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Crowding and frequent use of emergency department services in a Northwestern Ontario academic health sciences centre

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Crowding and Frequent Use of Emergency Department Services in a Northwestern Ontario Academic Health Sciences Centre

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Abstract

Emergency departments (ED)s exist for the purpose of caring for patients with urgent or life-threatening conditions which are time sensitive to treat. ED crowding is a condition where demand for ED services exceeds the facility's capability of meeting that demand, and often results in increased wait times for services. This thesis explored the factors related to ED crowding in an academic health sciences centre located in Northwestern Ontario. Predictors of frequent use were also examined, as were potential explanatory variables for an observed 18% increase in ED visits over a 5-year period. Hour of service, patient's age, sex, family physician status, and patient's place of residence were predictors of frequent use of the ED using a Generalized Estimating Equation (GEE) method. Age, acuity level upon presentation, family physician status, and patient's place of residence were predictive of ED crowding, using ED length of stay as a proxy measure. Patients with mental health diseases and disorders had the highest frequency of use of ED services. Patients with diseases and disorders of the circulatory system had the greatest overall effect on ED crowding. The increase in ED visits over the 5-year study period was attributed to an increase in the number of patients presenting to ED with conditions that could be managed elsewhere, if appropriate community-based services were available.

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Crowding and Frequent Use of Emergency Department Services in a Northwestern Ontario Academic Health Sciences Centre

Since becoming a fixture in hospitals across the world in the middle of the 20th century, the Emergency Department (ED) is a vital part of any health care system infrastructure (Bain & Johnson, 1971). The ED has been described as both a "safety net" for health care systems and a "provider of last resort" to vulnerable populations (Trzeciak & Rivers, 2003, p. 1). Emergency Departments exist for the purpose of caring for patients with urgent or life-threatening conditions which are time-sensitive to treat. With this purpose in mind, EDs are designed to rapidly assess and stabilize patients presenting with conditions that are acute in nature. Significant delays within the ED therefore are troubling and potentially dangerous, because they impair the ability of an ED to provide this time-sensitive treatment.

Overcrowding of EDs has been the subject of a great deal of attention among the media, politicians, healthcare administrators, professionals, and concerned citizens (Hoot & Aronsky, 2008). Studies discussing the issue of crowding can be found back as far as the 1960s in the United States (eg., Weinerman, Ratner, Robbins, & Lavenhar, 1966) and Canada (eg., Bain & Johnson, 1971). Overcrowding in EDs has therefore proven to be a troubling and pervasive issue across many different healthcare regions as well as internationally for many years (Drummond, 2002). Causes of and solutions to ED overcrowding are complex and multifaceted (Bernstein, 2006; Canadian Health Services Research Foundation, 2009; Drummond, 2002; Hoot & Aronsky, 2008; Schull, Slaughter & Redelmeier, 2002). Concern stemming from crowing has forced debate about the "appropriateness" of ED utilization, especially by those whose needs are considered non-urgent in nature or whose use is considered "frequent". The classic

assertion is that overutilization of EDs by patients whose needs are less than acute or are frequent users is a significant contributor to overcapacity situations (Commission on the Future of Health Care in Canada, 2002; General Accounting Office of the United States of America, 1993).

The study of ED utilization remains an important issue from a public health and systems administration perspective. Improved understanding of ED utilization as well as the factors that lead to crowding and over capacity situations allow for better planning of resources and policy development in this critical component of the health care system.

Emergency Department Utilization

Utilization of the ED varies greatly from person to person, and the vast majority of persons do not visit the ED at all. In a large study conducted in Massachusetts, it was found that only 24% of the residents of the state made even a single visit to the ED in 2003 (Fuda & Immekus, 2006). This result is consistent with ED utilization among American adults: 23%, were estimated to have visited an ED at least once in 2000 to 2001 across the entire USA (Hunt, Weber, Showstack, Colby, & Callaham, 2006). Based on survey data from 1990, Brown & Goel (1994) estimated that 21% of Ontario residents visited an ED at least one time during the year and that 6.4% visited an ED at two or more times, accounting for 58% of total visits. During 1993-2000, Ontario saw a decline of 10.3% in per capita ED visits which has been attributed to a drop in low-acuity cases presenting to EDs (Chan, Schull, & Schultz, 2001). However, during the same period the population rose by 8.9%, which combined with the closure of 20 EDs across the province caused a 9.7% increase in the average number of visits per ED across the province (Chan et al., 2001).

Emergency Department Acuity

Measuring the relative acuity of patients presenting to the ED is important as the ED exists to treat the most acute patients, while patients who are of low acuity are expected to receive care via other components of the health care system. In Canada, a standard classification system has been established to define the level of acuity of patients presenting to the ED, called the Canadian ED Triage and Acuity Scale, or the Canadian Triage and Acuity Scale (CTAS) for short. This triage scale has been adopted across all Canadian EDs and has been studied and verified as an appropriate triaging tool (Murray, Bullard, & Grafstien, 2004). CTAS levels range from 1 to 5, with 1 representing patients who require resuscitation, 2 representing patients requiring "emergent" care, 3 for patients requiring "urgent" care, 4 for "less-urgent" and 5 for "non-urgent". The current guidelines with respect to the recommendations for nursing care intervals for each CTAS level give a reflection of the acuity of each level (Murray, et al., 2004):

- Level 1 patients require continuous nursing care
- Level 2 patients should be reassessed every 15 minutes
- Level 3 patients should be reassessed every 30 minutes
- Level 4 patients should be reassessed every 60 minutes
- Level 5 patients should be reassessed every 120 minutes

In Canada, evidence suggests that approximately 30% of all visits are non-urgent in nature, as classified as CTAS levels of 4 or 5 (Vertesi, 2004).

Frequent Use

No generally accepted criteria currently exists determine what constitutes a "frequent" user and as a result each study has developed their own definition of

frequent use. This lack of a consistent definition of a frequent user limits the ability to compare results among the multitude of studies that have been published (Bryne et al., 2003). In their study of frequent users in the State of Massachusetts, which is also one of the largest studies of ED utilization ever undertaken, Fuda and Immekus (2006) defined a frequent user as a patient who visited the ED five or more times in a year, a population group which accounted for 17.6% of all ED visits. Other studies have defined a frequent user as patient who has visited as low as two or three times (Brown & Goel, 1994; Zucherman & Shen, 2004) or as high as 20 times in a given annual period (Ruger, Richter, Spitznagel, & Lewis, 2004).

In their definition of a frequent user Hunt, et al. (2006) argued that the definition of a frequent user should be based on the identification of a cluster of patients who were responsible for a disproportionate number of visits compared to the rest of the population, rather than on an arbitrary number of visits. It was their thought that a key consideration for the definition of this group was to ensure that it represented a significant enough percentage of the population utilizing an ED in order to be of use for the development of policy. Based on their unique ED data, they concluded that this disproportionate amount equated to at least 25% of the total visits. In their data users with four or more visits were responsible for 28% of the total visits, so they made the distinction that patients with four or more visits were to be deemed "frequent" users (Hunt, et al., 2006).

Factors Leading To Frequent Use of the ED

Health Status. Research suggests that frequent users of the ED may be justified in their frequent use, as the high-user population in Canada has a tendency to be legitimately sicker and therefore in greater need of health services when compared

the low user population (Roos, Forget, Walld, & MacWilliam, 2004). Hunt et al., (2006) found similar evidence in the USA. Utilizing data from the Community Tracking Study Household Survey, the authors found that poor physical and mental health were strongly associated with the frequent use population. Therefore perhaps the most significant factor leading to frequent use of healthcare resources is poor health.

While it is not necessarily surprising to find that poor health is correlated with frequent ED user, it is nonetheless of utmost importance to mention given the relatively high amount of rhetoric and opinion in healthcare circles inevitably clouding the issue (Bernstein, 2006). Also of note is the fact that many patients who present to the ED with minor conditions who could be treated elsewhere may still be coming to the ED appropriately. This appropriate ED use occurs when the patients' symptoms are indicative of the possibility of something more severe, with the non-urgency of the situation only being discovered after initial examination (Schull, Slaughter, & Redelmeier, 2002).

Health status has long been linked to low income and socioeconomic status. For example, residents of low-income areas in Manitoba have been found to have much higher rates of utilization of ambulatory care services and of hospitalizations when compared to residents of higher socioeconomic status (Roos, Walld, Uhanova, & Bond, 2005). In the United States, although there is still a higher usage rate of EDs by individuals in the lower income groups, the difference is less striking as higher income groups are also well represented in the frequent user group (Roos, Forget, Walld & MacWilliam, 2004)[0].

Mental Health. As well as poor physical health, frequent ED is associated with those suffering with mental health issues. Fuda and Immekus (2006) found that

frequent users of EDs in Massachusetts were much more likely to have a either a primary diagnosis of a mental health issues or a medical diagnosis with an associated mental health issue than infrequent users of the ED. Sandoval et al. (2010) found that patients who were frequent visitors to a large urban hospital that they studied were much more likely to screen positively for depression than those who were not frequent visitors (47% versus 27%, p=.017). As well as mental health issues, substance abuse is also associated with frequent ED utilization (Fuda & Immekus, 2006).

Age. Age is also a contributing factor to frequent use of an ED and is often confounded with health status. Elderly patients have a greater overall need for healthcare since the prevalence of chronic disease increases with age. Unsurprisingly, the elderly population tend to utilize EDs at a higher rate than younger age groups with respect to their share of the population (Aminzadeh & Dalziel, 2002). Of these visits, evidence suggests that compared to younger populations, the proportion of those visits that are considered to be non-urgent in nature are less in the elderly population (Parboosingh & Larsen, 1987). Elderly populations also tend to have a higher frequency in which their visits lead to inpatient admissions compared to younger population groups (Aminzadeh & Dalziel, 2002; (Walker, 1976). Parboosingh and Larsen (1987) found that patients with frequent hospital admissions, a positive attitude towards healthcare and many sources of healthcare were associated with higher ED utilization, while younger elderly patients and those with previous admissions were more likely to utilize the ED appropriately.

Primary Care. Another cause of high ED use is the effectiveness of the primary care system in the region serviced by an ED. Bain and Johnson (1971) found that patients tended to visit EDs based on convenience of service. Many of the patients they

surveyed who presented to the ED with non-urgent conditions indicated that they did so because they were not prepared to wait for an appointment with their family physician. Some even stated that they had phoned their family physician who urged them to set up an appointment with their office instead of visiting an ED because their condition was not urgent enough to justify the visit to the ED; however they still visited the ED because they were unwilling to wait for the appointment. Hunt et al. (2006) found that frequent users were also likely to be heavy users of other components of the healthcare system and that they tended to be dissatisfied with the medical care that they have received.

Lack of family physicians in the region has been cited as a possible issue by governments (Local Health Integration Network, 2009a), however research shows that patients who are frequent visitors to EDs can be more likely to have a family physician than those who are not frequent visitors (Sandoval et al., 2010). Among older populations, evidence suggests that most have access to family physicians and in fact many are referred to EDs for treatment by their family physicians (Aminzadeh & Dalziel, 2002).

The relationship between family physician status and urgency is both interesting and complex. In their study of an ED in rural Northern Ontario, Harris, Bombin, Chi, deBertoli and Long (2004) found that although more than 80 percent of the sample who visited the ED during the study period identified that they had a family physician, there were still some 45 percent of the visits which were classified by ED staff and physicians as non-urgent in nature. Of note is the fact that 71% of the self-referred portion of the sample indicated a belief that their family physician was unavailable at the time when they needed them, a perception which may have been accurate given that the majority

of family physicians in the community at the time of the study were reporting that the average wait for an appointment with their office was between 1 and 2 weeks. Another interesting finding from this study was that 61 percent of the sample indicated that they would be willing to use alternatives to the ED for non-urgent concerns if they were available; however only six percent of the sample had ever accessed available alternatives in the past. The authors concluded that three community interventions were necessary to reduce unnecessary use of the ED: the successful recruitment of additional family physicians to reduce wait times for offices, the creation of other agencies that non-urgent patients can access and the education of patients regarding other options for care.

Vertesi (2004) attempted to see if the CTAS assessment scores could be used as a tool to direct non-urgent patients away from the ED. The retrospective study found that use of CTAS scores in this way would have resulted in an efficiency gain of less than 5%. At the same time, 7.3% of patients requiring hospital admission would have been incorrectly referred out of the ED, putting those patients at risk. The author concluded that triage scores are not an appropriate way to screen and possibly deter patients from accessing the ED.

ED Overcrowding:

Many different attempts have been made to define ED overcrowding. In it's simplest sense, ED overcrowding can be a relatively benign indicator of poor customer service in health care, as demonstrated by the fact that in 2005-06, 55% of Ontarians who visited an ED felt that they waited too long to see a doctor (Hospital Report Research Collaborative, 2007)0. Simply put, crowding is caused when demand for ED services exceeds the available supply for ED provided by a particular health care facility,

therefore impacting the ability to deliver care to patients within an appropriate timeframe (Drummond, 2002). However, ED overcrowding can also be dangerous, as it has been associated with higher mortality rates in hospital (Bernstein et al., 2008). In a worst case scenario, crowding can create a situation where patients are forced to wait too long for life-saving interventions. While these cases are relatively rare, when they do occur they are a significant cause for concern (Schull et al., 2002).

Schull et al. (2002) attempted to define ED overcrowding in an urban environment more succinctly and concluded that ambulance diversions (when an ambulance on route to hospital needs to be sent to another hospital due to overcrowded conditions at the original destination) could be used as both a definition and proxy measure of ED overcrowding; however this definition has some inherent defects. First, it is reliant on policies and procedures being the same across all hospitals and second it does not work in smaller urban centres with fewer options for ambulance diversion. In these centres crowding is usually defined in terms of inappropriate wait times for service (Vertesi, 2004). Drummond (2002) defined overcrowding in terms of the time it takes for patients admitted from an ED to receive a hospital bed, with normal time being within two to three hours. In this model, overcrowding is considered to occur when the time required to admit a patient to an inpatient bed exceeds the four hour mark.

Causes of ED Crowding:

The quest for the causes of and solutions to ED overcrowding in North America has been the focus of many government and health institution projects as well as being widely discussed in the literature (Hoot & Aronsky, 2008). Much of the government and media attention on the issue has been focused on the appropriateness of the demand for ED resources. In response to rising utilization of EDs across the country, the

General Accounting Office of the United States of America (1993) issued an important report on the utilization of ED resources in the country, which among other things found that 43% of ED patients presented with non-urgent conditions which would be better treated through services otherwise available in the community. This finding was a catalyst for explosive growth in research focusing on the utilization of ED resources aimed at finding the solution to the over-utilization problem. In Canada, the same thought process can be found in influential health policy documents such as the Report by the Commission on the Future of Health Care in Canada (2002) which stated that "with effective primary health care in place, people would be less likely to rely on EDs to get advice or assistance with relatively minor ailments or persistent health conditions that cannot be adequately dealt with in busy EDs" (p. 118).

There is some controversy surrounding the effect that high ED utilization has on ED crowding. Due to the great deal of research on the issue of non-urgent ED visits, in 2003 the General Accounting Office in the USA reassessed the ED crowding issue and concluded that factors such as high occupancy rates and capacity issues were instead the main causal factors of ED crowding in the USA and not high ED utilization rates (Bernstein, 2006). In Ontario, this view was shared by the Ontario Hospital Association (2006) which concluded that the problem was not crowding in Ontario's EDs but rather the result of inadequate inpatient resources in hospitals and other unaddressed broad system issues, with ED crowding being a symptom of problems rather than a problem in and of itself.

Model of ED Crowding. Governments have been quick to focus on utilization factors, likely due to the fact that efforts to reduce demand would be cheaper from a funding perspective than efforts which would focus on the supply side of the equation.

Fortunately the literature has been much less biased in analyzing the issue. Asplin et al. (2003) developed a comprehensive conceptual model of ED crowding, citing three main factors which contribute to ED crowding: input, throughput and output. Input factors are those that affect demand. These include the obvious need for critical care of seriously ill patients, but also more subtle factors: shortfalls of community primary care services, access barriers (such as financial, transportation and other socioeconomic barriers) and finally the convenience factor (when care at the ED is perceived to be more convenient that community-based programs meant to serve low-acuity patients).

Throughput involves the efficiency and effectiveness of processes within the ED itself. Depending on how the ED is organized, efficient care can contribute to low wait times, whereas inefficient processes can grind EDs to a halt. The third component of the model involves the ability to move patients from the ED once they have been properly assessed and stabilized and the patient is ready to be either discharged from hospital or transferred to another area of the hospital in order to receive further care. Inability to move patients from the ED to the next step in care can cause backlogs, which can lead to ED staff caring for inpatients in overflow beds set up in the ED, affecting their ability to assess and stabilize new patients who are presenting at the same time. Obviously this can have a dramatic effect on the wait times within an ED and can also lead to off-load delays for ambulances or even diversions to other nearby hospitals (Schull, et al., 2002).

Factors of the Crowding Model. Rathlev et al. (2007) looked at several input, throughput and output factors using retrospective data on 92,000 visitors to the ED at a large, US inter-city hospital using length of stay in the ED as a measure of ED crowding. Their analysis found that three output factors: the number of elective surgical

admissions, number of ED admissions and overall hospital occupancy were associated with longer length of stay in the ED and together accounted for 31% of the variance in daily mean inpatient length of stay (LOS) in the ED: used by the authors as a proxy measure for ED crowding. Conversely, the input and throughput related factors of total ED volume and the number of attending hours were not found to have an effect on ED LOS. In their study of a large Canadian ED, Schull, Lazier, Vermeulen, Mawhinney and Morrison (2003) also found a correlation between the number of patients admitted to hospital, but waiting in the ED for a bed and their measure of ED crowding (in this case periods of ambulance diversion). Other factors associated with ambulance diversion included the number of admitted patients per time interval, the length of stay in the ED of admitted patients and longer mean assessment times of admitted patients per time interval. Throughput factors analysed included the number of ED nursing hours per interval and factors specific to individual attending physicians. Only one physician of 15 was found to be associated with higher diversions, while one was found to be associated with lower diversions. The volume of walk-in patients to the ED as well as patients with major trauma were not associated with crowding; however a higher number of patients arriving by ambulance in a time interval was found to be associated with higher ambulance diversion (the only input factor that was).

The Issue of "Appropriateness" of ED Visits

The term "inappropriate" has been used to describe those visits that contribute to crowding and would be considered avoidable in nature. This concept has sparked controversy and in some cases heated debate, especially among healthcare professionals working in EDs. Many, such as Vertisi (2004) point out that people present to the ED in physical distress and are only deemed inappropriate after an

analysis has taken place. As well, there are many who are seen in EDs which can seem at first glance to have minor ailments, however once a complete assessment is performed a more urgent medical condition is discovered. This calls into question the idea of any ED visit being labelled as "inappropriate".

In his commentary on the causes of frequent ED visitors, Bernstein (2006) called for "the end of inappropriateness" (p. 1), citing compelling evidence that frequent ED visitors actually have genuinely higher levels of morbidity and are in need of care. His assertion is that the perception of high rates of ED visits for minor and inappropriate reasons are not supported by the evidence. Given the evidence already presented, there is some level of truth to the argument; however there is another facet to the "appropriateness" debate.

As previously stated, EDs are designed for rapid diagnosis and treatment of emergency conditions. They are not designed to care for patients with medical or mental health issues which necessitate longer-term treatment plans. Therefore, if a population of visitors to an ED appears to be high in these areas it speaks to interventions which may be necessary in other areas of the healthcare system, rather than in the ED itself in order to give patients more appropriate treatment options.

This assertion appears to be supported. In their analysis of data from the Community Tracking Study Household Survey, Hunt et al. (2006) found that persons who were satisfied with their primary care provider were less likely to be frequent visitors of an ED than those who were not satisfied. As well, they identified that persons who were treated by the same physician at every visit were less likely to be frequent users of the ED than those who were treated by different physicians at each visit. High

ED utilization is therefore associated with primary care that is of low perceived quality and continuity.

Glazier et al. (2008) found that residents of Ontario with chronic conditions who made fewer than three visits to a physician's office during a two-year period of study were 1.17 times more likely to have visited an ED for care and were 1.19 times more likely to have been admitted to hospital during that period. Even more striking was that patients who made three or more visits but reported a low continuity of care during those visits were 1.55 times more likely to have visited an ED.

ED Utilization as a Measure of Community Primary Care Quality

The concept that certain conditions can be more adequately treated in a non-hospital setting has led to another expanding branch of health research. Here the relative strength and efficacy of a health region's primary care system is approximated through analysis of hospitalizations for certain conditions which should not result in hospitalization if managed effectively in the community. The term ambulatory care sensitive condition (ACSC) is used to describe a specific set of diseases and morbidities which, if managed effectively in the community, should not lead to hospitalization or ED visits (Billings, Zeitel, Lucomnik, Carey, Blank, & Newman, 1993). In this way, ACSCs can be used as indicators of a region's primary healthcare system's effectiveness.

High ED utilization for ACSCs can also underscore key service gaps which may be present in a hospital or health region. These services gaps, once identified, can lead to strategies to improve the overall quality of care in an institution or a region and lead to better health outcomes. Bindman et al. (1995) found that hospitalization rates for several ACSCs were inversely related to access to care in a region. As well, they concluded that improving access to health care was more likely to reduce hospitalization

rates than interventions designed to change physician practices. In studying the effect that rural health centers had on hospitalizations in rural Nebraska, Zhang, Mueller, Chen and Conway (2006) found that elderly persons residing in health professional shortage areas with at least one rural health centre were much less likely to have a hospitalization for an ACSC. Research also clearly shows that persons with admissions for ACSCs are substantially more likely to be readmitted for the same condition (Porter, Herring, Lacroix, & Levinton, 2007). These patients often end up an a cycle of futile, short-term treatment, which uses up resources intended to treat acute episodes rather than chronic conditions and does not resolve in any way the complex health issues that they face.

We also know that visits to hospitals put patients at risk of for hospital acquired infections, falls, medication errors and other adverse events, since the risks of these events are much higher in a hospital setting than in the general population (O'Brien & Nelson, 2002). Therefore, it is prudent to keep patients who can be treated elsewhere from receiving their care in an ED.

Northwestern Ontario

Although the poor health outcomes of residents of Northwestern Ontario have been well documented, little information is available on the ED usage patterns specific to the residents of Northwestern Ontario. Life expectancies and potential years life lost in Northwestern Ontario are lower than the provincial average (North West Local Health Integration Network, 2009b). Compared to the rest of the province as a whole, Northwestern Ontario as a region has high levels of chronic disease, diabetes, heavy drinking, smoking and various other morbidities (North West Local Health Integration Network, 2009b). As well, the Northwest region has consistently faced challenges in recruitment of health professionals to the area. The region has the second-highest rate

in the province of residents who are unattached to a family physician (Hay, Kasman & Rais, 2008) which as discussed has been associated with high ED utilization.

The Northwestern Ontario region is primarily serviced by one large academic health sciences centre situated in Thunder Bay: the Thunder Bay Regional Health Sciences Centre (TBRHSC). This facility is the only trauma centre and contains the only intensive care unit for an area that represents 47% of Ontario's landmass (roughly equivalent to the size of France) and is home to approximately 242,450 people (North West Local Health Integration Network, 2009b). The ED at the TBRHSC is responsible for 45% of the ED visits for the region and sees 97,000 visitors on an annual period (Ministry of Health and Long-Term Care, 2009).

Between 2009 and 2005, total visits to the ED at the TBRHSC grew by an astonishing 18.3%, while the total number of ED visits province-wide grew only 3.8% (Ministry of Health and Long-Term Care, 2009). Little is known about the reasons for the increase, which is in terms of cumulative average growth rate is 4.5 times higher than the provincial average. As well, it is important to note that the contrary to the rest of the province which grew in population during this period, the region of Northwestern Ontario has had a declining population (North West Local Health Integration Network, 2009a) and rates of ED usage per 1000 are more than twice as high in Northwestern Ontario than the provincial average (KPMG, 2009). It has been suggested that the primary reason for the apparent overutilization of ED resources in the community is the lack of access to primary care (North West Local Health Integration Network, 2010). As well, it has been expressed that mental health and additions play a large part in the continued struggles with ED crowding at the facility (Walker, 2011).

The Present Study:

This study examined two years of data representing visits to the ED at the TBRHSC. The data included demographics of the patient population along with pertinent clinical and operational information for the ED.

The goals of the study were threefold:

1. To find out what, if any differences exist between the two years of data in terms of the patient population being severed in order to identify reasons for the large increase in patient visits between the two years.
2. To identify from the data variables which were predictive of frequent use in order to determine what service gaps in the community might be contributing to the high utilization rates of the ED.
3. To identify predictive factors which were associated with periods of ED crowding, using ED LOS as a proxy measure of crowding.

This study is unique and innovative because no study to date has focused on Northwestern Ontario and the unique demographics of the population. As well, no study to date has utilized advanced statistical models to find predictors of frequent use and crowding conditions in the ED.

Methodology

Database

Clinical data covering ED visits to the TBRHSC were obtained for the most current one-year period available: April 1, 2009 to March 31, 2010 as well as a one-year period from 4 years prior: April 1, 2004 to March 31, 2005. This information was routinely collected and stored by the Thunder Bay Health Sciences Centre as a part of regular clinical documentation. Confidentiality in the data was ensured by including no names in the information file. Only unique patient identifiers were used, which had no

connection to identifiable patient information. Before any data were obtained, the proposed study was approved by the research ethics boards of both the Thunder Bay Health Sciences Centre and Lakehead University.

Variables

The data contained basic demographic information for each patient, including dates of birth, city of residence, sex, family physician, and means of arrival to the ED. Also collected were the date and time of admission to the ED as well as the date and time of discharge from the ED, and place of discharge (e.g. to another department within the hospital, another facility, or home). If the patient was admitted to hospital, the total length of stay in hospital was collected. Clinical data obtained included the reason for the visit (free text), the most responsible diagnosis (MRD), the principal intervention and the CTAS level.

The data included some small number of records with individual fields where the data were inconsistent, missing or otherwise unusable. In order to keep the dataset as complete and valid as possible, these records were preserved, with the records being omitted on the basis of the individual analyses being performed.

Data Analyses.

The data were analyzed using SPSS version 18. Preliminary analyses included descriptive analyses of demographic and clinical data for the two time periods. The goals of these analyses were to describe the population and to look for differences in the data between the two periods in order to highlight areas for policy development or further study.

The main analyses involved the use of generalized estimating equations (GEE) to find predictors of frequent use and ED crowding. The data were particularly suited to

the use of the GEE method for two main reasons. First, the data contained repeated measures: the successive visits to the ED by the same individual in the course of a year. Repeated measures can be handled particularly well by the GEE method, as it allows for the independent contributions of each term to be gleaned as a part of the overall prediction model, thus strengthening the validity of the prediction (Liang & Zeger, 1986)[0]. Although traditional regression analyses can deal with repeated measures, they require dependant variables to be approximately normally distributed. In this study, both the number of visits per person and the overall LOS more closely resembled a gamma distribution, which is acceptable to the GEE method of analysis but not traditional regression.

In order to predict frequent use, the number of visits per patient per year were calculated and used as the dependant variable in the predictive model. Month of service, hour of service, age of the patient (in years), sex and CTAS level were included as predictor variables. One of the advantages of the GEE method is the ability to handle categorical and value type variables (both discrete and continuous) in the same model, therefore the major clinical categories (MCC) of the MRDs were also included in the model.

To build the predictive model for ED crowding, Overall ED LOS was used as a proxy measure for ED crowding. Overall ED LOS was derived by adding the total time spent in the ED as a outpatient, as well as any inpatient LOS that was spent in waiting in the ED for a bed elsewhere in the hospital. As discussed in the literature, EDs are designed to rapidly stabilize and assess patients and then move them on either to the next phase of treatment or discharge them from the hospital, therefore it was felt that overall LOS in the ED would be a good proxy measure for crowding, as longer times

spent in the ED would be indicative of problems related to crowding. This is an approach which has been taken in the past by similar studies (eg., Rathlev et al., 2007).

Included in the analyses were linear terms centered from the mean in order to improve the ability to interpret the results. As well, quadratic terms were included in order to estimate any curvilinearity of the relationships which may be present in the data. Graphs were used to illustrate such trends when they were found to be significant and are presented as figures in the results.

Originally in the data set, the overall LOS variable was rounded to the nearest hour and as a result, included many records with a zero value. The zero values were all recoded as .4 to give them a nominal value, allowing the variable to be analyzed as a gamma distribution. As well, several extreme outliers were eliminated from the data set, as these values interfered with the model's ability to find intercept values, causing the model generation to fail.

Results

The number of visits to the ED in 2004/05 was 82033, compared to 101789 in 2009/10: an increase of 24.1% over the five-year period. These total visits were accumulated by a total of 45316 unique patients in 2004/05 and 51652 in 2009/10. Depending on the analysis being performed, results were shown in terms of either gross visits (n=82033 for 2004/05 and n=101789 for 2009/10) or in terms of unique patients (n=45316 for 2004/05 and n=51652 for 2009/10) based on which was deemed to be more valid under the circumstances. For the predictive models of ED crowding and frequent use, the total visits from both annual periods of study were combined to increase the power of the predictive models (n=183,822).

Differences Between 2004/05 and 2009/10

Age. An independent samples t-test showed the mean age of the patients per visit in 2004/05 (M=38.61, SD=23.836) to be significantly different than the mean age of the patients per visit to the ED in 2009/10 (M=40.11, SD=24.165), t(176548.611)=-13.306, p<.001. The maximum age in 2004/05 was 102 years and in 2009/10, 104 years. The minimum age in both years was less than one year of age. In 2004/05 visitors were 51.2% female and 48.8% male, while in 2009/10 visitors to the ED were 52.4% female and only 47.6% male.

CTAS Level. Tables 1 and 2 display the CTAS levels per visit for the years 2004/05 and 2009/10 respectively. Between the two annual periods in question, growth was seen in visits rates as CTAS levels 3, 4 and 5, while a decline in visits rated CTAS 1 and 2 was observed. An independent samples t-test revealed that the mean CTAS level in 2004/05 (M=3.12, SD=.732) was significantly different from the mean CTAS level in 2009/10 (M=3.10, SD=.781), t(23.909) = 7.003, p<0.001. That difference, however, was small due to the large number of CTAS level 3 patients and the relatively small number of resuscitation, emergent and non-urgent patients in both populations.

The two populations were very similar therefore, in terms of average acuity upon presentation; however it is of interest to note that growth in visits between the two years occurred primarily in the urgent and less-urgent categories. This growth is illustrated by the fact that in 2004/05 resuscitation and emergent visits represented 24.4 percent of the total, while in 2009/10 those visits represented only 16.4 percent of the total population.

Frequency of Use. Tables 3 and 4 show the frequency of visits to the ED in 2004/05 and 2009/10, respectively. The maximum number of visits per patient in 2004/05 was 72, compared to 62 in 2009/10. Patients who only visited once accounted

for 34.8 percent of the total visits in 2004/05, compared to 30.2 percent in 2009/10. Only a small percentage of total visits to the ED in both periods were accumulated by patients who visited the ED more than once per month on average: 4.8 percent in 2004/05 and 6.5 percent in 2009/10, representing 3,961 total visits in 2004/05 and 6,570 visits in 2009/10.

An independent samples t-test found the mean number of visits per unique patient in 2004/05 ($M=1.81$, $SD=1.855$) to be significantly different to the mean in 2009/10 ($M=1.97$, $SD=2.127$) $t(96963.511) = -12.544$, $p<0.001$. Patients who made four or more visits to the ED in one year accounted for 24,444 visits or 29.8 percent of total visits in 2004/05, compared to 36,117 visits or 35.5 percent in 2009/10. This is comparable, but higher than the results published by Hunt et al. (2006) which showed that patients with four or more visits accounted for 28 percent of total visits to the ED. Patients with five or more visits per year, the criteria used by Fuda & Immekus (2006) in the largest study of its kind currently available to define a frequent user, accounted for 17,604 visits, or 21.5 percent of the total in 2004/05 and 27,545 visits, or 27.1 percent of the total visits in 2009/10. Again, both of these figures are high compared to the 17.6 percent of the total visits found by Fuda & Immekus (2006) to be made up of people who visited greater than 5 times in an annual period.

Primary Care. Tables 5 breaks down how many visits had a physician or a primary health clinic associated with that patient for the visit. In order to generate the data in table 6, only the first instance of unique patient identifiers were included in the analysis to give an estimate of the proportion of the population visiting the ED in each year that had access to a family physician, absent of the effect of multiple visits by the

same individual. In both tables, there was very little difference observed between the two years of data.

MCC. Visits organized by MCC of MRD for 2004/05 and 2009/10 are shown in table 7. Comparing 2004/05 to 2009/10, the most significant increases in terms of MCCs were in the categories of diseases and disorders of the ear, nose, throat and mouth, diseases and disorders of the skin, subcutaneous tissue and breast and in diseases and disorders of the digestive system. Between the two periods, only the MCC of burns decreased in gross terms. The most prevalent MCCs in 2009/10 were significant trauma, injury, poisoning & toxic effects of drugs, diseases and disorders of the ear, nose, throat and mouth and diseases and disorders of the digestive system. It is interesting to note however, that trauma as an MCC was less prominent as a percentage of total ED visits in 2009/10, as were diseases and disorders of the musculoskeletal system and connective tissue even though the total number of cases in each category were up year to year.

Figure 1 depicts graphically the gross effect of each MCC on overall LOS in the ED and therefore ED crowding. Note that the MCC of diseases and disorders of the cardiovascular system had by far the most significant gross effect on ED crowding in the two year period examined by the study.

MRD. Tables 8 and 9 show the top 25 MRDs of patients who presented to the ED in 2004/05 and 2009/10 respectively. The top MRDs in both periods were similar, with significant growth occurring each of the top categories.

Region of Residence. Tables 10 and 11 show the visits to the ED for 2004/05 and 2009/10 by the region where the patients resided at the time of their visit. The vast majority of visits in both years were by patients residing in the City of Thunder

Bay, with only a small increase observed between 2004/05 (86.0 percent) and 2009/10 (87.1 percent).

Hour of Service. Total visits to the ED for the two years studied by hour of service are summarized in tables 1 and 12. The majority of visits (52.7% in 2004/05 and 53.7% in 2009/10) occurred between the hours of eight o'clock in the morning and four o'clock in the afternoon. In both years, the busiest hour of the day was between one and two o'clock in the afternoon.

Frequent vs. Non-Frequent User of the ED

In order to utilize descriptive statistics to compare frequent and non-frequent visitors to the ED, a new variable was created in order to group patients with 5 or more visits in each annual period as frequent visitors, with the rest of the patients being classified as non-frequent visitors in keeping with Fuda an Immekus (2006).

Age. Using t-tests of independent samples, the mean age of frequent users in both periods were found to higher than the mean age of non-frequent users. The results are summarized in table 14. To further analyze the relationship between age and frequent use of the ED, patients were grouped according to their age and chi squared analysis was performed to compare the two category type variables. The results are shown in table 15. Age group was found to be significantly associated with frequent use in 2004/05, Chi Sq (N=45307, df=9) = 149.348 and in 2009/10, Chi Sq (N=51641, df=9) = 200.636. In 2004/05, the deciles with the greatest positive differences between observed frequencies of frequent and non-frequent users were the eldest age groups (those greater than 70 years of age), while the youngest age groups (0-19), showed the greatest negative differences. In 2009/10, the trends were similar, with the notable exception of the 20-29 age group, which swung from a group with a

lower proportion of frequent visitors in 2004/05 to a group with higher percentage of frequent visitors in 2009/10.

Primary Care. Table 16 shows the results of chi-square test of independence of frequent use of the ED compared to whether or not the patient is affiliated with a family physician or primary care clinic. This test revealed one of the most poignant differences between the two years of data as in 2004/05 there was no significant association found (chi sq. [n=82033, df=1]=.622, p=.430), however in 2009/10 an association was observed between frequent use and not having a family physician or clinic (chi sq. [n=101789, df=1]=215.198, p<.001).

MCC. Significant differences were also observed between frequent and non-frequent users and diagnoses when grouped into major clinical categories for both years of data. Table 17 summarizes the results of the chi–square analysis. Major clinical categories that were found to be associated with frequent use included diseases and disorders of the digestive system, the lymphatic and blood system, mental diseases and disorders and other and miscellaneous case mix groups. By far the strongest association to frequent use was found to be in the category of diseases of the lymphatic and blood system, which was consistent between both years. Closer examination of this category revealed that the MRD of "other chemotherapy" made up 84% of the total visits for this major clinical category for the two years combined and represented the most common MRD for visit by frequent patients.

Predictive Model of Frequent Use

The GEE method with a gamma distribution was used to calculate parameter estimates for several variables in order to determine if they were significant predictors of the number of visits per person to the ED. Table 18 summarizes the results. Note that

the MCC "Significant trauma, injury, poisoning & toxic effects of drugs" was chosen as the reference category for the model and therefore had no effect calculated. Also, the MCCs "other reasons for hospitalization" and "miscellaneous and ungroupable data" were excluded from the analysis due to the somewhat ambiguous nature of these categories.

MCC. Of all of the MCCs, "Mental diseases & disorders" had the highest positive correlation with number of visits per patient per year (B=.884), with "diseases and disorders of the blood and lymphatic system" a very close second. Of the MCCs that were significant predictors, only "diseases and disorders of the eye" were negatively correlated with the number of visits per patient per year compared to the reference MCC. Figure 2 illustrates graphically the relationship between MCC and the number of visits per patient per year to the ED, highlighting the significant effect of the two MCCs with the greatest effect on frequency of visit. Of all of the MCCs, only "diseases and disorders of the female reproductive system" and "pregnancy and childbirth" were not significantly associated with the number of visits per patient, per year.

Hour of Service. Hour of service was found to be a predictor of number of visits in a year, with both the linear and quadratic term being significant ($p<.001$), reflecting the curvilinear nature of the relationship. Figure 3 graphically depicts this relationship. A clear trend is visible toward higher repeat visits in the off-hours of service at the ED, with those who are more likely to visit fewer times in a year tending to come in the morning.

Age. Again both the linear and quadratic term were found to be significant predictors of frequent use ($p<.001$). Figure 4 illustrates the relationship that was found. Somewhat surprisingly, the highest user group was found to be the middle-aged groups

between 30 and 49 years of age. Frequent use was lowest in the youngest age groups between 0-19 years of age. Past 39 years of age the mean number of visits per person actually declined with age.

Sex. Although the difference observed between the number of visits per patient for males and females was small, sex was found to be a predictor of frequent use ($p=.017$), with females tending to be overrepresented slightly in the frequency of ED visits per year.

CTAS. At the outset of this study it was expected that CTAS level would be a predictor of frequent use in the ED, however this was not found to be a significant predictor of frequency of visits in this model. One possible explanation for this was the fact that patients on the high end of frequent use tended to have very high in the variability of the acuity of their visits, due to acute episodes related to a chronic condition for example, while they might also have several more benign visits such as for dressing changes or other chemotherapy.

Family Physician. Whether or not a patient had access to a family physician or primary care provider was found to be a predictor of frequent use ($p=.024$). Those without access to a family physician had an estimated 8% more visits to the ED than those with a primary care provider listed.

Region. There was a strong correlation between the region where the patient is from and the number of visits per year ($p<.001$). Patients from the City of Thunder Bay had an estimated 41% more visits than those from other areas.

Predictive Model of ED Crowding

Table 18 summarizes the results of parameter estimation using the GEE method with gamma distribution and Overall ED LOS in hours as the dependant variable.

MCC. All of the MCCs were found to be significant predictors of overall LOS ($p<.001$). As before, the MCC "Significant trauma, injury, poisoning & toxic effects of drugs" was chosen as the reference category for the model and therefore had no effect calculated. The strongest effect in Overall LOS with respect to the reference category were observed in the MCCs related to "diseases and disorders of the hepatobiliary system and pancreas", "mental diseases and disorders" and "diseases and disorders of the circulatory system". MCCs with significantly lower Overall LOS than the reference category included "diseases and disorders of the eye" and "burns".

Age. Age was found to be a significant predictor of overall LOS ($p<.001$). Both the linear and quadratic terms were significant, meaning that the trend was significantly curvilinear in nature. Figure 4 illustrates the results. Note the exponential rise in overall LOS which was observed as the age of the patient increased.

CTAS level. The CTAS level of the visit to ED was a significant predictor of Overall LOS ($p<.001$). For every one point increase in CTAS level (therefore from 1 to 5 or as acuity upon presentation decreased) there was a 4.0% decrease in Overall LOS as estimated by the model.

Primary Care. Whether or not a patient had a family physician or was attached to a primary care clinic predicted overall ED LOS ($p=.001$), however the difference observed in this study was small, at only 3.2%. Those with a primary care provider listed had lower overall ED LOS predicted by the model than those without a primary care provider listed.

Month, hour of service and sex were not found to be significant predictors of overall ED LOS.

Discussion

Methodological Advances

To the author's knowledge, this study is the first to examine a large database of visits to the ED and build statistical models to predict both frequency of visits and crowding conditions from the demographics of the patients. Analysis in previous studies has been mostly limited to retrospective chart reviews with limited power (Byrne, Murphy, Plunket, et al., 2003), descriptive statistics which highlight associations (Fuda & Immekus, 2006), and multivariate analysis requiring definition of a "frequent user" based on an arbitrary definition of what number of visits per year constitutes a "frequent user" (Hunt et al., 2006). This study is the first to take advantage of advanced statistical techniques which enable more effective analysis of data containing repeated measures and are able to handle the data more appropriately.

Differences Between 2004/05 and 2009/10

Analysis of the descriptive statistics yielded few significant differences between 2004/05 and 2009/10, which was surprising given the 18% growth in the number of visits between the two periods with a corresponding decrease in the population of the region (North West Local Health Integration Network, 2009b). The data indicated that growth in visits occurred in less urgent cases as demonstrated by the CTAS levels. The number of visits classified as CTAS one and two (resuscitation and emergent) actually decreased between 2004/05 and 2009/10, both in gross terms and dramatically in terms of percentage of overall visits (from 24.4% to 16.4%), suggesting a shift of great clinical significance towards less and non-urgent care (and away from the mandate of EDs). A third of the patients seen in in the ED in 2009/10 (31.7%) were considered to be less or non-urgent in nature; and while evidence has shown that CTAS levels cannot reliably be

used as a measure of "inappropriate" visits (Vertisi, 2004) to see so much growth in non-urgent raises further questions of whether or not there are areas where specific interventions could reduce ED utilization and improve the overall quality of primary care in the region.

The mean number of visits per unique patient increased by 8.8% between 2004/05 and 2009/10, indicating that there was an increase in the frequency of utilization between the two periods. The overall effect of the increase in frequency of visits was significant to the gross increase in visits over the five year period.

With respect to the overall percentage of patients visiting the ED who had a family physician or primary care clinic listed, there was no change observed between 2004/05 and 2009/10. Lack of access to primary care in the community has been cited as a reason for the increase in ED visits in Northwestern Ontario (Northwest Local Health Integration Network, 2010), yet this data showed that there was no change between the two years studied in the proportion of patients overall who were associated with a primary care provider. Chi square analysis comparing frequent users of the ED to non-frequent in terms of primary care status found no difference in 2004/05. In 2009/10 frequent users were more likely than non-frequent to have no family physician or primary care clinic listed; however the difference was small and the impact was limited. Analysis of the hour of service for ED visits again showed very little difference between the two years of data.

The greatest differences observed between the two periods were found in the examination of certain MCCs. The growth in nearly all areas appears to reflect a population that is less healthy overall. All of the top 5 MRDs in 2009/10 grew significantly from 2004/05. The largest single category related to urinary tract infections

which is an ambulatory care sensitive condition for which, according to the Department of Health and Human Services Agency for Healthcare Research and Quality (2007), "Proper outpatient treatment may reduce admissions for urinary infection, and lower rates represent better quality care" (p. 38). There were several other MRDs worth noting as well, including "other chemotherapy" which grew by 58% over the 5 year period and "attention to sutures and dressings", which grew by 61%. Both of these categories would be considered largely ambulatory care related MRDs. In total, the top five MRDs alone in 2009/10 accounted for 14,804 visits, representing 14.5% of the total visits. In addition, growth in visits related to the top five MRDs between 2004/05 and 2009/10 were responsible for 19.1% of the increase in visits between the two years. Further investigation of the factors leading to this increase therefore is warranted to determine if specific interventions could reduce the demand on the ED by preventing or diverting visits.

Frequency of Use

The MCCs of "mental diseases and disorders" and "diseases and disorders of the blood and lymphatic system" stood out as having by far the greatest influence on frequent use of all of the MCCs. The high utilization of the ED by patients with mental health disorders was consistent with results from other studies (eg., Fuda and Immekus, 2006), and was expected. However, the high influence of diseases and disorders of the blood and lymphatic system was unexpected. Further examination of the data revealed that 85% of the visits in this MCC in 2009/10 were for the MRD of "other chemotherapy" and 78% of them were less or non-urgent in presentation (CTAS levels four and five).

As expected, age was found to be a significant predictor frequent use, however not in the way that was expected. Other studies found that the elderly were

disproportionately high users of the ED (Aminzadeh & Dalziel, 2002; Brown, Goel, 1994; Parboosingh & Larsen, 1987). The results from this study however, indicated that the highest frequency patients came from the middle-age groups: those between the ages of 30 and 49 years. Also expected was the fact that those with a family physician or primary care clinic listed had a lower predicted number of total visits than those without primary care coverage, as lack of primary care is commonly regarded as the largest contributing factor to high ED utilization in the community (Northwest Local Health Integration Network, 2010). This difference however, was much smaller than expected and the overall impact of family physician status was found to be minimal. Region of origin had a significant effect on frequency of use, as patients from the city of Thunder Bay used the ED 41% more as predicted by the model than those from elsewhere. Patients from Thunder Bay accounted for 88,612 visits in 2009/10, or 87.1% of total visits in that year, even though the population of Thunder Bay was only 122,900 people, or 52% of the total population of the Northwest Local Health Integration Network (NW LHIN) (North West Local Health Integration Network, 2009b). Therefore, compared to residents of the City of Thunder Bay, residents of the rest of the NW LHIN had disproportionately lower utilization of the ED at the TBRHSC.

Overall ED LOS

Diseases and disorders of the hepatobiliary system and pancreas as a MCC had the highest overall LOS compared to the reference category as predicted by the model. Patients admitted in this category could expect to wait for an inpatient bed an estimated 72.6% longer than those who presented to the ED for significant trauma, injury, poisoning & toxic effects of drugs. Examining the data in more detail revealed that the majority of visits which accounted for the high LOS cases in this

category were diagnosed as acute pancreatitis: a disease from which 80% recover without complications and one that is significantly associated with alcohol abuse (Frossard, Steer, & Pastor, 2008). Mental diseases and disorders were a very close second in terms of their high predicted value of overall LOS in the ED. Patients presenting to the ED with mental health issues as their ultimate primary diagnosis could expect to wait in the ED for a bed 71.8% longer than those with trauma, injury or poisoning as predicted by the GEE method.

Diseases and disorders of the circulatory system were also significant contributors to ED crowding. This MCC had a high predicted per visit value by the model, at 59.0% higher than the reference category and also accounted for by far the most hours spent overall in ED out of all of the MCCs. The total number of hours: at 151,081 for the two years studied, were 51.2% higher than the next closest category (diseases and disorders of the digestive system) and 200.3% higher than the total LOS in the ED by patients with MRDs of mental health diseases and disorders. It is extremely important therefore to highlight the fact that although the individual contributions of acute pancreatitis and mental health disorders to ED crowding were very high, the MCC with the greatest overall contribution to ED crowding in the period studied were diseases and disorders of the circulatory system.

Age was strongly associated with overall ED LOS. The relationship depicted in figure 6 is that of an exponential rise in ED LOS as age increases. This is consistent with the pattern presented by previous studies which found that eldery patients presenting to the ED tended to be in a poorer state of health overall (Parboosingh & Larsen, 1987) and that they tend to have a higher admission rate than younger groups (Aminzadeh & Dalziel, 2002). It should be noted however that this study did not examine the effect of

the elderly to the level where it was possible to determine whether or not the high effect on crowding was due to the lower state of health of this population or the absence of community services (home care, long-term care, etc…) which would otherwise allow acute admissions to be avoided.

Those with a family physician had a lower overall LOS than those without a family physician, although surprisingly this difference was very small (only 3.2%).

Implications

This study yielded surprising and interesting results, however this was due mostly to what was not found, rather than what was. We know that the number of visits to the ED between the two annual periods studied increased by 18% in spite of the fact that the population in the region actually declined yet analysis of many of the important demographic variables showed little change in the population profile between the two years.

Primary Care. The most surprising finding was the lack of any great effect found on the ED utilization of whether or not a patient had a family physician or primary care clinic listed, as the lack of primary care has long been regarded as the largest contributor to high ED utilization in the region (Northwest Local Health Integration Network, 2010). There was little to no evidence found in this study to support that assertion. There was no change observed in the proportion of patients followed by a family physician over the two year period and although primary care status was found to be a significant predictor of lower frequency of use of the ED as well as lower overall ED LOS, the estimated effect in both cases was fairly minimal – especially when we consider that 22% of the population did not have a primary care physician. It is interesting to note as well that the majority of visits to the ED occurred during the day during normal

business hours and as figure 7 shows Monday was actually found to be the day of the week with the highest number of visits in both years of data.

This study was not designed to definitively determine whether or not impaired access to primary care caused the great increase in visits between the two years in question. However, if impaired access to primary care were to be the main reason for the increase in visits one would have expected to find a drop in the percentage covered by primary care or a stronger trend towards visits outside of regular business hours. The results revealed no such change.

In their study of primary care in Thunder Bay, Howard, et al. (2008) found that different types of primary care clinics had varying degrees of success in keeping their patients from visiting the ED. Patients whose physicians operated in a family health group or fee for service model practice were 45% and 31% more likely to visit an ED in a year than patients covered by a family health network model practice. Some of the reasons cited by the authors included the improved access to walk-in clinics afforded to patients of family health network practices as well as some of the financial incentives imbedded in the structure of the compensation schemes of these practices to discourage patients from accessing the ED in favour of walk-in clinics. Expansion of this model in Thundery Bay could assist in reducing the relative burden placed on the ED. Other studies have found a strong link between convenience of appointments, perceived convenience or perceived lack of the availability of primary care (Bain & Johnson , 1971; Harris, et al., 2004). Perhaps more work needs to be done on educating the population as to their healthcare options and the benefits of receiving care through their primary care provider rather than visiting the ED.

Specific Interventions. There was a great deal of evidence to suggest that the health status of the population in the city of Thunder Bay worsened over the five year period between the two years of study, however there is also evidence suggesting that specific and targeted interventions could potentially have a great impact on ED utilization. The top five MRDs alone accounted for almost 20% of the increase in visits observed between the annual periods studied. Most were either ACSCs, or things such as dressing changes for which a visit to the ED is not necessary (except in absence of other community or hospital programs). Specific interventions in these areas could have a dramatic effect on reversing this increase and reducing the strain on the department. As well, the MCCs which were the strongest predictors of frequent use should be examined in further detail to determine if specific interventions would be able to have an impact on ED utilization. For example, upon closer examination the MCC that had the second greatest predicted effect on frequent use, diseases and disorders of the blood and lymphatic system, was made up of a large number of visits with the MRD "other chemotherapy": the majority of which are likely visits that could be diverted to other outpatient clinics or resources if available.

In gross terms, the MCC with the single largest effect on ED crowding in the periods studied was diseases and disorders of the cardiac system. Although the per-case contribution was not as significant as the highest MCC found in the predictive model: diseases and disorders of the hepatobiliary system and pancreas, the overall effect that cardiovascular diseases and disorders had on overall ED LOS and therefore crowding was substantially higher than any other group (see figure 1). Northwestern Ontario is significantly underserviced with respect to cardiovascular services, with no full-service program available in the entire region. Cardiovascular

services should be examined for feasibility as the lack of services appears to have a great impact on the ED as well as the health of the region. As for mental health diseases and disorders, they do play a part in ED crowding. With respect to the per-term effect, visits relating to this MCC were the second highest in terms of the predicted effect on overall ED LOS, however the gross effect was far below this highest contributor to overall ED LOS (in fact, it was sixth out of 18 MCCs: see figure 1). This could explain why it has been singled out in the media as a great contributor to ED crowding, when in fact it is far behind other MCCs in gross terms.

Limitations

This study contained only basic demographic information regarding patients visiting the ED and while some reasonable inferences could be made from the data by examining this data and determining patterns of frequent use, it was impossible to conclusively discover the reasons for the large increase in visits over the five years between the data sets. Further studies should include the use of ED patient surveys to investigate the reasons that patients choose to visit the ED instead of seeking care elsewhere in the system. Similar studies have been performed in other health regions and have concluded that patients were over utilizing ED resources for reasons other than what was expected, such as for convenience or timeliness of service, or lack of knowledge of other options (Harris, et al., 2004). A study producing results targeted at further understanding the patient factors leading to ED use, rather than the medical or demographic factors would be of tremendous benefit to healthcare providers and policy makers in the region.

Conclusions

The growth in ED visits that occurred between 2004/05 and 2009/10 was primarily due an increase in less-urgent and non-urgent visits, including many that would be considered for ACSCs. The majority of patients who visited the ED reported access to a primary care provider and no difference was observed in the proportion of patients who had access to primary care between the two years studied.

Frequency of visits per patient did increase by 8.8% between 2004/05 and 2009/10. Visits related to mental diseases and disorders and diseases and disorders of the blood and lymphatic system were the MCCs with the highest association with frequent use, although in gross terms the highest use MCC was significant trauma, injury, poisoning and toxic effects of drugs.

The MCC with the greatest overall effect on ED crowding was diseases and disorders of the cardiovascular system. On an individual level, diseases and disorders of the blood and lymphatic system had the greatest effect on overall ED LOS, with mental health diseases and disorders also having high individual predicted values. The strong individual predictive effect of mental health diseases and disorders explains the perception of its significant role in ED crowding. Future research should focus on patient reasons for visits to the ED and increasing awareness of alternative services available.

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Table 1

Frequencies of CTAS Levels for Patients Presenting to the ED in 2004/05 by Visits

CTAS Level	Frequency	Percent	Cumulative Percent
1	1054	1.3	1.3
2	18942	23.1	24.4
3	40819	49.8	74.1
4	19472	23.7	97.9
5	1746	2.1	100.0
Total	82033	100.0	

Table 2

Frequencies of CTAS Levels for Patients Presenting to the ED in 2009/10 by Visits

CTAS Level	Frequency	Percent	Cumulative Percent
1	419	.4	.4
2	16260	16.0	16.4
3	52862	51.9	68.3
4	29471	29.0	97.3
5	2774	2.7	100.0
Missing	3	.0	100.0
Total	101789	100.0	

Table 3

Total Visits to the ED in 2004/05 by Frequency of Visits per Unique Patient in an Annual Period

Number of Visits in Annual Period	Total Number of Visits	Percent	Cumulative Percent
1	28526	34.8	34.8
2	18224	22.2	57.0
3	10839	13.2	70.2
4	6840	8.3	78.5
5	4385	5.3	83.9
6	2868	3.5	87.4
7	2114	2.6	90.0
8	1648	2.0	92.0
9	972	1.2	93.2
10	930	1.1	94.3
11	726	.9	95.2
12	432	.5	95.7
13	546	.7	96.4
14	476	.6	96.9
15	150	.2	97.1
16	320	.4	97.5
17	340	.4	97.9
18	108	.1	98.1
19	209	.3	98.3
20	160	.2	98.5
21	84	.1	98.6
22	22	.0	98.6
23	69	.1	98.7
24	72	.1	98.8
25	125	.2	99.0
26	26	.0	99.0
27	54	.1	99.1
28	56	.1	99.1
29	87	.1	99.2

Number of Visits in Annual Period	Total Number of Visits	Percent	Cumulative Percent
30	30	.0	99.3
31	93	.1	99.4
36	36	.0	99.4
38	38	.0	99.5
43	86	.1	99.6
44	44	.1	99.6
48	48	.1	99.7
55	55	.1	99.8
56	56	.1	99.8
67	67	.1	99.9
72	72	.1	100.0
Total	82033	100.0	

Table 4

Total Visits to the ED in 2009/10 by Frequency of Visits per Unique Patient in an Annual Period

Number of Visits in Annual Period	Total Number of Visits	Percent	Cumulative Percent
1	30755	30.2	30.2
2	21030	20.7	50.9
3	13887	13.6	64.5
4	8572	8.4	72.9
5	6535	6.4	79.4
6	4410	4.3	83.7
7	2926	2.9	86.6
8	2376	2.3	88.9
9	1998	2.0	90.9
10	1630	1.6	92.5
11	1100	1.1	93.5
12	648	.6	94.2
13	806	.8	95.0
14	770	.8	95.7
15	420	.4	96.1
16	528	.5	96.7
17	306	.3	97.0
18	288	.3	97.2
19	190	.2	97.4
20	320	.3	97.7
21	105	.1	97.8
22	220	.2	98.1
23	161	.2	98.2
24	168	.2	98.4
25	225	.2	98.6
26	26	.0	98.6
27	135	.1	98.8
28	28	.0	98.8
29	87	.1	98.9

Number of Visits in Annual Period	Total Number of Visits	Percent	Cumulative Percent
30	90	.1	99.0
31	93	.1	99.1
33	33	.0	99.1
34	68	.1	99.2
36	36	.0	99.2
38	38	.0	99.2
39	78	.1	99.3
40	40	.0	99.3
41	82	.1	99.4
42	84	.1	99.5
43	43	.0	99.6
44	44	.0	99.6
45	45	.0	99.6
46	46	.0	99.7
48	48	.0	99.7
49	49	.0	99.8
50	50	.0	99.8
54	54	.1	99.9
56	56	.1	99.9
62	62	.1	100.0
Total	101789	100.0	

Table 5

Patient's Family Physician Status by Total Visits to the ED

	Visits		% of Total	
	2004/05	2009/10	2004/05	2009/10
Yes, visit has family physician or clinic associated with it	63481	77193	77.4	75.8
No, visit does not have family physician or clinic associated	18552	24596	22.6	24.2
Total	82033	101789	100.0	100.0

Table 6

Family Physician Status by Unique Patient with a Visit to the ED in an Annual Period

	Patients		% of Total	
	2004/05	2009/10	2004/05	2009/10
Yes, patient has family physician or clinic listed	35149	39993	77.6	77.4
No, patient does not family physician or clinic listed	10167	11659	22.4	22.6
Total	45316	51652	100.0	100.0

Table 7

MCCs of the MRDs Associated With Each Visit to the ED in an Annual Period

		Visits			
		2004/05	2009/10	Change	% Change
Diseases and disorders of the nervous system	Count	2766	3281	515	18.62%
	% within Dataset	3.4%	3.2%	-0.20%	-5.88%
Diseases and disorders of the eye	Count	2525	2616	91	3.60%
	% within Dataset	3.1%	2.6%	-0.50%	-16.13%
Diseases and disorders of the ear, nose, throat and mouth	Count	9653	12759	3106	32.18%
	% within Dataset	11.8%	12.5%	0.70%	5.93%
Diseases and disorders of the respiratory system	Count	4974	6208	1234	24.81%
	% within Dataset	6.1%	6.1%	0.00%	0.00%
Diseases and disorders of the circulatory system	Count	6386	7421	1035	16.21%
	% within Dataset	7.8%	7.3%	-0.50%	-6.41%
Diseases and disorders of the digestive system	Count	7924	10178	2254	28.45%
	% within Dataset	9.7%	10.0%	0.30%	3.09%
Diseases and disorders of the hepatobiliary system and pancreas system	Count	599	983	384	64.11%
	% within Dataset	.7%	1.0%	0.30%	42.86%
Diseases and disorders of the musculoskeletal system and connective tissue	Count	8354	9576	1222	14.63%
	% within Dataset	10.2%	9.4%	-0.80%	-7.84%
Diseases and disorders of the skin, subcutaneous tissue and breast	Count	6651	9160	2509	37.72%
	% within Dataset	8.1%	9.0%	0.90%	11.11%
Diseases and disorders of the endocrine system, nutrition and metabolism	Count	726	839	113	15.56%
	% within Dataset	.9%	.8%	-0.10%	-11.11%
Diseases and disorders of the kidney, urinary tract & male reproductive system	Count	3894	4998	1104	28.35%
	% within Dataset	4.7%	4.9%	0.20%	4.26%
Diseases and disorders of the female reproductive system	Count	602	777	175	29.07%
	% within Dataset	.7%	.8%	0.10%	14.29%
Pregnancy and	Count	625	910	285	45.60%

		Visits			
		2004/05	2009/10	Change	% Change
childbirth	% within Dataset	.8%	.9%	0.10%	12.50%
Diseases and disorders of the blood and lymphatic system	Count	2529	3991	1462	57.81%
	% within Dataset	3.1%	3.9%	0.80%	25.81%
Multisystemic or unspecified site infections	Count	1428	2351	923	64.64%
	% within Dataset	1.7%	2.3%	0.60%	35.29%
Mental diseases & disorders	Count	3124	3923	799	25.58%
	% within Dataset	3.8%	3.9%	0.10%	2.63%
Burns	Count	308	265	-43	-13.96%
	% within Dataset	.4%	.3%	-0.10%	-25.00%
Significant trauma, injury, poisoning & toxic effects of drugs	Count	13434	14077	643	4.79%
	% within Dataset	16.4%	13.8%	-2.60%	-15.85%
Other reasons for hospitalization	Count	2205	3027	822	37.28%
	% within Dataset	2.7%	3.0%	0.30%	11.11%
Miscellaneous CMG & ungroupable data	Count	3291	4440	1149	34.91%
	% within Dataset	4.0%	4.4%	0.40%	10.00%

Table 8

Top 25 MRDs from 2004/05 by Frequency of Visits to the ED

MRD	Frequency	Percent	Cumulative Percent
Acute URTI unspecified	2908	3.5	3.5
Chest pain unspecified	2136	2.6	6.1
Other chemotherapy	2105	2.6	8.7
Other and unspecified abdominal pain	2058	2.5	11.2
Urinary tract infection site not spec	1808	2.2	13.4
Attention to surg dressings & sutures	1352	1.6	15.1
Otitis media unspecified	1313	1.6	16.7
Acute pharyngitis unspecified	1171	1.4	18.1
Opn wnd finger w/o damage nail, uncomp	1081	1.3	19.4
Pneumonia unspecified	993	1.2	20.6
Noninfect gastroenteritis & colitis NOS	931	1.1	21.8
Asthma, unspec w/o st status asthmaticus	853	1.0	22.8
Low back pain	822	1.0	23.8
Other chest pain	805	1.0	24.8
Bronchitis not spec as acute or chronic	634	.8	25.6
Dizziness and giddiness	622	.8	26.3
Depressive episode unspecified	606	.7	27.1
Sprain and strain of ankle, unspecified	606	.7	27.8
Headache	602	.7	28.5
Unspecified injury of head	573	.7	29.2
Pain in lower limb	542	.7	29.9
Dyspnea	517	.6	30.5
Viral infection unspecified	501	.6	31.1
Fever unspecified	496	.6	31.7
Open wounds oth parts head, uncomplicate	495	.6	32.3
Total	26530	32.3	

Table 9

Top 25 MRDs from 2009/10 by Frequency of Visits to the ED

MRD	Frequency	Percent	Cumulative Percent
Acute URTI unspecified	4023	4.0	4.0
Other chemotherapy	3385	3.3	7.3
Other and unspecified abdominal pain	2648	2.6	9.9
Urinary tract infection site not spec	2570	2.5	12.4
Attention to surg dressings & sutures	2178	2.1	14.5
Chest pain unspecified	2036	2.0	16.5
Gastroe & colitis of unspec origin	1719	1.7	18.2
Pneumonia unspecified	1513	1.5	19.7
Otitis media unspecified	1414	1.4	21.1
Low back pain	1358	1.3	22.4
Other chest pain	1351	1.3	23.8
Viral infection unspecified	1302	1.3	25.0
Acute pharyngitis unspecified	1232	1.2	26.3
Unspecified injury of head	1148	1.1	27.4
Opn wnd finger w/o damage nail, uncomp	1118	1.1	28.5
Pain in lower limb	944	.9	29.4
Headache	779	.8	30.2
Cellulitis of lower limb	776	.8	30.9
Dizziness and giddiness	772	.8	31.7
Ment/beh disrd dt alcohol use ac intox	720	.7	32.4
Bronchitis not spec as acute or chronic	716	.7	33.1
Issue of repeat prescription	669	.7	33.8
Dorsalgia, unspecified site	648	.6	34.4
Dyspnea	639	.6	35.0
Sprain and strain of ankle, unspecified	638	.6	35.7
Total	36296	35.7	

Table 10

Visits to the ED by Patients' Region of Residence, 2004/05

		Frequency	Percent	Cumulative Percent
Valid	City of Thunder Bay	70558	86.0	86.1
	Other NW LHIN	9119	11.1	97.3
	NE LHIN	358	.4	100.0
	Other Ontario	796	1.0	98.2
	Out of province	973	1.2	99.4
	Out of country - US	94	.1	99.5
	Out of country - Other	31	.0	99.6
	Total	81929	99.9	
Missing	System	104	.1	
Total		82033	100.0	

Table 11

Visits to the ED by Patients' Region of Residence, 2009/10

		Frequency	Percent	Cumulative Percent
Valid	City of Thunder Bay	88612	87.1	87.2
	Other NW LHIN	11003	10.8	98.0
	NE LHIN	334	.3	100.0
	Other Ontario	752	.7	98.8
	Out of province	791	.8	99.5
	Out of country - US	91	.1	99.6
	Out of country - Other	41	.0	99.7
	Total	101624	99.8	
Missing	System	165	.2	
Total		101789	100.0	

Table 12

Visits to the ED by Hour of Service, 2004/05

Service Hour	Frequency	Percent	Cumulative Percent
0	1950	2.4	2.4
1	1469	1.8	4.2
2	1236	1.5	5.7
3	1050	1.3	7.0
4	954	1.2	8.1
5	832	1.0	9.1
6	1015	1.2	10.4
7	1875	2.3	12.7
8	3368	4.1	16.8
9	4450	5.4	22.2
10	5387	6.6	28.8
11	5086	6.2	35.0
12	5264	6.4	41.4
13	5468	6.7	48.0
14	4907	6.0	54.0
15	4605	5.6	59.6
16	4635	5.7	65.3
17	4429	5.4	70.7
18	4836	5.9	76.6
19	4967	6.1	82.6
20	4336	5.3	87.9
21	4020	4.9	92.8
22	3350	4.1	96.9
23	2544	3.1	100.0
Total	82033	100.0	

Table 13

Visits to the ED by Hour of Service, 2009/10

Service Hour	Frequency	Percent	Cumulative Percent
0	2295	2.3	2.3
1	1692	1.7	3.9
2	1441	1.4	5.3
3	1245	1.2	6.6
4	1117	1.1	7.7
5	1061	1.0	8.7
6	1301	1.3	10.0
7	2776	2.7	12.7
8	4630	4.5	17.2
9	5897	5.8	23.0
10	6585	6.5	29.5
11	6340	6.2	35.7
12	6338	6.2	42.0
13	6696	6.6	48.5
14	6326	6.2	54.8
15	6025	5.9	60.7
16	5857	5.8	66.4
17	5601	5.5	71.9
18	5788	5.7	77.6
19	5831	5.7	83.4
20	5064	5.0	88.3
21	4633	4.6	92.9
22	4096	4.0	96.9
23	3154	3.1	100.0
Total	101789	100.0	

Table 14

Mean Ages of Frequent and Non-Frequent Users of the ED for 2004/05 and 2009/10 by Unique Patient

	2004/05			2009/10		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Non-Frequent	42952	37.32	23.610	48031	38.74	24.023
Frequent	2355	42.54	23.800	3610	43.11	24.023
			P<.001			P<.001
			t(45305)=-10.432			t(51639)=-10.523

** Levene's test was not significant in both years data, p>.05*

Table 15

Chi-Square Analysis of Frequent and Non-Frequent Users of the ED by Age Group

		2004/05			2009/10		
		Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
< 10 years of age	Count	5481	215	5696	5740	305	6045
	% within Frequent_User	12.8%	9.1%	12.6%	12.0%	8.4%	11.7%
10-19 years of age	Count	6096	197	6293	6496	293	6789
	% within Frequent_User	14.2%	8.4%	13.9%	13.5%	8.1%	13.1%
20-29 years of age	Count	6748	359	7107	7603	605	8208
	% within Frequent_User	15.7%	15.2%	15.7%	15.8%	16.8%	15.9%
30-39 years of age	Count	5560	342	5902	5671	491	6162
	% within Frequent_User	12.9%	14.5%	13.0%	11.8%	13.6%	11.9%
40-49 years of age	Count	6045	374	6419	6134	515	6649
	% within Frequent_User	14.1%	15.9%	14.2%	12.8%	14.3%	12.9%
50-59 years of age	Count	4733	272	5005	6036	430	6466
	% within Frequent_User	11.0%	11.5%	11.0%	12.6%	11.9%	12.5%
60-69 years of age	Count	3046	175	3221	4195	323	4518
	% within Frequent_User	7.1%	7.4%	7.1%	8.7%	8.9%	8.7%

		2004/05			2009/10		
		Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
70-79 years of age	Count	2944	248	3192	3191	328	3519
	% within Frequent_User	6.9%	10.5%	7.0%	6.6%	9.1%	6.8%
80-89 years of age	Count	1946	141	2087	2428	276	2704
	% within Frequent_User	4.5%	6.0%	4.6%	5.1%	7.6%	5.2%
90+ years of age	Count	353	32	385	537	44	581
	% within Frequent_User	.8%	1.4%	.8%	1.1%	1.2%	1.1%
Totals	Count	42952	2355	45307	48031	3610	51641
	% within Frequent_User	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 16

Chi-Square of Frequent and Non-Frequent Users of the ED by Family Physician Status

		2004/05			2009/10		
		Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
Yes, has familiy physician	Count	49897	13584	63481	57194	19999	77193
	% within Frequent_User	77.4%	77.2%	77.4%	77.0%	72.6%	75.8%
No family physician listed	Count	14532	4020	18552	17050	7546	24596
	% within Frequent_User	22.6%	22.8%	22.6%	23.0%	27.4%	24.2%
Total	Count	64429	17604	82033	74244	27545	101789
	% within Frequent_User	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 17

Chi-Square of Frequent and Non-Frequent Users of the ED by MCC

		2004/05			2009/10		
		Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
Diseases and disorders of the nervous system	Count	2040	726	2766	2444	837	3281
	% within Frequent_User	3.2%	4.1%	3.4%	3.3%	3.0%	3.2%
Diseases and disorders of the eye	Count	2322	203	2525	2293	323	2616
	% within Frequent_User	3.6%	1.2%	3.1%	3.1%	1.2%	2.6%
Diseases and disorders of the ear, nose, throat and mouth	Count	8187	1466	9653	10400	2359	12759
	% within Frequent_User	12.7%	8.3%	11.8%	14.0%	8.6%	12.5%
Diseases and disorders of the respiratory system	Count	3891	1083	4974	4719	1489	6208
	% within Frequent_User	6.0%	6.2%	6.1%	6.4%	5.4%	6.1%
Diseases and disorders of the circulatory system	Count	5110	1276	6386	5601	1820	7421
	% within Frequent_User	7.9%	7.3%	7.8%	7.5%	6.6%	7.3%
Diseases and disorders of the digestive system	Count	6136	1788	7924	7265	2913	10178
	% within Frequent_User	9.5%	10.2%	9.7%	9.8%	10.6%	10.0%
Diseases and disorders of the	Count	424	175	599	669	314	983

		2004/05			2009/10		
		Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
hepatobiliary system and pancreas system	% within Frequent_User	.7%	1.0%	.7%	.9%	1.1%	1.0%
Diseases and disorders of the musculoskeletal system and connective tissue	Count	6999	1355	8354	7386	2190	9576
	% within Frequent_User	10.9%	7.7%	10.2%	9.9%	8.0%	9.4%
Diseases and disorders of the skin, subcutaneous tissue and breast	Count	5438	1213	6651	6831	2329	9160
	% within Frequent_User	8.4%	6.9%	8.1%	9.2%	8.5%	9.0%
Diseases and disorders of the endocrine system, nutrition and metabolism	Count	532	194	726	566	273	839
	% within Frequent_User	.8%	1.1%	.9%	.8%	1.0%	.8%
Diseases and disorders of the kidney, urinary tract & male reproductive system	Count	2965	929	3894	3663	1335	4998
	% within Frequent_User	4.6%	5.3%	4.7%	4.9%	4.8%	4.9%
Diseases and disorders of the female reproductive system	Count	503	99	602	625	152	777
	% within Frequent_User	.8%	.6%	.7%	.8%	.6%	.8%
Pregnancy and childbirth	Count	527	98	625	656	254	910
	% within Frequent_User	.8%	.6%	.8%	.9%	.9%	.9%
Diseases and disorders of the blood and lymphatic system	Count	793	1736	2529	941	3050	3991
	% within Frequent_User	1.2%	9.9%	3.1%	1.3%	11.1%	3.9%

		2004/05			2009/10		
		Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
Multisystemic or unspecified site infections	Count	1209	219	1428	1923	428	2351
	% within Frequent_User	1.9%	1.2%	1.7%	2.6%	1.6%	2.3%
Mental diseases & disorders	Count	1728	1396	3124	2126	1797	3923
	% within Frequent_User	2.7%	7.9%	3.8%	2.9%	6.5%	3.9%
Burns	Count	262	46	308	203	62	265
	% within Frequent_User	.4%	.3%	.4%	.3%	.2%	.3%
Significant trauma, injury, poisoning & toxic effects of drugs	Count	11860	1574	13434	11884	2193	14077
	% within Frequent_User	18.4%	8.9%	16.4%	16.0%	8.0%	13.8%
Other reasons for hospitalization	Count	1500	705	2205	1925	1102	3027
	% within Frequent_User	2.3%	4.0%	2.7%	2.6%	4.0%	3.0%
Miscellaneous CMG & ungroupable data	Count	1977	1314	3291	2119	2321	4440
	% within Frequent_User	3.1%	7.5%	4.0%	2.9%	8.4%	4.4%
Total	Count	64403	17595	81998	74239	27541	101780
	% within Frequent_User	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
				p<.001			p<.001

	2004/05			2009/10		
	Non-Frequent	Frequent	Total	Non-Frequent	Frequent	Total
			chi sq. (n=81998, df=1)=6739.725			chi sq. (n=101780, df=1)=9202.315

Table 18

Parameter Estimates on GEE Analysis of Predictors of the Number of Visits per Person (Per Visit)

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	1.328	.0328	1.263	1.392	1642.577	1	.000
Diseases and disorders of the nervous system	.346	.0572	.234	.458	36.627	1	.000
Diseases and disorders of the eye	-.186	.0347	-.254	-.118	28.633	1	.000
Diseases and disorders of the ear, nose, throat and mouth	.117	.0309	.057	.178	14.395	1	.000
Diseases and disorders of the respiratory system	.251	.0410	.170	.331	37.441	1	.000
Diseases and disorders of the circulatory system	.185	.0372	.112	.258	24.777	1	.000
Diseases and disorders of the digestive system	.362	.0466	.270	.453	60.230	1	.000
Diseases and disorders of the hepatobiliary system and pancreas system	.410	.0745	.264	.556	30.369	1	.000
Diseases and disorders of the musculoskeletal system and connective tissue	.198	.0315	.136	.260	39.346	1	.000
Diseases and disorders of the skin, subcutaneous tissue and breast	.193	.0295	.136	.251	43.104	1	.000
Diseases and disorders of the endocrine system, nutrition and metabolism	.366	.0536	.260	.471	46.436	1	.000

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
Diseases and disorders of the kidney, urinary tract & male reproductive system	.211	.0415	.130	.293	25.949	1	.000
Diseases and disorders of the female reproductive system	.080	.0570	-.031	.192	1.994	1	.158
Pregnancy and childbirth	.105	.0710	-.034	.244	2.181	1	.140
Diseases and disorders of the blood and lymphatic system	.820	.0424	.737	.903	373.634	1	.000
Multisystemic or unspecified site infections	.095	.0329	.031	.159	8.341	1	.004
Mental diseases & disorders	.884	.0607	.765	1.003	212.246	1	.000
Burns	.085	.0601	-.033	.203	2.010	1	.156
Significant trauma, injury, poisoning & toxic effects of drugs	0[a]	.	.	.	.	.	.
Year	.039	.0202	.000	.079	3.776	1	.052
Month	.012	.0065	-.001	.025	3.541	1	.060
Month (quadratic)	-.001	.0005	-.002	.000	1.842	1	.175
Hour	-.022	.0048	-.032	-.013	22.005	1	.000
Hour (quadratic)	.001	.0002	.001	.001	28.212	1	.000
Age	.018	.0022	.014	.022	64.038	1	.000
Age (quadratic)	.000	<.001	.000	.000	45.013	1	.000
Sex	-.083	.0350	-.152	-.015	5.694	1	.017
CTAS level	-.005	.0096	-.024	.014	.300	1	.584

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
Family Doctor (Y/N)	.081	.0358	.011	.151	5.119	1	.024
Reside in Thunder Bay (Y/N)	.410	.0399	.332	.488	105.595	1	.000
Age * Sex	.003	.0008	.001	.004	14.691	1	.000
Age * CTAS level	.002	.0014	-.001	.005	2.516	1	.113
Age (quadratic) * CTAS level	<.001	<.001	-<.001	<.001	.244	1	.621
Sex * CTAS level	.014	.0226	-.031	.058	.366	1	.545
(Scale)	1.552						

a. set to zero because this parameter is redundant

Table 19

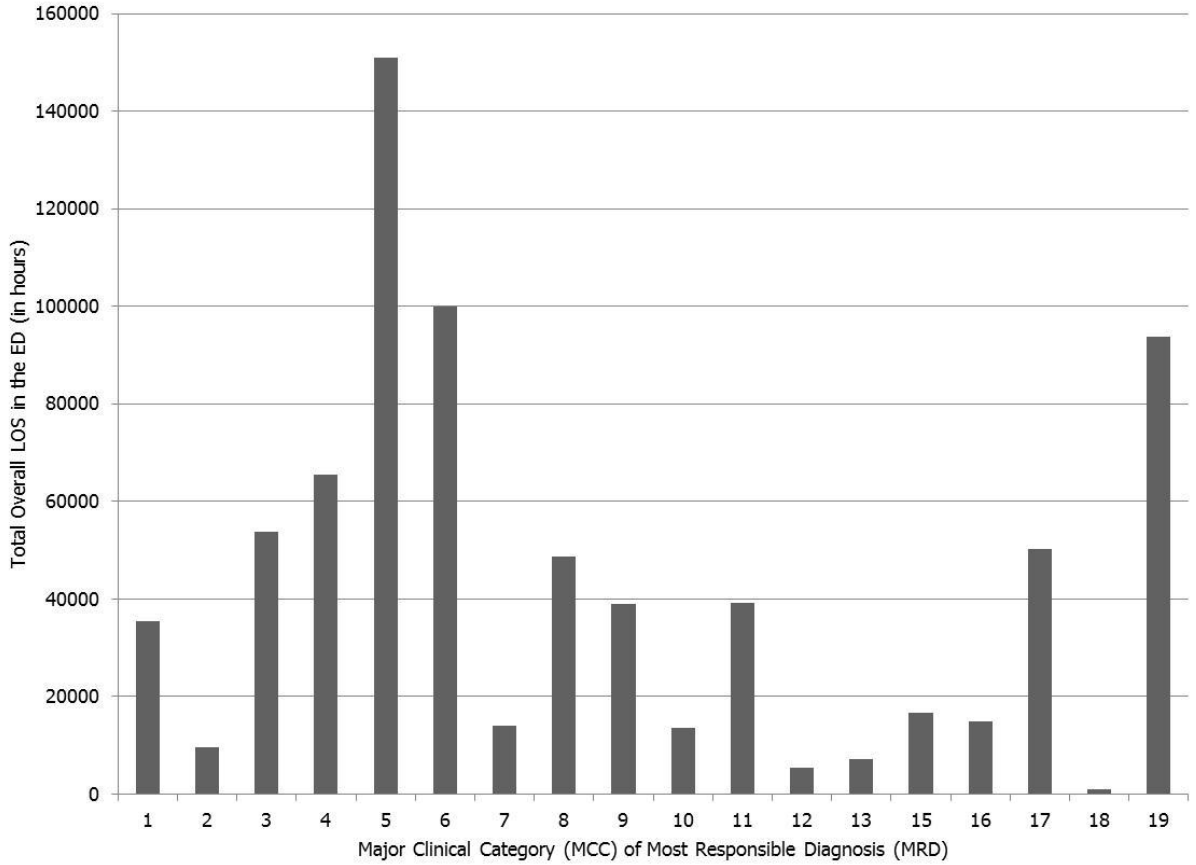
Parameter Estimates on GEE Analysis of Predictors of Overall ED LOS per Visit

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Parameter	B	Std. Error
(Intercept)	1.170	.0117	1.147	1.193	9937.323	1	.000
Diseases and disorders of the nervous system	.265	.0436	.180	.351	36.973	1	.000
Diseases and disorders of the eye	-.512	.0167	-.545	-.480	944.433	1	.000
Diseases and disorders of the ear, nose, throat and mouth	-.215	.0221	-.258	-.171	94.242	1	.000
Diseases and disorders of the respiratory system	.260	.0214	.218	.302	146.443	1	.000
Diseases and disorders of the circulatory system	.590	.0201	.551	.630	866.004	1	.000
Diseases and disorders of the digestive system	.355	.0149	.326	.385	569.758	1	.000
Diseases and disorders of the hepatobiliary system and pancreas system	.726	.0340	.660	.793	456.893	1	.000
Diseases and disorders of the musculoskeletal system and connective tissue	-.155	.0135	-.181	-.128	131.328	1	.000
Diseases and disorders of the skin, subcutaneous tissue and breast	-.184	.0148	-.213	-.155	152.964	1	.000
Diseases and disorders of the endocrine system, nutrition and metabolism	.588	.0403	.509	.667	213.424	1	.000
Diseases and disorders of the kidney, urinary tract & male reproductive system	.104	.0187	.068	.141	31.040	1	.000

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Parameter	B	Std. Error
Diseases and disorders of the female reproductive system	.236	.0227	.191	.280	108.189	1	.000
Pregnancy and childbirth	.397	.0235	.351	.443	285.180	1	.000
Diseases and disorders of the blood and lymphatic system	-.197	.0180	-.233	-.162	120.501	1	.000
Multisystemic or unspecified site infections	.172	.0389	.096	.248	19.519	1	.000
Mental diseases & disorders	.718	.0229	.673	.763	984.473	1	.000
Burns	-.504	.0534	-.609	-.400	89.161	1	.000
Significant trauma, injury, poisoning & toxic effects of drugs	0[a]	.	.	.	.	.	.
Year	-.043	.0049	-.052	-.033	78.196	1	.000
Month	-.008	.0044	-.017	.001	3.192	1	.074
Month (quadratic)	.000	.0003	-.001	.000	.728	1	.394
Hour	-.002	.0024	-.007	.002	.892	1	.345
Hour (quadratic)	-<.001	.0001	.000	.000	.104	1	.747
Age	.006	.0007	.005	.007	71.602	1	.000
Age (quadratic)	<.001	<.001	<.001	<.001	30.592	1	.000
Sex	-.016	.0085	-.033	.000	3.709	1	.054
CTAS level	-.395	.0072	-.409	-.381	3047.926	1	.000
Family Doctor (Y/N)	.032	.0096	.013	.051	10.981	1	.001
Reside in Thunder Bay (Y/N)	-.063	.0137	-.090	-.036	20.910	1	.000
Age * Sex	-<.001	.0003	-.001	.001	.008	1	.929

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Parameter	B	Std. Error
Age * CTAS level	-.003	.0002	-.004	-.003	233.416	1	.000
Sex * CTAS level	-.027	.0118	-.050	-.004	5.259	1	.022
(Scale)	2.901						

a. set to zero because this parameter is redundant



1	Diseases and disorders of the nervous system
2	Diseases and disorders of the eye
3	Diseases and disorders of the ear, nose, throat and mouth
4	Diseases and disorders of the respiratory system
5	Diseases and disorders of the circulatory system
6	Diseases and disorders of the digestive system
7	Diseases and disorders of the hepatobiliary system and pancreas system
8	Diseases and disorders of the musculoskeletal system and connective tissue
9	Diseases and disorders of the skin, subcutaneous tissue and breast
10	Diseases and disorders of the endocrine system, nutrition and metabolism
11	Diseases and disorders of the kidney, urinary tract & male reproductive system
12	Diseases and disorders of the female reproductive system
13	Pregnancy and childbirth
15	Diseases and disorders of the blood and lymphatic system
16	Multisystemic or unspecified site infections
17	Mental diseases & disorders
18	Burns
19	Significant trauma, injury, poisoning & toxic effects of drugs
20	Other reasons for hospitalization
99	Miscellaneous CMG & Ungroupable Data

Figure 1. Total ED Overall LOS by MCC

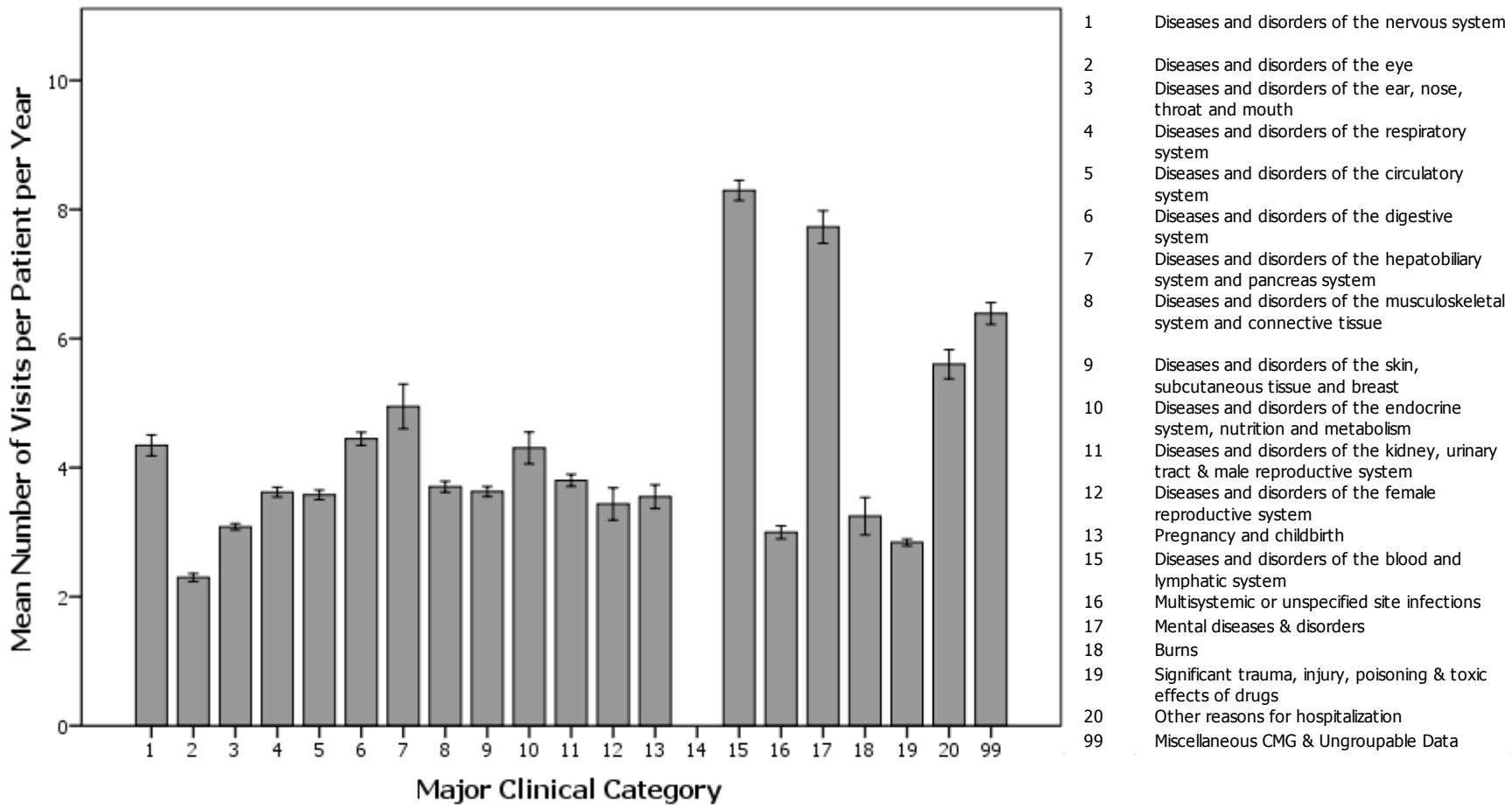


Figure 2. Mean Annual Number of Visits per Patient by MCC of MRD

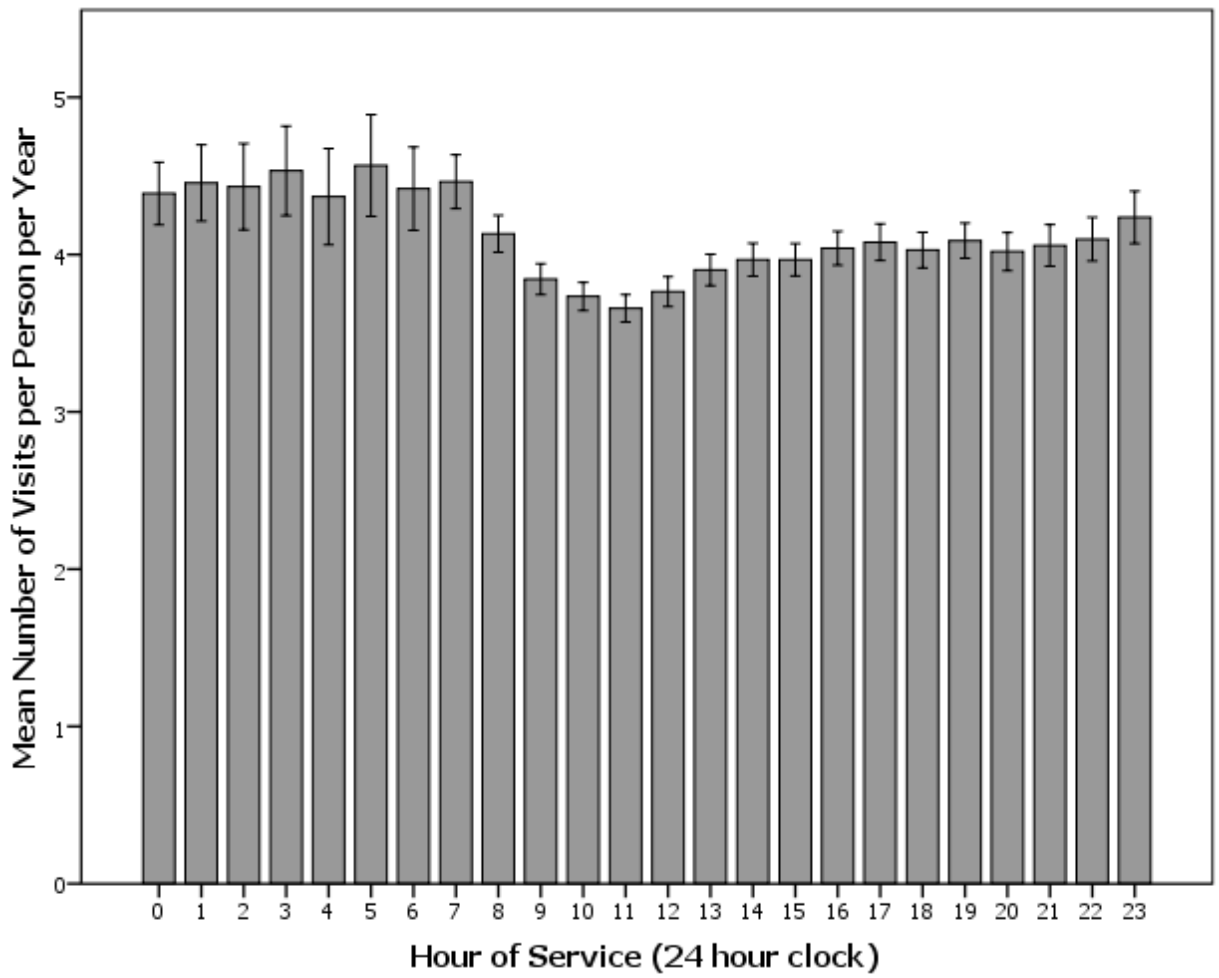


Figure 3. Mean Number of Visits per Year by Service Hour

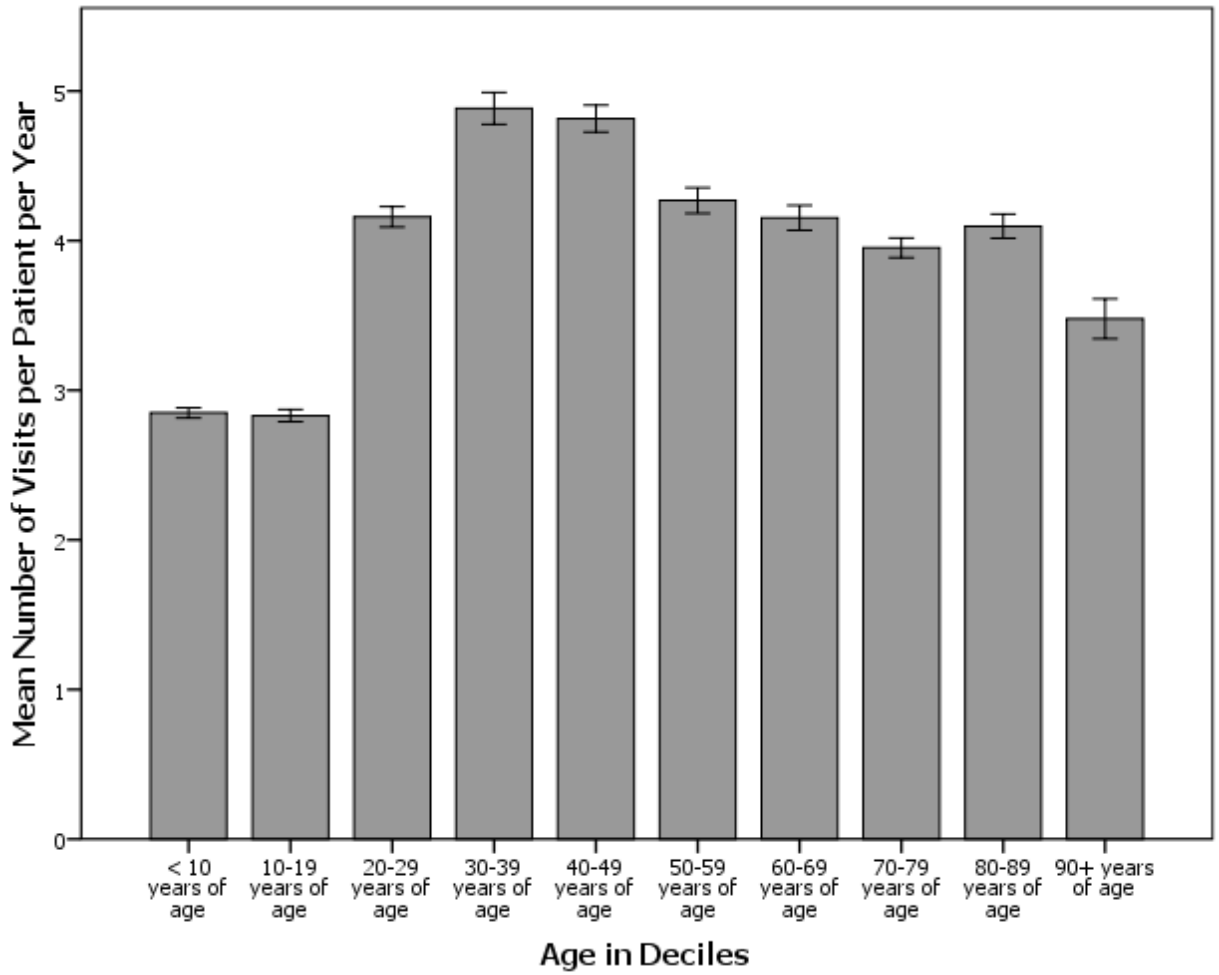
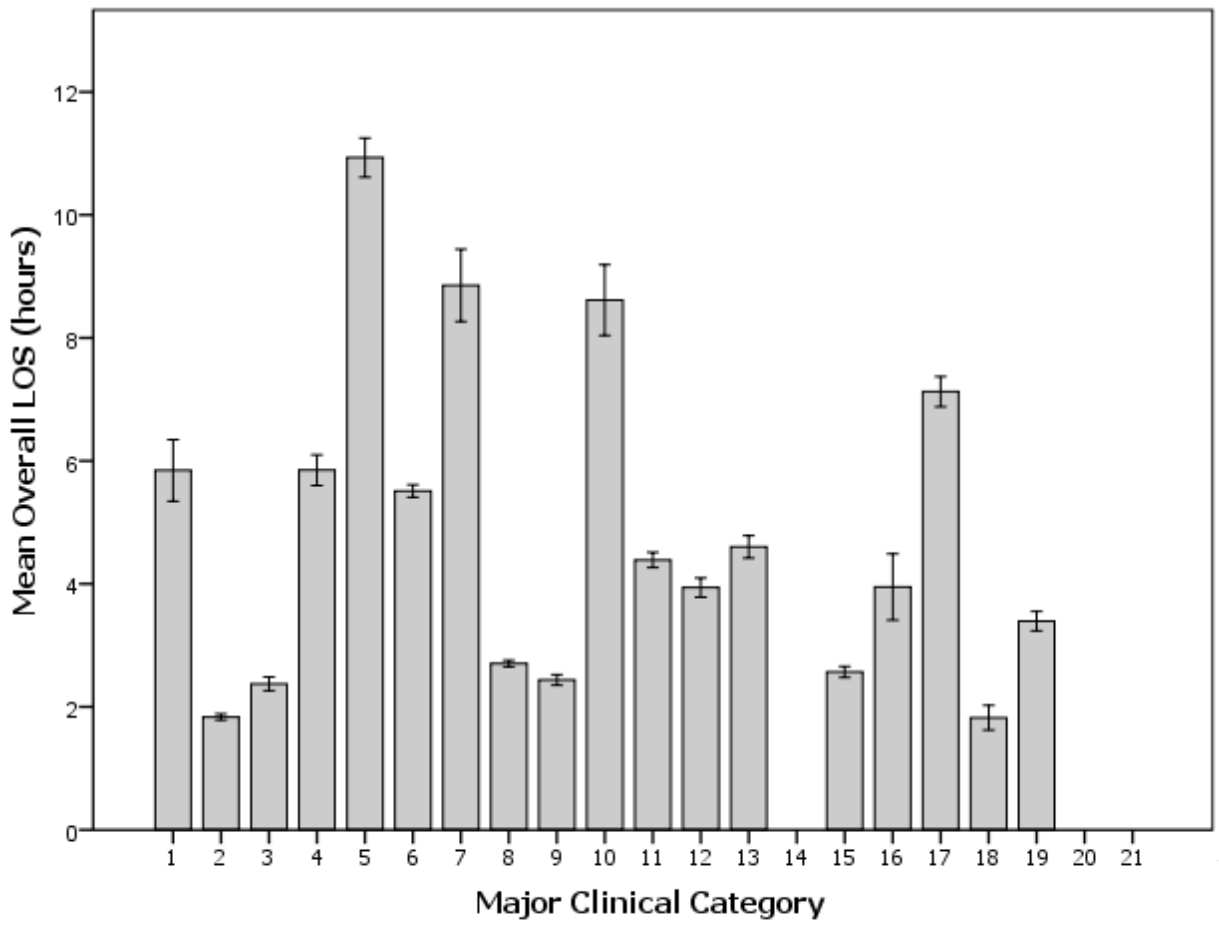


Figure 4. Mean Number of Visits Per Patient, Per Year by Age Decile



1	Diseases and disorders of the nervous system
2	Diseases and disorders of the eye
3	Diseases and disorders of the ear, nose, throat and mouth
4	Diseases and disorders of the respiratory system
5	Diseases and disorders of the circulatory system
6	Diseases and disorders of the digestive system
7	Diseases and disorders of the hepatobiliary system and pancreas system
8	Diseases and disorders of the musculoskeletal system and connective tissue
9	Diseases and disorders of the skin, subcutaneous tissue and breast
10	Diseases and disorders of the endocrine system, nutrition and metabolism
11	Diseases and disorders of the kidney, urinary tract & male reproductive system
12	Diseases and disorders of the female reproductive system
13	Pregnancy and childbirth
15	Diseases and disorders of the blood and lymphatic system
16	Multisystemic or unspecified site infections
17	Mental diseases & disorders
18	Burns
19	Significant trauma, injury, poisoning & toxic effects of drugs
20	Other reasons for hospitalization
99	Miscellaneous CMG & Ungroupable Data

Figure 5. Mean Overall LOS by Major Clinical Category (MCC) of Most Responsible Diagnosis (MRD)

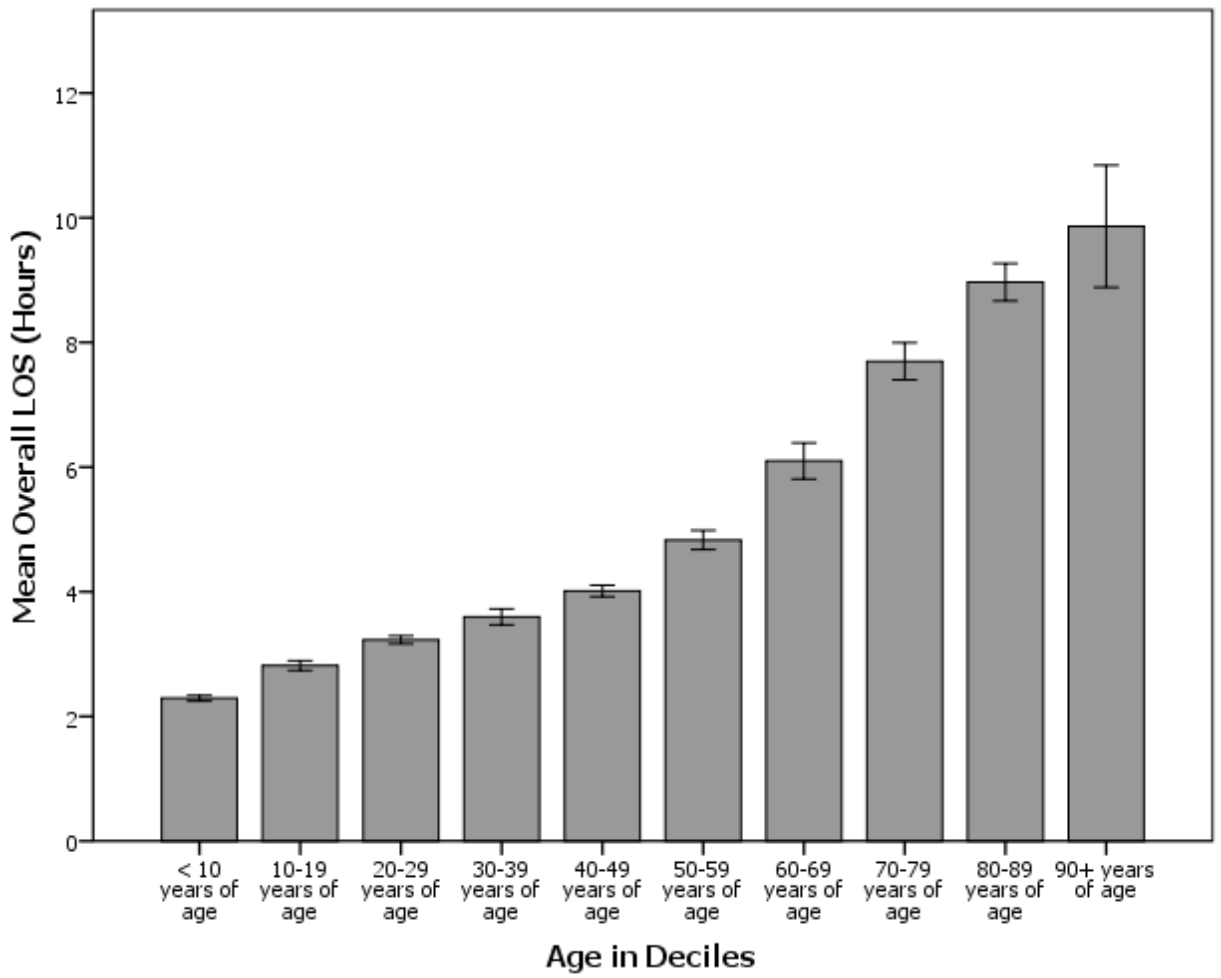


Figure 6. Mean Overall ED LOS by Age Decile

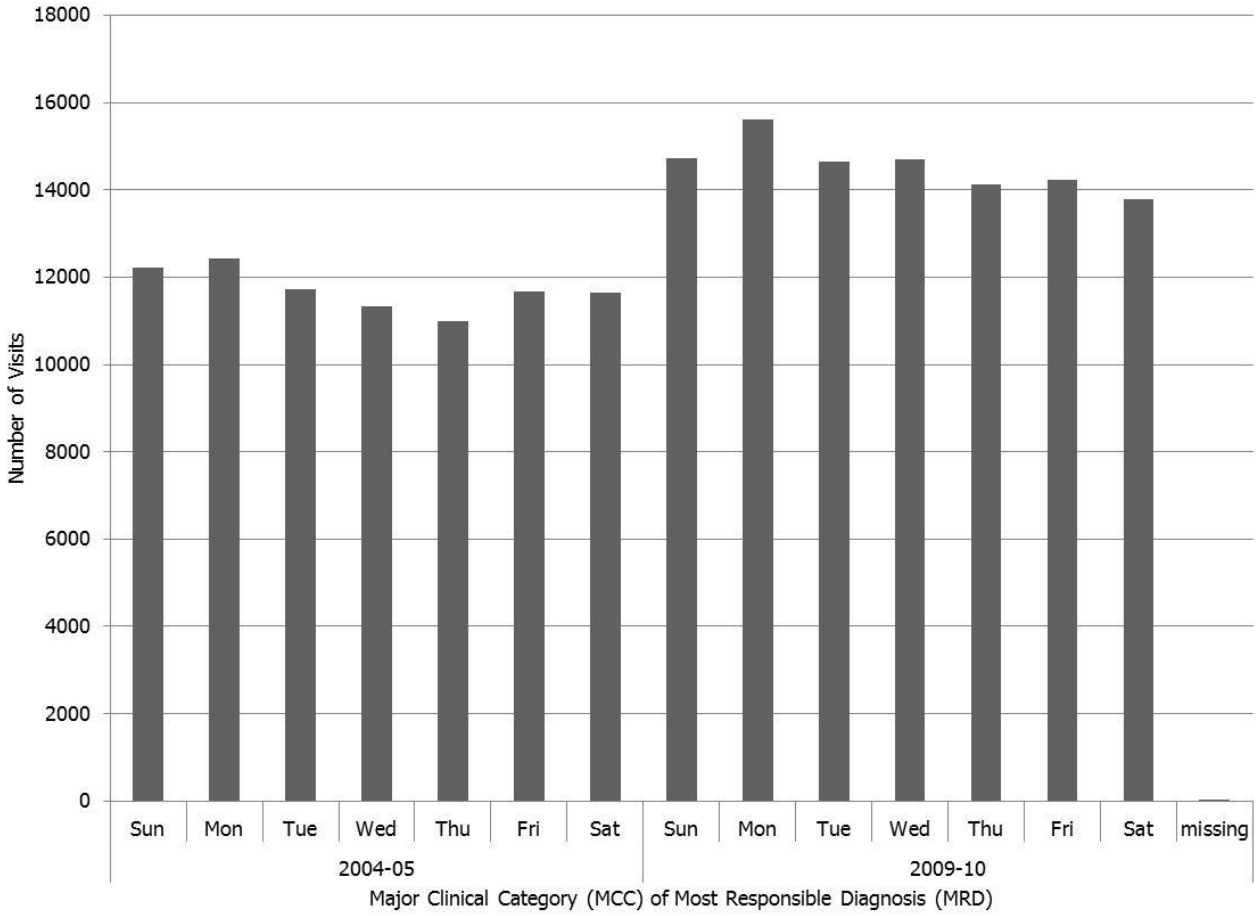


Figure 7. Total Number of Visits per Day per Year