine the impact of sex, weekday/weekend, age (categorized as below or above five years of age), comorbidity, deprivation index and the association with visit counts for caries-related ED visits over time.
(using quarterly data). Table 3 shows the results of the log-linear analysis that male sex, age under five years, having no co-morbidity and having a higher deprivation score was associated with higher numbers of caries-related visits. Furthermore, a greater proportion of visits occurred during the weekend than during the week.

Table 3: Impact of variables and association with visit counts

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Deviance</th>
<th>Pr(&gt;Chi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1</td>
<td>58.52</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>4.35</td>
<td>0.06</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>1</td>
<td>750.88</td>
<td>0.00</td>
</tr>
<tr>
<td>Deprivation Index</td>
<td>4</td>
<td>253.44</td>
<td>0.00</td>
</tr>
<tr>
<td>Weekday</td>
<td>1</td>
<td>216.92</td>
<td>0.00</td>
</tr>
<tr>
<td>Quarter</td>
<td>29</td>
<td>68.62</td>
<td>0.00</td>
</tr>
</tbody>
</table>

When parameter estimates with relation to the outcome for sex, weekday/weekend, age and comorbidity categories were obtained, only one of the interactions was found to be statistically significant. There was a significant interaction between the increased number of visits over time and the proportion of visits made on the weekend (p=0.04). The increase in the proportion of visits made on the weekend versus the week increased over the study period by 3.5 percent. Two-way interactions of time with sex, age category, comorbidity and deprivation index were not statistically significant, meaning that these variables did not change over time. The p-value for comparing the main model listed above with the one including all the two-way interactions was 0.07. However, the interpretation of the overall interactions as being significant is not accurate as the p-value of 0.07 was driven by the interaction between weekend/weekday and quarter, which resulted in a significant p-value of 0.04.
SECTION 4.5 INTERPRETATION

The current study is the first to examine long-term utilization trends for caries-related complaints at a Canadian children’s hospital ED. Poison models are useful when examining trends in counts of an event that are changing over time. The results indicated a 48 percent increase in caries-related complaints over the study period. Overall patient volumes at SickKids’ ED are estimated to have increased 40 percent from 45,000 children in 2003 to approximately 63,000 children in 2012.\(^\text{17}\) This study is consistent with the US trend in that the rise in caries-related visits is greater than the overall increase in ED use. The model demonstrates that more males than females, more families from lower SES and more children under the age of five years old use the ED for caries-related complaints. However, these demographic characteristics remained stable with time and did not influence the increase in the number of visits seen over the study period.

Children younger than five years of age with caries-related complaints comprised over half of the patients. Many of these children presented with severe early childhood caries. This is consistent with the US studies that found that patients with caries-related complaints were younger than those presenting for other non-dental emergencies. While this study was not able to document the proportion of patients for which the ED visit was the first contact with a dentist, other studies estimate that the emergency visit was the first dental encounter for over one-quarter of caries-related ED visits.\(^\text{18}\)

Males represented almost 60 percent of the visits made for caries-related complaints, which is similar to the proportion of children’s ED visits for all complaints of 52.8 percent.\(^\text{19}\) American studies focusing on children’s ED use for dental-related complaints report that males
comprise up to 56.7 percent of all visits, but this has been attributed to more males than females presenting with trauma.\(^7\) Other studies that have focused on caries-related and early childhood caries visits found that males represented a higher proportion of ED visits in children at 54 to 56 percent.\(^8\)\(^-\)\(^20\) Estimates of US caries rates by sex estimated that males have slightly more caries experience than females in the primary dentition with 44.4 percent of males having caries compared to 39.8 percent in females.\(^21\) Since there are no local or national prevalence estimates for caries in children below six years of age in Canada, it must be inferred that the increased number of ED visits for caries-related complaints by males follows an overall trend of caries prevalence by sex.

The proportion of patients with comorbidities was greater than that reported in US studies, which reported 92 to 97 percent of patients as being otherwise healthy.\(^8\)\(^,\)\(^22\) The most common diagnosis in this study was asthma, which was reported at 7.2 percent, which is consistent with the prevalence in Toronto children at 6.8 percent.\(^23\) Neurological conditions including developmental delay, cerebral palsy, seizure disorders and autism represented a cumulative eight percent of patients. Autism represented two percent of the sample; double the reported prevalence.\(^24\) In Sheller et al.’s study of US children two percent had a diagnosis of asthma, which was much below the reported US prevalence, so perhaps the difference lies in the history taking or perhaps our population is biased for more medically compromised children.\(^18\) Regardless of the difference, these results suggest that the majority of patients using hospital EDs for caries-related complaints are otherwise healthy.

Overall, ED use was strongly correlated with the geographical distance from the hospital. Families travelling from less than ten km away comprised 61 percent of visits. This pattern could be due to convenience for those closest to the hospital, but it could also be that Sickkids is
located in a densely populated area. Further qualitative studies that focus on communities with high use of the ED for caries-related complaints would be required to fully elucidate family motivations for presenting to the hospital.

The total number of patients for which ON-MARG DI quintile were available for were 1,662 patients of the 1,901. This was due to an inability to assign a deprivation score due to data suppression from the census, for example income level for the dissemination area. The overall trend is that the majority of patients resided in the most deprived quintiles. These results suggest that low SES families visit the ED in higher numbers for caries-related complaints than families of higher SES. In Canada, dental care is financed primarily through insurance, both private and public, as well as out-of-pocket payments.\textsuperscript{25} That lower SES families use the ED for the sequelae of untreated caries is consistent with prior findings that lower SES children have more caries and more advanced infection; and experience lower treatment rates than children from higher SES families.\textsuperscript{26, 27} Many of the presenting children would be eligible for public programs and perhaps efforts towards informing low income families of the resources available could help ensure that treatment is provided prior to the development of symptoms requiring an ED visit.

While factors such as age under five years, male sex, low SES and being otherwise healthy characterized the population, none of these factors changed over time. The proportion of these patient characteristics remained constant over the time studied. The only characteristics of the visits that appeared to change with time by quarter was visit made by weekend or weekday with a very slight increase in the proportion that presented on the weekend over time.

Treating physicians and dentists did not consistently record attempts made to receive emergency dental care at other sources. This is information that should be asked of every patient that presents to the ED for emergency care. It is important to know if there were barriers to
receiving care elsewhere and furthermore to receiving primary care dental examinations. Noting this information would help to clarify whether the ED was used due to financial constraints, lack of a primary care provider, convenience or other motivating factors. Further studies that aim to understand the needs and barriers to care faced by this population could help to develop appropriate public health interventions to overcome these obstacles.

Limitations

The major limitation of this study lies in that it is a retrospective chart review and as such is inherently limited by the contextual constraints of chart-based information. A further limitation of the study lay in the issue that postal codes sometimes straddled DAs resulting in a postal code with multiple DAs. To assign the most appropriate DA, a file within the PCCF+ was used to identify the DA with the majority of dwellings assigned to a particular postal code. As a result, only partial correspondence between the postal code and DAs and subsequently ON-MARG deprivation quintile may have occasionally occurred.

Conclusions

Analysis of caries-related ED visits at SickKids hospital over a ten-year period demonstrated that here was an increasing trend in ED use for caries-related complaints in Canada’s largest children’s hospital. The patients who presented were the very young, many with caries in addition to the caries-related condition that led to visit, and were in need of comprehensive care. For children of families with low SES, hospital EDs appear to provide an important access point to dental treatment for caries-related complaints. With the number of visits increasing, children’s hospital EDs should be prepared to manage the emergent sequelae of dental caries.
SECTION 4.6 ACKNOWLEDGEMENTS

The authors thank those who helped in this research effort: Beatrice Beaubien, PhD, Project Manager, Data Management and Custom Applications, The Hospital for Sick Children, Toronto, Canada for her assistance with data base development and management; and Chetna Mistry and Emily Nisbett, summer research students, Department of Dentistry, The Hospital for Sick Children, Toronto, Canada for their help with data entry.
Section 4.7 References

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CHAPTER 5:

Management of caries-related complaints at a children’s hospital emergency department

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48
SECTION 5.1 ABSTRACT

PURPOSE: To determine the diagnoses and causative teeth of caries-related emergency complaints that presented to children’s hospital and the treatment provided over a ten-year period.

METHODS: A retrospective review of the health records of all children who presented to The Hospital for Sick Children (SickKids) with caries-related emergency complaints from January 1, 2003 to December 31, 2012 was completed. A caries-related complaint was defined as a chief complaint of pain and/or swelling due to the sequelae of dental decay as recorded in the chart by the treating physician or dentist. Visit information collected included chief complaint, diagnosis, associated teeth, treatment rendered and patient disposition at discharge.

RESULTS: The study included 2,032 caries-related visits over ten-years. The most common presenting complaint was pain (51 percent) and the most common diagnosis abscess (40 percent). The primary maxillary central incisors (22 percent) were the most common causative teeth. Dental treatment within the ED was provided for 22 percent of patients. Thirty-eight percent of those triaged received a prescription for antibiotics and/or analgesics. Overall, 44 percent of children received definitive surgical treatment within the hospital to resolve the primary cause of the visit.

CONCLUSIONS: Children’s hospital EDs should be prepared to manage the emergent sequelae of dental caries.

KEYWORDS: PEDIATRIC DENTAL SERVICES, TRENDS, CARIES, EMERGENCY DEPARTMENT
SECTION 5.2 INTRODUCTION

In the United States and Canada, hospital emergency departments (EDs) have become an increasingly important point of care for people seeking treatment for oral complaints.\(^1,2\) In children’s hospitals with a dental service, it is commonly thought that the role of a children’s dental service in the ED is to administer treatment for patients with trauma to the oral cavity. However, the number of visits related to dental caries in children’s hospitals appears to be increasing.\(^3,4\) Caries-related complaints include dental decay and associated pain, diseases of the pulp and periapical tissues, dental abscesses and cellulitis of odontogenic origin. The Hospital for Sick Children (SickKids) in Toronto, Canada’s most populated city, reported a ten-year increase of 48 percent in caries-related emergency department visits from 2003 to 2012.\(^5\)

Caries-related emergencies and associated sequelae can be managed in a variety of ways depending on the specific diagnosis. Symptoms such as swelling and pain can be managed with antibiotics and analgesics but ultimately surgical intervention is required to definitively address the source of the dental emergency. Primary teeth with large carious lesions and reversible pulpitis may be managed with a sedative, temporary restoration to provide pain relief. When the infection is more advanced then management of the pulp or extraction may be necessary. For permanent teeth, temporary restorations, pulpectomy and when absolutely necessary extraction is recommended.\(^6\)

Generally, children who present with a caries-related complaint to an ED are seen by a physician, prescribed a course of oral antibiotics and given a recommendation for follow-up care with a dentist.\(^7,8\) Hospitals have no or varying levels of dental services that range from an on-call consultation service with operating room privileges, in-hospital dental departments and, as is the case at SickKids, an ED suite equipped with dental
armamentarium to provide care. Nevertheless, in children’s hospitals that provide ED dental services, patients presenting with a caries-related complaint are often still likely managed medically. In a study at the Children’s Medical Center of Dallas, for example, a dentist was consulted for only six of 156 children that presented to the ED over the course of one year (1996-1997). Few children received definitive dental treatment despite the availability of a 24-hours dental consulting service.

Although caries-related emergencies in children are an important public health concern, no study at a Canadian hospital has investigated the nature of presentation and treatment provided. As a result, this study aims to determine the chief complaint, associated teeth and diagnoses of caries-related emergency complaints that presented to a tertiary care children’s hospital (SickKids) over a ten-year period, and determine the treatment provided to resolve the entire emergency episode over the same timeframe.

**SECTION 5.3 METHODS**

This study consisted of a retrospective review of the health records of all children who presented to the SickKids ED with caries-related emergency complaints from January 1, 2003 to December 31, 2012 inclusive. A visit for an emergency caries-related complaint seen within the ED was identified as a registration where the principal diagnosis at discharge was coded using the International Classification of Disease (ICD-10) block code equal to K00-K14 (diseases of oral cavity, salivary glands and jaws). The health records department populated a list of children seen within the specified dates with the applicable ICD-10 codes. Once the children were identified, final eligibility was determined by reviewing the corresponding health records in the electronic patient chart. A caries-related emergency complaint was defined as a chief complaint
due to the sequelae of dental decay including caries, reversible pulpitis, irreversible pulpitis, abscess or cellulitis as recorded in the chart by either the treating physician or dentist. Complaints related to trauma, salivary glands, cysts and tumors of the jaws, temporomandibular joint, teething, gingival stomatitis or causes undetermined were excluded from the study. Incomplete chart entries were also excluded.

Visit information collected included presenting chief complaint, final diagnosis, involved tooth, treatment rendered and patient disposition at discharge. The data were entered into a FileMaker Pro/Server 12 (2012)® database. Elements of the FileMaker Pro/Server 12 (2012)® dataset were exported to SPSS 23 (2012)® for final analysis. Frequencies of chief complaints, diagnoses, tooth involved and treatments rendered were calculated. The Research Ethics Board at SickKids approved this study. Data were secured in accordance with Research Ethics Board requirements (REB approval number: 1000039465).

SECTION 5.4 RESULTS

During the ten-year study period, 2,032 children presented to the ED with a caries-related complaint. Over the course of the study the number of visits for a caries-related complaint increased 48 percent. Table 1 presents the visits by chief complaint. Over 50 percent of patients presented to the ED due to pain. Chief complaints of loss of appetite, not sleeping and bleeding comprised the two percent noted as “other.”

<table>
<thead>
<tr>
<th>Chief Complaint</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>999</td>
<td>49</td>
</tr>
<tr>
<td>Swelling</td>
<td>872</td>
<td>43</td>
</tr>
<tr>
<td>Cavities</td>
<td>122</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>39</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 2 is a summary of prevalence of dental diagnoses for children discharged from the ED. The most frequent (36 percent) diagnosis made was abscess, but when abscess and cellulitis were combined, over fifty percent of children presented with some sort of oral swelling. Early childhood caries (ECC) was identified in 10 percent of children, indicating that multiple teeth were involved in the emergency.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscess</td>
<td>812</td>
<td>40</td>
</tr>
<tr>
<td>Caries</td>
<td>754</td>
<td>37</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>359</td>
<td>18</td>
</tr>
<tr>
<td>Pulpitis</td>
<td>107</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,032</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The causative teeth are presented in Table 3. The specific tooth was unknown or a diagnosis of ECC was recorded for 758 children (37 percent.) This left 1,274 children with 1,996 identified teeth associated with the caries-related visit. Of those with an identified causative tooth, over 90 percent of visits involved a primary tooth with the maxillary primary centrals as the most commonly associated teeth. The maxillary primary first molar was also the most commonly involved tooth with a diagnosis of cellulitis and the most commonly associated with an admission. When a permanent tooth was reported the most frequently involved was the mandibular permanent first molar at three percent.
Table 3a: Presentation by causative primary tooth

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary Primary Central</td>
<td>447</td>
<td>22</td>
</tr>
<tr>
<td>Maxillary Primary Lateral</td>
<td>269</td>
<td>14</td>
</tr>
<tr>
<td>Maxillary Primary Canine</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>Maxillary Primary 1st Molar</td>
<td>350</td>
<td>18</td>
</tr>
<tr>
<td>Maxillary Primary 2nd Molar</td>
<td>153</td>
<td>8</td>
</tr>
<tr>
<td>Mandibular Primary Central</td>
<td>11</td>
<td>0.5</td>
</tr>
<tr>
<td>Mandibular Primary Lateral</td>
<td>8</td>
<td>0.4</td>
</tr>
<tr>
<td>Mandibular Primary Canine</td>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>Mandibular Primary 1st Molar</td>
<td>270</td>
<td>13</td>
</tr>
<tr>
<td>Mandibular Primary 2nd Molar</td>
<td>273</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total Primary Teeth</strong></td>
<td><strong>1826</strong></td>
<td><strong>92</strong>*</td>
</tr>
</tbody>
</table>

*As a percent of the overall total (primary + permanent teeth)

Table 3b: Presentation by causative permanent tooth

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary Permanent Central</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Maxillary Permanent Lateral</td>
<td>9</td>
<td>0.5</td>
</tr>
<tr>
<td>Maxillary Permanent Canine</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Maxillary Permanent 2nd Premolar</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Maxillary Permanent 1st Molar</td>
<td>38</td>
<td>2</td>
</tr>
<tr>
<td>Maxillary Permanent 2nd Molar</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Mandibular Permanent Central</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Mandibular Permanent Lateral</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Mandibular Permanent 2nd Premolar</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Mandibular Permanent 1st Molar</td>
<td>67</td>
<td>3</td>
</tr>
<tr>
<td>Mandibular Permanent 2nd Molar</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Permanent Teeth</strong></td>
<td><strong>170</strong></td>
<td><strong>8</strong></td>
</tr>
<tr>
<td><strong>Total Identified Teeth</strong></td>
<td><strong>1996</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**As a percent of the overall total (primary + permanent teeth)

Families presenting to the ED were triaged by a nurse who ascertained that the chief complaint was oral in nature. An ED physician then either managed the complaint or requested consultation with the on-call dentist who then saw the patient. The patient flow until resolution
of the entire episode of care is presented in Figure 1. The majority of children (60 percent) received a dental consultation within the ED. Overall, 868 children received a prescription for oral antibiotics and/or oral analgesics, the majority of which was prescribed by the ED physician without a dental consult (65 percent of the prescriptions provided).

In total, 22 percent of children received definitive dental care within the ED. When consulted, dentists performed definitive dental treatment (n=450) over a prescription of antibiotics (n =302). The most frequent treatment provided within the ED was extraction (n=402). The most commonly extracted teeth were the maxillary primary incisors (n=102) and maxillary primary first molar (n= 101). Permanent tooth extraction was rarely performed in the ED (n = 8) with maxillary permanent first molar being most common (n=5), followed by mandibular permanent first molar (n=4) and a single case of the maxillary central incisor.

The majority of treatment was carried out in the ED using local anesthetic and parent support to help stabilize the child. Of those children that had treatment performed in the ED, nine percent received sedation. The most common modality of sedation used was nasal midazolam. Two children received intravenous ketamine. The number of sedations performed increased over time with the majority (85 percent) being performed in the last five years of the study period.

Over the ten years, four percent of children required immediate treatment under general anesthesia and a further nine percent of children were admitted to manage their symptoms. Ultimately, 44 percent of patients received care either within the ED, the operating room or in the dental clinic at SickKids.
Figure 1: Disposition of caries-related complaints to the SickKids ED

**Section 5.5 Discussion**

The results of this study provide insight into the needs of children presenting to a major children’s hospital ED with caries-related complaints and the treatment provided over a ten-year period. Pain caused by dental caries was the most common reason for seeking care at the hospital ED, a finding supported by earlier studies. Diagnosis of abscess and caries were almost equal, but when cellulitis and abscess were combined, over 50 percent of patients presented with perioral swelling. It is not surprising that parents of children with facial or oral swellings would seek emergency care. Children with caries-related complaints in our sample presented with fever, irritability, decreased appetite and sleep disturbance. Parents of children with these signs and
symptoms that arguably interfered with daily activities likely felt that immediate attention was needed and helps to explain why families sought care in a hospital ED.

Over 90 percent of visits involved primary teeth. The most common teeth were the maxillary primary central incisors at 22 percent followed by the maxillary primary first molar at 18 percent. This is in keeping with the pattern of severe ECC (S-ECC) whereby the maxillary anterior teeth are affected first, followed by the maxillary molars and then the mandibular molars. The maxillary first molar was the tooth most commonly associated with a diagnosis of abscess or cellulitis and unsurprisingly the most commonly involved in a hospital admission. A diagnosis of S-ECC was made in 13 percent of patients, indicating that the children five years old and younger with extensive treatment needs made up a meaningful proportion of the population. Because dental caries is a progressive disease that spreads both within affected teeth and throughout the dentition, it unsurprising that so many children had multiple caries infected teeth.

The most common permanent tooth associated with a caries-related emergency was the mandibular first molar. It is important to note that the carious process that leads to acute symptoms takes time to develop. Older children with relatively new dentitions may have fewer opportunities to have disease extensive enough to elicit symptoms requiring emergency attention. Further, older children may have a greater opportunity to obtain care in private practice by general dentists because of a willingness to treat older children. In studies that looked at the general population, the 19 to 35 age group comprised the largest cohort of caries-related ED patients. In an American adult population that sought care at an ED, 80 percent subsequently visited a dental office to receive definitive surgical treatment of the causative tooth. It is also
reported that caries-related complaints are more likely to receive a medication prescription relative to all other ED complaints.\textsuperscript{2} However, many of these studies are carried out at institutions that do not have an on-call dentist. Our results reveal a consistent level of consult with the on-call dental service with over 60 percent of children receiving an examination by a dentist. The proportion of children that received a definitive surgical treatment at children’s hospitals that provide an on-call dental service can arguably vary, but one study of a children’s hospital with an on-call dental service revealed that most patients were still managed pharmacologically.\textsuperscript{9} That 22 percent of children had definitive surgical care within the SickKids ED is due to the presence of a dental clinic in the ED. A further 18 percent of children were referred to the dental clinic and subsequently received definitive surgical intervention within SickKids as well. Common documented reasons for delayed treatment included parental preference for definitive treatment when the child was feeling better, limited patient cooperation requiring assistance that could be better managed within the general dental clinic, and extensive treatment needs that would require general anesthesia. Of interest is the increased use of sedation that occurred over the course of the study. This is consistent with recent trends in the children’s dental community away from traditional methods of behavior management, such as restraint, towards sedation.\textsuperscript{16}

While this study helps us understand caries-related emergencies that presented to an ED, the picture is not yet complete. An evaluation of self-reported ED visits for oral complaints in the adult population of Canada demonstrated that access to dental insurance or publicly funded care was associated with reduced utilization of the ED for oral complaints.\textsuperscript{1} In the US, patients covered by Medicaid or those without dental insurance present to the ED disproportionately more than those with private dental coverage.\textsuperscript{17} The question also remains as to the cost
implications of these ED visits and whether it would be more economical for governments to simply provide more preventive insurance coverage to those who cannot afford a private insurance plan. While a US study shows preventive care is three times more expensive than providing treatment within the ED, it is unknown whether this finding would hold true in Canada. Future studies evaluating the cost of providing care within a Canadian EDs could help evaluate the feasibility of more centers establishing emergency dental services.

**SECTION 5.6 CONCLUSIONS**

1. At SickKids, a major tertiary care children’s hospital in Canada’s most populated city, the ED appears to provide an important access point to dental treatment for caries-related complaints.

2. At our institution, the majority of patients with a caries-related complaint received a consultation with a dentist and definitive care was provided within the ED for over 20 percent of children. Overall, 43.5 percent of children received a diagnosis and identification of the associated teeth with definitive treatment within the hospital.

3. With the number of visits increasing, pediatric hospital EDs should be prepared to manage the emergent sequelae of dental caries.
SECTION 5.7 ACKNOWLEDGEMENTS

The authors thank those who helped in this research effort: Beatrice Beaubien, PhD, Project Manager, Data Management and Custom Applications, The Hospital for Sick Children, Toronto, Canada for her assistance with data base development and management;; and Chetna Mistry and Emily Nisbett, summer research students, Department of Dentistry, The Hospital for Sick Children, Toronto, Canada for their help with data entry.
SECTION 5.8 REFERENCES

CHAPTER 6:

The cost of treating caries-related complaints at a children’s hospital emergency department

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SECTION 6.1 ABSTRACT

OBJECTIVES: To determine the diagnoses of caries-related emergency complaints that presented to a tertiary care children’s hospital and the costs associated with treatment over five-years.

METHODS: A retrospective review of the health records of all children who presented to The Hospital for Sick Children (SickKids) with caries-related emergency complaints from January 1, 2008 to December 31, 2012 was completed. A caries-related complaint was defined as a chief complaint of pain or swelling due to the sequelae of dental decay (reversible pulpitis, irreversible pulpitis, abscess or cellulitis) as recorded in the chart by the treating physician or dentist. Visit information collected included chief complaint, final diagnosis, treatment rendered and patient disposition at discharge. Decision Support Services, a hospital department that analyses resource use and associated costs, calculated the institutional costs for the episodes of emergency care.

RESULTS: The study included 1,081 visits over the five-year period. The most common presenting complaint was pain (50.8 percent) and the most common diagnosis abscess (35.6 percent). A dentist was consulted for 60.0 percent of children and dental treatment within the ED was provided for 25.9 percent while a further 5.18 percent had treatment under general anaesthesia. Approximately 35 percent of those triaged in the ED received pharmacological management alone. The mean cost of treatment per patient was $575.17 CDN (95% CI $501.91-$648.43).

CONCLUSIONS: With an increasing number of presentations and a mean cost of almost $600 CDN, caries-related visits to children’s hospital EDs are not insignificant. Children’s EDs need to be appropriately equipped to provide necessary care or appropriate referral.

KEYWORDS: PEDIATRIC DENTAL SERVICES, COSTS, CARIES, EMERGENCY DEPARTMENT
SECTION 6.2 INTRODUCTION

Hospital emergency departments (EDs) have become an increasingly important point of care for people seeking treatment for oral complaints.\(^1,^2\) Children with oral complaints may present to a hospital for treatment of traumatic injuries, the sequelae of dental caries, oral mucosal conditions and other issues. Importantly, the number of visits related to dental caries in hospitals appears to be increasing.\(^3,^4\) Caries-related complaints include dental decay and associated pain, diseases of the pulp and periapical tissues, dental abscesses and cellulitis of odontogenic origin. The Hospital for Sick Children (SickKids) in Toronto, Canada reported a ten-year increase of 48 percent in caries-related emergency department visits from 2003 to 2012.\(^5\)

Dental caries and associated sequelae can impact the functional, developmental and social aspects of a child’s overall wellbeing. The pain associated with dental caries may lead to reduced eating, interrupted sleep, behavior issues, poor learning and lower self esteem.\(^6\) At Boston Children’s Hospital, 92 percent of children that made caries-related ED visits presented with a chief complaint of oral pain. Seventy percent of children were subsequently diagnosed with caries or abscess secondary to caries. Of those presenting with pain, 56 percent reported being in discomfort for 72 hours or less and 26 percent had visited a dentist for the same issue that led to their visit to the ED.\(^7\) At Columbus Children’s Hospital in Ohio, caries was the primary diagnosis in 73 percent of teeth, with abscess present in 33 percent of children and early childhood caries (ECC) accounting for 18 percent of all cases with a diagnosis of caries.\(^8\)

American and Canadian studies confirm that for adult populations, the majority of caries-related complaints are managed pharmacologically with prescription medications.\(^2,^9,^14\) A similar
pattern has been demonstrated in children’s hospital EDs with most children who present with a caries-related complaint being prescribed a course of oral antibiotics and a recommendation for follow-up care with a dentist.\textsuperscript{10, 11} In children’s hospitals that provided emergency dental services, patients presenting with a caries-related complaint were still likely to be managed medically.\textsuperscript{12, 13} In a study at the Children’s Medical Center of Dallas a dentist was consulted for only six of 156 children that presented to the ED.\textsuperscript{12} Few children received definitive dental treatment despite the availability of a 24 hours dental consulting service.\textsuperscript{12}

Caries-related conditions are generally not self-limiting and if left untreated become progressively worse, requiring more extensive and costly care. In the United States in 2006, the total hospital charges for dental caries ED visits by children was estimated at $14.3 million USD with a mean per charge of $667.48 USD.\textsuperscript{14} This study did not include more advanced sequelae of dental caries such as abscess or cellulitis that may present to hospital EDs. ED use for caries-related complaints is a topic of ongoing interest for policy makers, as it has been thought to occur as a result of poor access to dental care. In Canada, provincial health insurance covers most of the costs of hospital and physician treatment, while dental treatment is charged to the patient, his/her insurance or government program when applicable. In Ontario, the exception is some surgical-dental treatment delivered in-hospital for eligible patients, including treatment of dental-related hospital ED visits. The average cost for a caries-related ED visit in Ontario in 2007 for all age groups including those that led to an admission was estimated at $575.00 CDN.\textsuperscript{15} To date, there are no studies examining the hospital-incurred costs of such visits at a Canadian children’s hospital.
SECTION 6.3 METHODS

The study consisted of a retrospective review of the health records of all children who presented to SickKids Emergency Department (ED) with caries-related emergency complaints from January 1, 2008 to December 31, 2012 inclusive. A caries-related emergency complaint was defined as a chief complaint of pain or swelling due to the sequelae of dental decay including reversible pulpitis, irreversible pulpitis, abscess or cellulitis as recorded in the chart by either the treating physician or dentist. A visit for an emergency oral complaint seen within the ED was identified as a registration where the principal diagnosis at discharge was coded using the International Classification of Disease (ICD-10) block code equal to K00-K14 (diseases of oral cavity, salivary glands and jaws). The medical records department populated a list of children seen within the specified dates with the applicable ICD-10 codes. Once the children were identified, final eligibility was determined by reviewing the corresponding health records in the electronic patient chart. Complaints related to trauma, salivary glands, cysts and tumors of the jaws, temporomandibular joint, teething, gingival stomatitis or causes undetermined were excluded from the study. Incomplete chart entries were excluded.

Visit information collected included presenting chief complaint, final diagnosis, causative tooth, treatment rendered and patient disposition at discharge. Decision Support Services, a department within the hospital that analyses resource use and associated costs, calculated the institutional costs for the episodes of emergency care. Decision Support Services used case costing at the encounter level in order to determine an average cost and total cost of emergency care for the population. Case costing, or service recipient costing, is an activity-based costing model that tracks and costs service delivery to individual service recipients by service date. Case costing uses actual dollars, reflected in the hospital finance general ledger, to distribute the direct
or indirect costs to the patient level. Direct costs are the costs directly associated with providing patient care including nursing, lab tests, diagnostic imaging, pharmacy and food. Indirect costs include relevant overhead costs such as administration, finance and human resources. Distribution of these costs are based on nursing workload hours, actual inventory cost of supplies, pharmacy costs and standard workload hours for diagnostic imaging departments. An allocation calculation is performed for indirect costs taking into account the reciprocal utilization of overhead functions. The dental costs were tabulated using the treatment codes submitted to OHIP and associated fees according to the 2006 version of the Schedule of Benefits for Dental Services under the Health Insurance Act. Costs were reported in Canadian dollars.

The data were entered into a FileMaker Pro/Server 12 (2012)® database. Elements of the FileMaker Pro/ Server 12 (2012)® dataset was exported to SPSS 23 (2012)® for final data analysis. Frequencies of chief complaints, diagnoses, tooth involved and treatments rendered were calculated. Descriptive statistics including the mean and standard deviation for costs both by department and by overall treatment were calculated. The Research Ethics Board at SickKids approved this study. Data were secured in accordance with Research Ethics Board requirements (REB approval #:1000039465).

SECTION 6.4 RESULTS

During the five-year study period, 1,123 children presented to the ED with a caries-related complaint. Of these 1,081 had complete costing information available and were included in this study (96.3 percent). There was a year over year increase of 4.8 percent during the five years. Table 1 presents the visits by chief complaint with over 50 percent coming to the ED due
to pain. Chief complaints of loss of appetite, not sleeping and bleeding comprised the 2.3 percent noted as “other.”

Table 1: Presentation by chief complaint

<table>
<thead>
<tr>
<th>Chief Complaint</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>549</td>
<td>51</td>
</tr>
<tr>
<td>Swelling</td>
<td>440</td>
<td>17</td>
</tr>
<tr>
<td>Cavities</td>
<td>67</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1081</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table 2 is a summary of prevalence of different diagnoses. The most frequent (36 percent) diagnosis made was abscess, but when abscess and cellulitis were combined, over 50 percent of children presented with some sort of oral swelling. ECC was identified in ten percent of children.

Table 2: Presentation by diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscess</td>
<td>385</td>
<td>36</td>
</tr>
<tr>
<td>Caries</td>
<td>382</td>
<td>35</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>240</td>
<td>22</td>
</tr>
<tr>
<td>Pulpitis</td>
<td>64</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1081</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Families presenting to the ED were triaged by a nurse who ascertained that the chief complaint was oral in nature. An ED physician then either managed the complaint or requested consult with the on-call dentist. The majority of children (60 percent) received a dental consultation within the ED with 26 percent receiving definitive dental care within the ED. The
The most frequent treatment provided was extraction (23 percent). The treatment provided and cost by modality of care is presented in Table 3. The average cost of providing definitive surgical management within the ED was $284.17 CDN less than the overall mean cost of care of $575.17 CDN. There was a statistically significant difference in means between those receiving treatment within the ED and children that received treatment outside of the ED. Children treated under general anesthesia had the highest mean cost at $3,330.30 CDN.

Table 3: Frequency and cost by modality of care

<table>
<thead>
<tr>
<th>Modality of care</th>
<th>Number</th>
<th>Mean Cost ($)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Anesthesia</td>
<td>56</td>
<td>3,330.39</td>
<td>2426.64 - 4234.14</td>
</tr>
<tr>
<td>Admission</td>
<td>97</td>
<td>2,086.34</td>
<td>1839.81 – 2341.87</td>
</tr>
<tr>
<td>Antibiotics IV</td>
<td>25</td>
<td>1,004.12</td>
<td>586.10 – 1422.15</td>
</tr>
<tr>
<td>Treatment in ED</td>
<td>280</td>
<td>291.00</td>
<td>267.63 – 314.37</td>
</tr>
<tr>
<td>Antibiotics PO/treatment later</td>
<td>34</td>
<td>250.54</td>
<td>213.65 - 287.43</td>
</tr>
<tr>
<td>Antibiotics PO</td>
<td>241</td>
<td>230.77</td>
<td>156.96 – 304.58</td>
</tr>
<tr>
<td>None</td>
<td>186</td>
<td>189.29</td>
<td>172.74 – 205.83</td>
</tr>
<tr>
<td>Referral to hospital clinic</td>
<td>30</td>
<td>185.98</td>
<td>163.15 - 208.82</td>
</tr>
<tr>
<td>Analgesics</td>
<td>132</td>
<td>161.95</td>
<td>152.98 – 170.92</td>
</tr>
<tr>
<td>Total</td>
<td>1081</td>
<td>575.17</td>
<td>501.91 - 648.43</td>
</tr>
</tbody>
</table>

The cost breakdown is presented in Table 4. The mean cost per visit was $575.17 CDN. The range was $63.31 CDN to $24,717.01 CDN. The maximum cost for a visit was for a patient with acute lymphoblastic leukemia, who required a ten-day admission. The majority of cost for this case was nursing resources. When this potential outlier is taken out of the calculation of mean cost, the result is $552.82 CDN.
Table 4: Cost by allocation

<table>
<thead>
<tr>
<th>Costs ($)</th>
<th>ED</th>
<th>DI*</th>
<th>Labs</th>
<th>Nursing</th>
<th>OR**</th>
<th>Pharm</th>
<th>Dental</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>12,5509.78</td>
<td>2,964.87</td>
<td>16,801.67</td>
<td>173,892.64</td>
<td>41,056.19</td>
<td>26,622.43</td>
<td>59,069.47</td>
<td>13,398.99</td>
<td>459,316.05</td>
</tr>
<tr>
<td>Indirect</td>
<td>52,071.94</td>
<td>969.64</td>
<td>6,120.69</td>
<td>73,469.09</td>
<td>15,359.13</td>
<td>9,568.25</td>
<td>NA</td>
<td>4,883.14</td>
<td>162,441.88</td>
</tr>
<tr>
<td>Total</td>
<td>177,581.72</td>
<td>3,934.51</td>
<td>22,922.36</td>
<td>247,361.72</td>
<td>56,415.32</td>
<td>36,190.69</td>
<td>59,069.47</td>
<td>18,282.13</td>
<td>621,757.93</td>
</tr>
</tbody>
</table>

*DI = Diagnostic Imaging  
**OR = Operating Room
SECTION 6.5 DISCUSSION

The results of this study provide insight into the needs of children presenting to children’s hospital ED with caries-related complaints and the costs to this hospital for providing care. Over the five-year study period, there was a year over year increase in visits of 4.8 percent for a cumulative 24 percent increase in caries-related ED visits. During the same time period the overall number of patient visits to the SickKids ED increased only 16 percent. Pain caused by dental caries was the most common reason for seeking care at the hospital ED, a finding supported by earlier studies. Diagnoses of abscess and caries were almost equal in proportion. Cellulitis and abscess combined accounted for over 50 percent of patients presented with perioral swelling. Acute symptoms are thought to be the most immediate determinant of care seeking behavior. What a health care provider may consider to be minor may be seen as very serious by worried parents. It is not surprising that parents of children with facial or oral swellings would seek emergency care. Children with caries-related complaints often present with fever, irritability, decreased appetite and sleep disturbance. Parents of children with these signs and symptoms that interfered with daily activities may feel that immediate attention is needed and help to explain why families seek care in hospital EDs.

In an American adult population that sought care at the ED, 80 percent subsequently visited a dental office suggesting that while the ED treated the emergency symptoms, the underlying dental cause was not addressed. Caries-related complaints were more likely to receive a medication prescription relative to all other ED complaints. Many of these studies were carried out at institutions that did not have an on-call dentist. Our results reveal a consistent level of consult with the on-call dental service with over 60 percent of children receiving an examination by a dentist. The proportion of children that received a definitive dental treatment at
children’s hospitals that provide an on-call dental service vary,\textsuperscript{4, 18, 20} but a study carried out at a children’s hospital with an on-call dental service, revealed that most patients were still managed pharmacologically.\textsuperscript{12} This may be due to the long-standing presence of the dental department within the hospital and awareness by the emergency physicians of the available dental consulting service. In this study, as a result of the frequent dental consults, treatment within the ED was provided for over 25 percent of patients with a further 5.9 percent receiving referral to the dental clinic for later treatment.

A 2000 study reported that 9.3 percent of children’s ED visits for oral problems resulted in a hospital admission.\textsuperscript{21} Our study had a similar rate of admission at 9.0 percent. While this was only 97 patients over the five years, the mean cost of $2,086.34 CDN amounts to a cumulative cost of over $200,000 CDN. Most of the expense was in nursing costs required to manage more advanced sequelae such as dehydration, severe pain and fever.

Our study’s strength was that the estimates represent the entire presenting population of caries-related complaints to the ED and are not based on a convenience or probabilistic sample. In addition, our study used encounter level costing as opposed to previous studies that utilized indirect costing measures that relied on resource intensity weights and case groupings to estimate costs. Interestingly, the results are almost identical to the Ontario estimate of costs for visits for dental conditions at general hospital EDs of $575.03 CDN.\textsuperscript{15} The fact that the more specific costing used in this study had similar results shows that both methodologies can be used to estimate such costs. The mean cost found in our study of $575.17 CDN lies within the range reported in US studies of $360 - $667.48 USD.\textsuperscript{14, 22, 23} The maximum visit cost was for a patient with a dental abscess and acute lymphoblastic leukemia that resulted in a cost of $24,717.01 CDN and a length of stay of ten days. When this potential outlier is taken out of the calculation
of mean cost, the result is $552.82 CDN, which is still on the higher end of the reported range. It is important to mention that this is still an underestimate as the cost of physician fees was not included and is a limitation of the study. It should be noted that the Ontario estimate for all hospital emergency departments did include physician claims in the cost calculation.\(^{15}\)

In Canada, dental care is financed primarily through insurance, both private and public, as well as out-of-pocket payments,\(^{24}\) so increases in caries-related visits to children’s hospital EDs suggests that public policies in Canada are potentially failing to adequately provide access to dental care. Without interventions from policy makers, caries-related ED visits are likely to continue to increase, with implications for overall health care costs. Policy makers in the US are beginning to explore creative alternatives to improve access to dental care. Pilot programs have demonstrated the effectiveness of ED diversion programs aimed at patients who present at an ED with a caries-related complaint. For example, in Calhoun County, Michigan a partnership between local dentists, community stakeholders and low-income residents is changing the delivery of emergency dental care.\(^{25}\) Patients that demonstrate financial need are referred to volunteer dentists from several sources, including EDs. Volunteer dentists provide care in their own offices. In lieu of payment, patients provide community service to local nonprofit organizations. Within five years of establishing the program, ED visits for dental pain decreased by 72 percent and it is estimated that the local hospital saved six million dollars (USD).\(^{25}\) Innovative programs that increase access to dental care in order to decrease ED utilization could help to ensure timely, comprehensive, and affordable dental care for vulnerable children and adult populations.

This is the first Canadian study provide information on the management and costs to the health care system of providing care for caries-related complaints at a children’s hospital ED.
Our findings are specific to the Toronto area and cannot be generalized to other areas. Reports from other cities in Canada would be necessary to see if the data represent national estimates and patterns. At our institution, the majority of patients received a consultation with a dentist and definitive care was provided within the ED for over one quarter of patients. With an increasing number of children’s ED presentations and an average cost of almost $600 CDN, children’s hospital EDs arguably need to be equipped to treat children with caries-related complaints.

**SECTION 6.6 ACKNOWLEDGEMENTS**

The authors thank those who helped in this research effort: Beatrice Beaubien, PhD, Project Manager, Data Management and Custom Applications for her assistance with data base development and management; Ethel Lagman, Decision Support Specialist and Ladan Dadgar, Director, Decision Support for providing the costing information; and Chetna Mistry and Emily Nisbett, summer research students, Department of Dentistry, for their help with data entry, all at The Hospital for Sick Children, Toronto, Canada.
SECTION 6.7 REFERENCES
CHAPTER 7: CONCLUSIONS

SECTION 7.1 CONCLUDING REMARKS

This study is the first to examine long-term utilization trends and costs associated with providing care for caries-related complaints at a Canadian children’s hospital ED. Findings from this study added several pieces of information to the current knowledge on caries-related visits to a children’s hospital ED. First, it determined the annual frequency of children 0-17 years who presented to a tertiary care children’s hospital with a caries-related emergency complaint over a ten-year period. Second, it determined the demographic characteristics of the families that presented to the ED for caries-related emergency complaints. Third, it determined the types of caries-related emergency complaints that presented and the treatment provided over the study period. Finally, it examined the costs associated with providing treatment for caries-related emergency complaints over a five-year period.

Findings from this study showed a 48 percent increase in caries-related complaints over ten years. This was greater than the 40 percent increase in all emergency departments visits at the SickKids ED indicating that the rise in caries-related visits is greater than the overall increase in ED use (Chan, 2012). Over the next 30 years, the annual number of ED visits to Canadian EDs could increase by 40 percent from 15 million in 2013 to over 21 million in 2043 (Canadian Foundation for Healthcare Improvement, 2013). If the number of visits for caries-related complaints to continue to outpace growth for all ED visits, then hospital resources may not be able to meet demand in the future. Identifying the factors that spur the use of the hospital ED will ultimately help policy makers create programs to improve dental services and potentially lessen the reliance on the ED to manage caries-related complaints.
The results demonstrate that factors such as age less than five years, male sex, low SES and being otherwise healthy characterized the population using the ED for caries-related complaints. These demographic characteristics remained stable with time and did not influence the increase in the number of visits seen over the study period. Of concern is that children younger than five years of age with caries-related complaints comprised over half of the patients and many of these children presented with severe early childhood caries. This is consistent with the US studies that found that patients with caries-related complaints were younger than those presenting for other non-dental emergencies. While this study was not able to document the proportion of patients for which the ED visit was the first contact with a dentist, other studies estimate that the emergency visit was the first dental encounter for over one-quarter of caries-related ED visits (Sheller, Williams, & Lombardi, 1997). Treating physicians and dentists did not consistently record attempts made to receive emergency dental care at other sources. This is information that should be asked of every patient that presents to the ED for emergency care. It is important to know if there were barriers to receiving care elsewhere and furthermore to receiving primary care dental examinations. Noting this information would help to clarify whether the ED was used due to financial constraints, lack of a primary care provider, convenience or other motivating factors. Further studies that aim to understand the needs and barriers to care faced by this population could help to develop appropriate public health interventions to overcome these obstacles.

The results of this study provide insight into the needs of children presenting to a major children’s hospital ED with caries-related complaints and the treatment provided over a ten-year period. Pain caused by dental caries was the most common reason for seeking care at the hospital ED, a finding supported by earlier studies (Fleming, Gregg, & Saunders, 1991; Graham, Webb,
Diagnosis of abscess and caries were almost equal, but when cellulitis and abscess were combined, over 50 percent of patients presented with perioral swelling. It is not surprising that parents of children with facial or oral swellings would seek emergency care. Children with caries-related complaints in our sample presented with fever, irritability, decreased appetite and sleep disturbance. Parents of children with these signs and symptoms that arguably interfered with daily activities likely felt that immediate attention was needed and helps to explain why families sought care in a hospital ED.

In our study, the majority of patients required extractions to definitively manage the cause of the visit and 20 percent of children had an extraction performed in the ED. Previous studies reported that caries-related complaints are more likely to receive a medication prescription relative to all other ED complaints (Lewis, Lynch, & Johnston, 2003). However, many of these studies are carried out at institutions that do not have an on-call dentist. Our results reveal a consistent level of consult with the on-call dental service with over 60 percent of children receiving an examination by a dentist. The proportion of children that received a definitive surgical treatment at children’s hospitals that provide an on-call dental service can arguably vary, but one study of a children’s hospital with an on-call dental service revealed that most patients were still managed pharmacologically (Graham et al., 2000). While this study can help to map out the pathways to resolution of caries-related emergencies that present to the ED, there are still many unknowns. As many children were sent back to the community for follow-up care the final outcome remains unknown. Future directions of research could include follow-up studies to investigate if the family followed through with the provided referral for dental care.
The cost analysis component of this study is important to policy makers in general. For example, an evaluation of self-reported ED visits for oral complaints in the adult population of Canada demonstrated that access to dental insurance or publicly funded care was associated with reduced utilization of the ED for oral complaints (Quiñonez, 2011). In the US, patients covered by Medicaid or those without dental insurance present to the ED disproportionately more than those with private dental coverage (Quinby, Sheller, Williams, & Grembowski, 2004). The question remains, would it be more economical for the government to simply provide more preventive services to those in need? While there is a study in the US that shows preventive care is three times more expensive than providing treatment within the ED (Pettinato, Webb, & Seale, 2000), it remains to be seen whether this finding would hold true in Canada.

While this study helps us understand caries-related emergencies that presented to a children’s ED, the full picture is not yet complete. Future studies offer the opportunity to improve both patient outcomes and to reduce costs to the health care system through new strategies to provide care to the families who are more likely to utilize the ED for caries-related complaints.
SECTION 7.2 FUTURE RESEARCH

1. Intervention time series analysis could be used to analyze the effect of a new policy or pilot program on the number of caries-related visits to the hospital ED over time.

2. Prospective interviews with presenting patients could elucidate motivations for approaching the ED for treatment of caries-related complaints.

3. Examination of associated teeth for previous restorations could determine if failed restorations lead to a meaningful proportion of caries-related emergencies.

4. Cost comparison of existing costing methodologies to costing at the encounter level to compare the accuracy and efficiency of each method for future health care costing studies.
REFERENCES


