FACTORS AFFECTING EMERGENCY DEPARTMENT WAITING ROOM TIMES IN WINNIPEG

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ABOUT THE MANITOBA CENTRE FOR HEALTH POLICY

The Manitoba Centre for Health Policy (MCHP) is located within the Department of Community Health Sciences, College of Medicine, Rady Faculty of Health Sciences, University of Manitoba. The mission of MCHP is to provide accurate and timely information to healthcare decision–makers, analysts and providers, so they can offer services which are effective and efficient in maintaining and improving the health of Manitobans. Our researchers rely upon the unique Manitoba Population Research Data Repository (Repository) to describe and explain patterns of care and profiles of illness and to explore other factors that influence health, including income, education, employment, and social status. This Repository is unique in terms of its comprehensiveness, degree of integration, and orientation around an anonymized population registry.

Members of MCHP consult extensively with government officials, healthcare administrators, and clinicians to develop a research agenda that is topical and relevant. This strength, along with its rigorous academic standards, enables MCHP to contribute to the health policy process. MCHP undertakes several major research projects, such as this one, every year under contract to Manitoba Health, Seniors and Active Living. In addition, our researchers secure external funding by competing for research grants. We are widely published and internationally recognized. Further, our researchers collaborate with a number of highly respected scientists from Canada, the United States, Europe, and Australia.

We thank the University of Manitoba, Rady Faculty of Health Sciences, Max Rady College of Medicine, Health Research Ethics Board for their review of this project. MCHP complies with all legislative acts and regulations governing the protection and use of sensitive information. We implement strict policies and procedures to protect the privacy and security of anonymized data used to produce this report and we keep the provincial Health Information Privacy Committee informed of all work undertaken for Manitoba Health, Seniors and Active Living.

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We acknowledge the University of Manitoba Health Research Ethics Board for their review of the proposed research projects. The Health Information Privacy Committee (HIPC) is kept informed of all MCHP deliverables. The HIPC numbers for the two projects represented in this report are 2010/11-36 and 2013/2014-45. We also acknowledge Manitoba Health, Seniors and Active Living, as well as the Winnipeg Regional Health Authority for the use of their data.

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ACRONYMS

ADT	Admission, Discharge, and Transfer
ALC	Alternate Level of Care
CAEP	Canadian Association of Emergency Physicians
CT	Computed Tomography
CTAS	Canadian Emergency Department Triage & Acuity Scale
ED	Emergency Department
EDIS	Emergency Department Information System
ENT	Ear; Nose; Throat/Mouth/Neck
HIPC	Health Information Privacy Committee
HSC	Health Sciences Centre
ICD	International Classification of Disease
ICU	Intensive Care Unit
IQR	Inter-Quartile Range
LWBS	Left Without Being Seen
MCHP	Manitoba Centre for Health Policy
MRI	Magnetic Resonance Imaging
PCH	Personal Care Home
PHIN	Personal Health Identification Number

EXECUTIVE SUMMARY

Background Information, Study Purpose, and Research Questions

The Canadian Association of Emergency Physicians (CAEP) recommends that higher acuity patients who are not subsequently hospitalized should have a median Emergency Department (ED) visit duration of at most 4 hours, and a 90th percentile visit duration of 8 hours. ED visit durations in Winnipeg far surpass this recommendation, and ED wait times in this region are similarly amongst the longest in Canada. Understanding the factors affecting ED wait times is a first step in developing more effective reform strategies.

The determinants of ED wait times include *input* (e.g., the volume of incoming patients), *throughput* (e.g., provider supply, the number and type of diagnostic tests being performed), and *output* (e.g., the number of ED patients waiting for hospital admission) factors. Scientists have concluded that ED wait times are most strongly influenced by output factors, arguing that the inability to transfer patients into hospital 'backs up' EDs, so that incoming patients have nowhere to go. The solutions put forward to resolve this dilemma include increasing the number of hospital beds and/or reducing the number of hospitalized patients designated as alternative level of care (by, for example, building more personal care homes).

The decision to hospitalize ED patients is often preceded by diagnostic tests (throughput factors), which are complex in nature. Time is required to prepare patients and to transport them to and from the test, to complete the procedure, and to interpret test results. However, the extent to which diagnostic tests influence ED wait times is largely unknown. This means that much of the evidence on output factors is potentially confounded (i.e., we should not conclude that prolonged ED wait times are due to output factors, when at least some of this influence may be due to events preceding the decision to hospitalize). Defining the unique impact of these factors helps stakeholders to develop effective reform strategies to reduce ED waits.

The Emergency Department Information System (EDIS) was fully implemented in Winnipeg on April 1, 2009. EDIS captures a wealth of data on patient wait, care, and boarding (from the provider's decision to hospitalize a patient to the patient's actual hospital admission) times, plus information on various input (the number of patients arriving with different CTAS levels[1]), throughput (the number and type of diagnostic procedures and blood tests performed), and output (the number of patients waiting for hospital admission) factors. These measures are time-stamped for each ED visit, and can be linked to other Manitoba Population Research Data Repository (Repository) files housed at the Manitoba Centre for Health Policy (MCHP).

The purpose of this research is two-fold. First, since EDIS is relatively new to Manitoba, we investigated this system to understand how to use these data. The strengths and challenges of these data fields are summarized in this report, and strategies for further improving EDIS are provided. Second, these data were used to identify which of input, throughput, and output factors most strongly influence ED wait times, overall and with comparison across the six adult ED sites in Winnipeg. ***Three research questions*** are addressed:

1. What data fields are available in EDIS, what are their strengths and challenges, and how can EDIS be further improved for research and evaluation purposes?
2. What types of input, throughput, and output factors can be measured using EDIS, and how do adult ED sites in Winnipeg vary by these factors?
3. How do select input, throughput, and output factors uniquely impact ED waiting room times? To what extent does this differ across adult ED sites in Winnipeg?

1 The Canadian Emergency Department Triage & Acuity Scale (CTAS) is part of EDIS and defines patients' acuity based on a standard set of questions asked at the time of triage. Based in part on their responses, patients are grouped into one of five categories based on their urgency of need. These include: i) resuscitation (CTAS 1), to define patients who are most acutely ill; ii) emergent (CTAS 2), to define patient with conditions that are a potential threat to their life, limb or function; iii) urgent (CTAS 3) to define patients with potentially serious challenges; iv) less/non-urgent (CTAS 4&5), to define patients who have minor acute conditions or chronic conditions that are stable.

Basic Research Methods

MCHP houses administrative claims data in the Repository that are collected during routine administration of the universal healthcare system in Manitoba. The Repository includes information of key interest to health care planners, and includes person-level data on (for example) contacts with physicians and hospitals, pharmaceutical dispensing, as well as use of home care services and personal care homes. Person-level data in the Repository contains anonymous information only, and does not contain identifying information such as patient and provider name, street address and true health number. These data can, however, be linked using a scrambled identifier assigned to each registered Manitoban, enabling population-based research to be conducted on a wide range of topics.

This research was conducted by linking EDIS to select files in the Repository. Our analyses focus on ED use patterns in Winnipeg, Manitoba, Canada, where six adult EDs are located. Across all sites combined, trends in ED use are first analyzed from 2003/04 to 2012/13, describing the extent to which ED use patterns have changed over time. Using 2012/13 data, a detailed analysis of the factors affecting ED waiting room times is then provided, stratified by patient CTAS level. Results are provided across all sites combined and with site comparisons.

Several of our analyses in this report express findings as a percent of ED capacity (e.g., defining waiting room times when EDs were at 30% capacity with patients waiting for diagnostic tests). Working with Winnipeg stakeholders, we developed a strategy for defining the number of regularly used treatment areas in each ED (i.e., locations where patients receive care, such as beds, resuscitation rooms, minor treatment areas, and suture rooms). These treatment areas were used to calculate ED operating capacities (i.e., how full EDs were at any given time), patient turnover rates (i.e., the number of patients cared for daily per treatment area), and to fairly make comparisons across ED sites (e.g., comparing waiting room times across sites when EDs were at 30% capacity).

Major Research Findings

Data Findings

EDIS is a much improved data system compared to the previous systems used in Winnipeg. Noteworthy strengths of EDIS include clearly demarked patient transition times used to define various wait and care durations, the inclusion of diagnostic tests and blood work data, and the ability to link ED providers to the patient. Challenges with EDIS (using 2012/13 data) include the absence of diagnostic and blood test order times (needed to understand how long patients wait for these tests), the lack of reliable consult data[2] (needed to understand how long it takes to receive care from specialists), and the absence of data reflecting nursing care. Data improvements in each of these areas are recommended to better understand the complex nature of waiting and caring in emergency departments.

Emergency Department Use Patterns

We examined ED use patterns longitudinally (from 2003/04 to 2012/13) and across sites in 2012/13. Highlights of these analyses are summarized as follows:

- In any given year, about one percent of ED visits are made for highly urgent (CTAS 1) reasons, 14% are made by people with emergent issues (CTAS 2), 38% are made by people with urgent (CTAS 3) issues, and 43% are made by patients triaged as having less urgent (CTAS 4&5) concerns.
- About 200,000 ED visits were reported in each year from 2003/04 (N=195,697 visits) to 2007/08 (N=198,798 visits). EDIS was implemented in 2009/10 and at this time most EDs were renovated in part to increase their treatment area capacity. Commencing this year, the number of ED visits changed substantially. Total visit counts increased by 12.0% (N=222,526 visits) in 2009/10 and have remained at this level thereafter. Despite this

2 Specialist physicians (e.g., psychiatrists, internal specialists) and allied providers (e.g., physiotherapy, home care) are often called to consult on ED patients. These providers are typically not located in the ED but are rather 'on call'.

increase, the proportion of visits triaged as lower acuity has remained fairly stable across time (e.g., about 39% of all ED visits were triaged as CTAS 4&5 annually from 2003/04 to 2007/08, versus 42% of all visits in 2012/13). Further, the percent of 'incomplete' ED visits (i.e., where patients leave without seeing a physician) has increased steadily with time, ranging from 5.9% of visits in 2004/05, 7.8% of visits in 2007/08, to 10% of visits in 2012/13. From these and other findings, we conclude that further increasing the number of ED treatment areas in Winnipeg would likely have limited value.

- Emergency Departments are very busy. In 2012/13, between the hours of 8:00 a.m. and 8:00 p.m., Winnipeg EDs operated at a median capacity of 128.1%. In other words, about half of the time when patients presented at an ED, there were already 28.1% more patients present than treatment areas available. Data on patient turnover, however, tells a slightly different story. While some EDs care for different patients throughout the day (e.g., Seven Oaks cared daily for a median of 2.4 visits per treatment area), other sites were often filled with the same people (e.g., Grace cared daily for a median of 1.3 visits per treatment area). Adult ED sites also differ by many other factors (e.g., by the age of their patients, by the number of visits made for mental health versus different types of physical health conditions, by how often diagnostic tests were performed, and by how often patients were admitted to hospital), each of which potentially influence these turnover rates.
- In 2012/13, the median duration of all daytime (8:00 a.m. to 8:00 p.m.) ED visits was 5.1 hours. This duration was longest for the highest acuity CTAS 1 (median 6.1 hours) and CTAS 2 (median 7.3 hours) patients, and was shortest for lowest acuity (CTAS 4&5) patients (median 4.0 hours). Patients, however, spent this time differently depending on their acuity level. While higher acuity (e.g., CTAS 2) patients spent less of their time waiting for care (e.g., median waiting room time=42 minutes) and more time receiving it (median treatment time=3.5 hours), the opposite is shown for lower acuity patients. CTAS 4&5 patients spent a median of 1.6 hours in waiting rooms, and a median of 1.1 hours receiving care.
- The distribution of time for all components of ED visits are skewed, meaning that a small number of patients had very long durations. For example, while the median waiting room time for CTAS 2 patients was only 42 minutes, during 10% of these visits (about 6 visits daily) patients remained in the waiting room for at least 4.7 hours. In contrast, the median post-treatment time (from the end of physician treatment to patient disposition) for CTAS 4&5 patients was 0 minutes, but at least 1.6 hours for 10% of these patients.

Factors Affecting ED Waiting Room Times

We investigated how input, throughput, and output factors affected ED waiting room times. These times were very short (median of 6 minutes) for acutely ill patients (CTAS 1; comprising 1.1% of all ED visits), and were generally not influenced by any input, throughput, or output factors. Acutely ill ED patients therefore consistently received care quickly.

For all other patients (CTAS 2 through 5), higher volumes of incoming lower acuity people (input factors) generally did not impact waiting room times. Instead, these times were influenced by output (i.e., the number of patients waiting to be admitted into hospital) and especially throughput (i.e., the number of patients waiting for diagnostic tests) factors. To illustrate, EDs had periods of time where 5% to 45% of treatment areas had patients waiting to be hospitalized, and in these scenarios median CTAS 2 waiting room times ranged from 20.5 minutes to 2.3 hours (138.7 minutes). Similarly, during periods where 5% to 45% of treatment areas had patients waiting for x-rays, median CTAS 2 waiting room times also increased substantially (from 14.5 minutes to 4.9 hours). From these and other results, we conclude that reform strategies to reduce waiting room time times should focus on both the hospital and ED care environment (i.e., output and throughput factors).

ED boarding times were weakly associated with hospital occupancy and also with the proportion of hospital beds occupied by alternate level of care (ALC) patients. Our results show that hospitals were less than 90% full when two-thirds of ED patients were waiting for hospital admission. On these occasions median ED boarding times increased by only 3.4 minutes for every 1% increase in hospital capacity. Similarly, hospitals were between 5% and 15% filled with ALC patients when two-thirds of ED patients were waiting for a hospital bed. On these occasions median ED boarding time increased by only 2.4 minutes for every 1% increase in the proportion of hospital beds occupied by ALC patients. While these increases were much greater at higher levels of hospital occupancy (e.g., median boarding time increased 4.4 hours when hospitals were 91% versus 100% full), overall from these results we conclude that reform strategies focusing on output factors need to involve more than simply creating more hospital space.

This report also highlights the particular challenges experienced at the Grace Hospital during the study period. This ED had an older patient clientele and performed some types of diagnostic tests more frequently than elsewhere. Patient turnover was also lowest at this ED versus all other EDs in Winnipeg. Similarly, our statistical modeling results show that throughput and output factors impacted waiting room times much more strongly at Grace versus elsewhere, especially for lower acuity patients.

Major Conclusions and Policy Implications

From this research we conclude that reform aimed at reducing ED waiting room times should focus on process strategies and not creating more space (e.g., adding more ED treatment areas or hospital beds). Within the ED this includes ensuring that: i) guidelines clearly indicate when diagnostic tests should be ordered; ii) the process for ordering, preparing, conducting, and interpreting diagnostic tests is timely; and, iii) an appropriate supply of equipment and personnel is available to conduct these tests when needed. Similarly, strategies are required to ensure that patients are transitioned from ED to hospital in a timely manner.

Future Research Directions

This research identifies potential areas of ED reform but not how those reforms should take place. Future research is required to help understand what types of changes are required, and how these can best and most practically be implemented within the everyday hectic ED and hospital care environments. Administrative data systems have value for measuring how well these reform strategies help to improve ED patient flow.

CHAPTER 1: OVERVIEW, STUDY PURPOSE, AND DOCUMENT ORGANIZATION

Emergency department (ED) crowding occurs when the demand for care exceeds the ability to provide it in a timely fashion (Bond et al., 2007). Crowded EDs are associated with reduced quality care (Pines, Prabhu, Hilton, Hollander, & Datner, 2010), more medication errors (Kulstad, Sikka, Sweis, Kelley, & Rzechula, 2010), increased patient mortality (Sun et al., 2013), and extended waiting times for newly arriving patients (Affleck, Parks, Drummond, Rowe, & Ovens, 2013; Bernstein et al., 2009). EDs in Winnipeg have received much media attention (The Canadian Press, 2015; Kusch, 2014; Puxley, 2014), particularly as wait times in this region are shown to be amongst the longest in Canada (Kusch, 2015).

Using Asplin et al.'s (2003) conceptual framework, the determinants of ED wait times include *input* (e.g., the volume of incoming patients), *throughput* (e.g., provider supply, the number and type of diagnostic tests being performed), and *output* (e.g., the number of ED patients waiting for hospital admission, hospital capacity) factors. There is good evidence showing that input factors minimally impact these times. Several authors (Rathlev et al., 2007; Schull, Kiss, & Szalai, 2006; Trzeciak & Rivers, 2003) have shown that higher volumes of low acuity patients only marginally increase ED wait times for people who are more acutely ill. Higher volumes of acutely ill patients do, however, significantly increase ED wait times and total visit durations for patients who are less acutely ill (Xu et al., 2013). These results reflect ED queuing strategies. Canadian EDs utilize the Canadian Triage and Acuity Scale (CTAS) (Beveridge et al., 1998) to help decide the order in which patients are seen. This order is based on a 'first come-first seen' basis, with priority given to people who are more acutely ill (i.e., requiring resuscitation, CTAS 1) versus people who require less- and non-urgent care (CTAS levels 4 and 5).

What then drives longer ED waits? In 2006, the Ontario Hospital Association provided 17 recommendations for improving access to ED care, many of which focus on improving hospital patient flow, reducing the number of alternate level of care (ALC) hospital days, and expanding the long-term care (e.g., nursing home) system (Physician Hospital Care Committee, 2006). Similarly, in 2009 the Canadian Association of Emergency Physicians (CAEP) issued a position paper stating that the "principal cause of ED overcrowding is hospital overcrowding" (Canadian Association of Emergency Physicians, 2006), citing as the primary determinants a shortage in the supply of acute care hospital beds combined with growing numbers of ALC hospital patients. Much evidence supports these statements; in their review of the literature, several scientists have concluded that the primary cause of ED crowding lies with challenges transferring ED patients into hospital (Asplin, 2009; Asplin & Magid, 2007; Moskop, Sklar, Geiderman, Schears, & Bookman, 2009a; Moskop, Sklar, Geiderman, Schears, & Bookman, 2009b). Chalfin et al. (2007) show that delayed admissions from the ED into intensive care units (ICUs) are associated with higher rates of patient death (Chalfin, Trzeciak, Likourezos, Baumann, & Dellinger, 2007), while Bhakta shows that improving ICU bed admitting protocols can help to reduce ED visit durations for critically ill patients (Bhakta et al., 2013). Hospital factors therefore undoubtedly play an important role in helping to manage ED crowding. This is particularly important as patients are admitted into hospital after 12% to 19% of all ED visits (Doupe M. et al., 2008; Forster, Stiell, Wells, Lee, & van Walraven, 2003).

It is important to note, however, that throughput and output factors are highly related, and most ED patients who are hospitalized first require a diagnostic test. Modeling the unique effect of these factors therefore requires their impact to be studied simultaneously. Presently, most of the literature measures output factors only (Arkun et al., 2010; Fatovich, Nagree, & Sprivulis, 2005; Lucas et al., 2009; Rathlev et al., 2007; Rathlev et al., 2012; Vermeulen et al., 2009; White et al., 2013; Wiler et al., 2012; Ye et al., 2012), or is based on expert opinion (Bond et al., 2007; Cass, 2005; United States General Accounting Office, 2003). Similarly, while some researchers have shown that throughput factors (e.g., the number and type of procedures performed during ED visits, consultation rates) significantly impact ED visit durations (Gardner, Sarkar, Maselli, & Gonzales, 2007; Kocher, Meurer, Desmond, & Nallamothu, 2012; Yoon, Steiner, & Reinhardt, 2003), the effect of these factors are generally not measured independently of output

variables. Defining how throughput and output factors uniquely impact ED wait times has significant care practice and policy implications as they help to ensure the development of effective and targeted reform strategies.

The Emergency Department Information System (EDIS) was fully implemented in Winnipeg by April 1, 2009. Unlike the previous ED data system which provided general admission and discharge information only, EDIS captures a wealth of data on patient wait, care, and boarding times (i.e., the length of time from a provider's decision to hospitalize a patient to the patient's actual hospital admission), and more information about various input (defining the number of patients arriving by CTAS level), throughput (identifying the number and type of diagnostic procedures and blood tests performed), and output (defining the number of patients waiting for hospital admission) factors. These measures are time-stamped for each ED visit, and can be linked to the healthcare use files in the Manitoba Population Research Data Repository (Repository), housed at the Manitoba Centre for Health Policy (MCHP).

The purpose of this research is twofold. First, as EDIS data have never been used at MCHP, this system was investigated to identify the various data fields that are available for use in research. The strengths and challenges of these data fields are summarized, and strategies for further improving EDIS are provided. Second, select data from EDIS were used to identify input, throughput, and output factors that most strongly influence ED wait times, overall and with comparison across the six adult ED sites in Winnipeg.

Three research questions are addressed in this research:

1. What data fields are available in EDIS, what are their strengths and challenges, and how can EDIS be further improved for research purposes?
2. What types of input, throughput, and output factors can be measured using EDIS, and how do adult ED sites in Winnipeg vary by these factors?
3. How do select input, throughput, and output factors uniquely impact ED waiting room times? To what extent does this differ across adult ED sites in Winnipeg?

Details of this report are provided in two sections comprising eight chapters. The general methods used to conduct this research are provided in Chapter 2, with additional methods provided at the beginning of each chapter. Chapters 3 and 4 compose Section I of this report, which is entitled *An Examination of the EDIS Data System*. This section describes the types of data that are available from EDIS and its key data fields (Chapter 3). Also, because 10 years of ED data are available at MCHP, some historical trends in ED use are provided (Chapter 4). From this section we conclude that EDIS is a much improved data system compared to previous systems used in Winnipeg. We also show that ED visits occurred disproportionately by patient age and across socio-demographic factors, and demonstrate that the past increases in the number of ED visits occurred primarily for less and non-urgent reasons.

Section II of this report (*An Analysis of Input, Throughput, and Output Factors Affecting ED Wait Times*) comprises Chapters 5 through 7. A description of various input, throughput, and output factors is provided in Chapter 5, overall and across Winnipeg sites. The unique impact of these factors on ED waiting room time is provided in Chapters 6 (all ED sites combined) and 7 (site-specific comparisons). Study conclusions, reform implications, and future research directions are provided in Chapter 8 of this report.

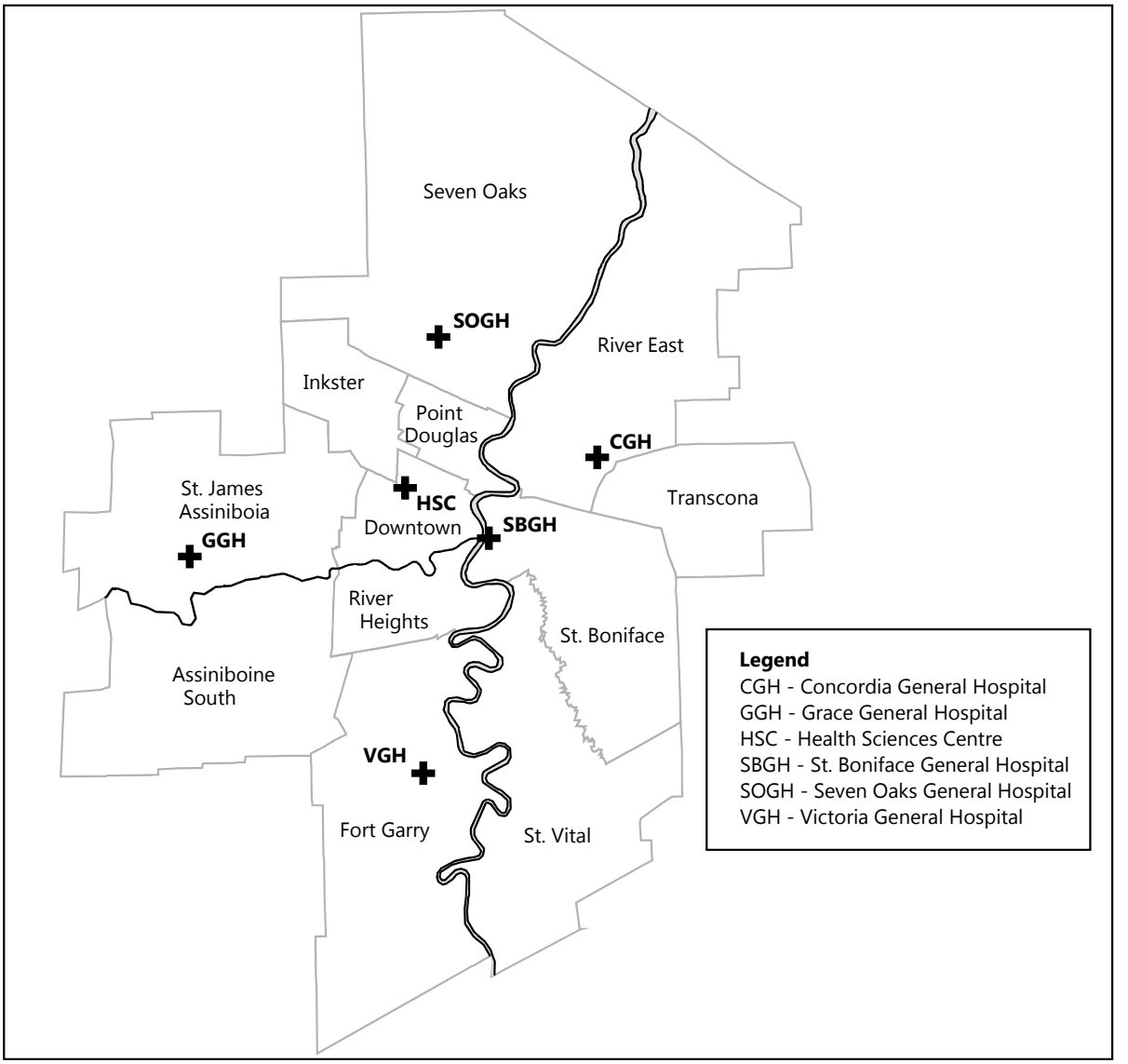
CHAPTER 2: GENERAL RESEARCH METHODS

This chapter identifies the ED sites upon which the research was conducted, defines the study period, provides the MCHP data files used to conduct the research, and lists the study exclusion criteria. All data management, programming and analyses were performed using SAS® version 9.4.

Adult Emergency Department Sites Included in this Research

This research was conducted in Winnipeg, Manitoba, Canada. About two-thirds of the Manitoba population reside in Winnipeg (population 730,000), and the majority of tertiary care specialized services (e.g., cardiac surgery, neurology, intensive care) are located in this region. Winnipeg houses six adult EDs at the Health Sciences Centre (HSC), the St. Boniface General Hospital (St. Boniface), the Victoria General Hospital (Victoria), the Seven Oaks General Hospital (Seven Oaks), the Grace General Hospital (Grace), and the Concordia General Hospital (Concordia). HSC and St. Boniface are tertiary care hospitals, while all other hospitals are community sites. A map of these sites is provided in Figure 2.1. Sites not included in this research include the Children's ED (located at HSC) and the Urgent Care Centre (located at the Misericordia Hospital, proximal to HSC).

Figure 2.1: Locations of Emergency Departments in Winnipeg



Defining the Study Period

Section I of this report uses ten years of data (2003/04 to 2012/13) to analyze historical trends in ED use. Section II of this report (Chapters 5 through 7) focuses on ED visits that occurred between April 1, 2012 and March 31, 2013 (i.e., 2012/13).

MCHP Data Files Used to Conduct this Research

MCHP houses administrative data in the Manitoba Population Research Data Repository (called the 'Repository') that are collected during routine administration of the universal healthcare system in Manitoba. The Repository includes information of key interest to health care planners, and includes person-level data on (for example) contacts with physicians and hospitals, pharmaceutical dispensing, as well as use of home care services and personal care homes. Person-level data in the Repository is anonymous, and does not contain identifying information such as patient and provider name, street address and actual health number. These data can however, be linked using a scrambled identifier assigned to each registered Manitoba resident, enabling population-based research to be conducted on a wide range of topics. A list of Research Deliverables conducted at MCHP is available at the following website: http://umanitoba.ca/faculties/health_sciences/medicine/units/community_health_sciences/departmental_units/mchp/research.html. Strict regulations are enforced at MCHP to protect patient anonymity in the Repository.

The Repository files used in this research and the rationale for using each file are as follows:

- The Emergency Department Information System (EDIS). This file contains our major research outcome (waiting room time), plus all other components of an ED visit (e.g., treatment time, post-treatment time, boarding time). Many of the input (e.g., volume of incoming patients by CTAS level), throughput (e.g., the number and type of diagnostic tests performed, ED provider supply), and output (e.g., ED patients waiting for hospital admission) factors used in this report were also obtained from this file. More details about these measures are provided in Section II of this report.
- The Registry File. This file contains a list of all registered Manitoba residents annually, and was used to define all ED users by their socio-demographic factors including age, sex, and area of residence (i.e., Winnipeg community area). Also, the six-digit postal codes from this file can be used to group people by their Census dissemination area, for which average household income values are also publically available. Based on this information, Manitoba residents can be assigned to one of five area-level income quintiles, each quintile comprising about 20 percent of the population.
- The Hospital Discharge Abstract File. This file identifies people by their hospital admission and separation dates. Data from this file were used to help validate the EDIS files (i.e., identifying how often patients defined in EDIS as being hospitalized were actually admitted). Also, the International Classification of Disease (ICD 10) codes for each hospital record were used (in conjunction with ICD 9 codes in the medical claims data) to identify ED patients who were diagnosed with various chronic physical and mental diseases. These disease-specific algorithms have been validated for use with administrative data (Lix et al., 2006), and/or have been used extensively by MCHP researchers (Martens et al., 2004).
- The Medical Claims File. This file provides the number and type of physician contacts made by study participants, and the diagnosis made by physicians (ICD 9 codes) during each patient visit. This file was used in combination with the hospital abstract file to identify patients diagnosed with various chronic physical and mental diseases at the time of the study.
- The Long Term Care Utilization File. This file defines people who are residing in a licensed Personal Care Home (PCH). It was used in this study to define ED patients who were transferred from and back to PCH facilities.

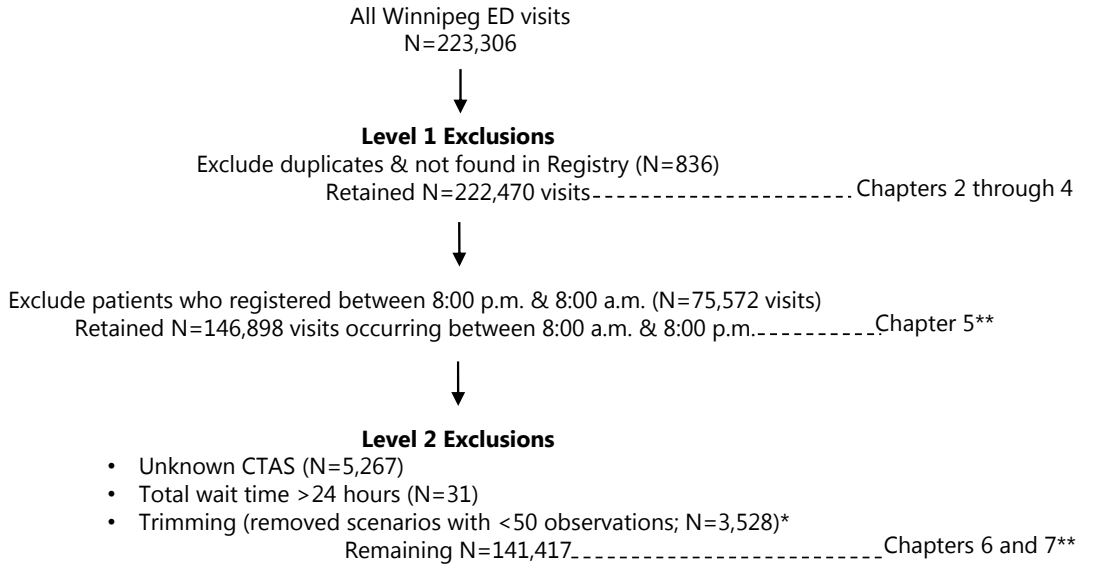
Detailed descriptions of these databases can be found on MCHP's Repository Data List (webpage: http://umanitoba.ca/faculties/health_sciences/medicine/units/chs/departmental_units/mchp/resources/repository/datalist.html)

Study Exclusion Criteria

From EDIS, we determined that 132,839 people made 223,306 ED visits to Winnipeg's six adult ED sites during the 2012/13 fiscal year (i.e., April 1, 2012 to March 31, 2012) (Figure 2.2). Two levels of exclusions were applied to these data prior to their use:

- All files housed at MCHP are de-identified at the person-level and coded using personal health information numbers (PHINs) that are anonymized across all MCHP Repository files. Using this strategy, each ED visit was defined by a (scrambled) PHIN, ED location, as well as date and time of the visit. *Level 1 Exclusions* comprise duplicate records by these measures and visits made by people not found in the MCHP registry (e.g., not living in Manitoba, incorrect PHINs). This removed 0.4% of visits captured in the original 2012/13 EDIS data file. Chapters 2-4 of this report are based on Level 1 exclusions only (N=222,470 visits).
- Chapters 5-7 of this report describe various input, throughput, and output factors, and their influence on waiting room times. Similar to others (Xu et al., 2013), all analyses in these chapters were conducted on ED visits where patients registered between 8:00 a.m. and 8:00 p.m. (N=146,898 visits), based on evidence showing that both ED wait and boarding times tend to be shorter during daytime hours versus night time hours (Asaro, Lewis, & Boxerman, 2007; Karaca, Wong, & Mutter, 2012; Ye et al., 2012). Our results in Chapters 5-7 are reported using these daytime visits.
- Chapters 6 and 7 define factors associated with ED waiting room times, stratified by CTAS level. Prior to these analyses and as *Level 2 Exclusions*, ED visits with missing CTAS scores (N=5,267) and with waiting room times lasting longer than 24 hours (N=31 visits) were removed. Last, our analyses were conducted using a summarized data set, where each ED visit (called an 'index visit' in this report) was linked to a group of patients who were already in the ED (called 'existing visits'; see Chapter 6 for more details). A combination of index-existing visits was removed if extreme but rare scenarios were identified (e.g., if, for a given index visit, the ED was 100% filled with existing patients waiting for certain tests). These scenarios were excluded if they occurred less than 50 times (i.e., at least once/week across all sites combined during 2012/13). This process removed N=3,528 index-existing visit combinations, and helps to ensure that our results in Chapters 6 and 7 are based on regularly occurring events.

Figure 2.2: Study Exclusion Criteria



* This process was used to ensure that the results from statistical modeling were based on commonly occurring events (about once per week per ED site across all CTAS levels combined); see Chapter 6 for more details.
** Descriptive analyses in Chapters 6 & 7 were based on Level 1 exclusions only. These are noted in the appropriate figures in those chapters.

SECTION I: AN EXAMINATION OF THE EDIS DATA SYSTEM

CHAPTER 3: DESCRIBING KEY EDIS DATA FIELDS

Chapter Highlights

This chapter describes the EDIS data fields, identifies the strengths of this system, and provides suggestions for further improvements. Highlights of this chapter are as follows:

- EDIS is a much richer supply of information than the previous ED (Admission, Discharge, and Transfer (ADT) and E-triage) systems. Key to EDIS is the ability to partition ED visit durations into various sub-components (e.g., waiting room, care, and post-treatment times), and the ability to identify diagnostic tests and blood work procedures conducted during visits. We recommend the following improvements to further increase the value of this system. First, a more reliable and complete description of patient arrival status would help to define patients who arrived at EDs by ambulance, police escort, and other means. Second, diagnostic test order times are not available in EDIS, making it impossible to know how long people wait for different diagnostic tests. Third, medical consults are shown to influence ED patient flow (Drummond, 2002; Geskey, Geeting, West, & Hollenbeak, 2013), but are not consistently captured in EDIS.[3]
- Our analyses in this chapter confirm that EDIS data are of high quality for research and evaluation, and in most instances are accurate and complete. First, the components of visit duration align with patient acuity as we would expect; while higher acuity patients had very short wait followed by longer care times, lower acuity patients had longer waits followed by shorter treatment times. Second, key measures in EDIS mostly 'agree with' each other or with other Repository files. For example, the vast majority of left without being seen (LWBS) patients had no provider time recorded in EDIS, most patients hospitalized had some type of diagnostic test first, most patients identified in EDIS as being hospitalized were found in the hospital abstract file, and almost all patients reported in EDIS to have died were also reported as dead in other Repository files.

Chapter-Specific Methods

Details about the EDIS data are reported in this chapter. This information was developed by reviewing each field (e.g., searching for missing data, summarizing response options), and by cross-tabulating different response options to see if they agree. All analyses in this chapter are descriptive in nature (i.e., frequencies and percentages), and were conducted after performing Level I exclusions (see Figure 2.2). Results are presented for all sites combined using data from 2012/13.

3 Specialist physicians (e.g., psychiatrists, internal specialists) are often called to consult on ED patients. These physicians are not located within the ED but are rather 'on call'. Data on other types of consults (e.g., for physiotherapy, home care) are also not recorded in EDIS.

Detailed Study Results

An Overview of the Data Available in EDIS, and the Strengths and Challenges of these Data

Prior to 2009, emergency department use patterns were captured using a combination of the ADT and E-triage data systems. ADT provided information on patient arrival and discharge status, while E-triage recorded the computer-generated CTAS scores for each visit. Data from these systems were date and time stamped for each ED site, allowing total ED visit duration to be captured. No information on ED wait, care, and boarding times were available. Information was also not captured on the type of provider who saw the patient, or about the type of procedures conducted during the visit.

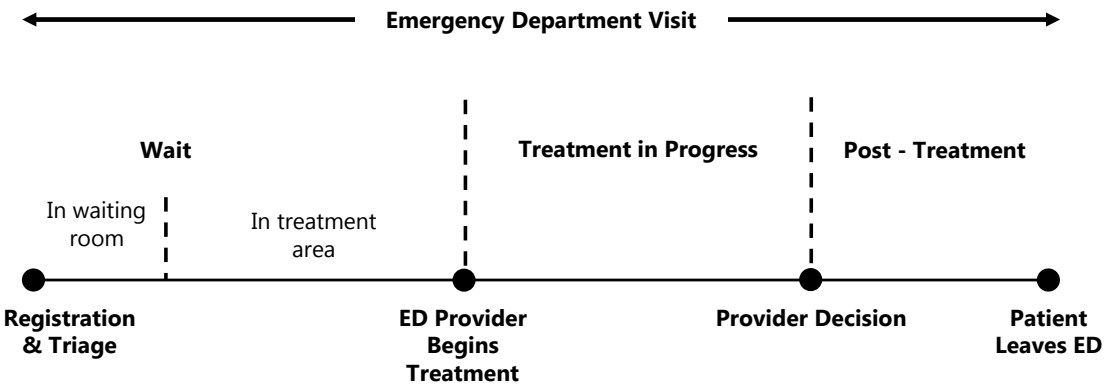
In contrast, EDIS provides a much richer description of ED visits in Winnipeg. The following data fields are available in this system:

- Arrival Status: Similar to the ADT and E-triage systems, each ED visit is denoted by ED site, date and time, and arrival status. Also similar to ADT, arrival status can be coded as 'ambulance' (using ambulance identification numbers) versus 'else' (all other types of arrival combined). Arrival status data is entered in EDIS as free text, and thus standard additional arrival status options (e.g., police escort) are not available.
- CTAS Code: The Canadian Emergency Department Triage & Acuity Scale (CTAS) is part of EDIS, and has been used 'pre-EDIS' in Winnipeg since 2004/05. CTAS relies on a standard set of questions asked at the time of triage. Based in part on patient responses, the CTAS program allocates patients into one of five categories based on their urgency of need.[4] These categories include:
  - *i. Resuscitation (Level I)*: This category identifies patients who have conditions that are a threat to their life or to a limb, and who require immediate aggressive interventions (e.g., patients who are non–responsive, who have absent or unstable vital signs, who are experiencing severe respiratory distress);
  - *ii. Emergent (Level II)*: This category identifies patients who have conditions that are a potential threat to their life, limb or function, and who require rapid medical interventions or delegated acts. Examples include patients who are experiencing seizures or head trauma, continuous visceral or sudden sharp chest pains, vomiting of blood, or have severe difficulty breathing;
  - iii. *Urgent (Level III)*: This category defines patients who have conditions that could potentially progress to a more serious problem requiring immediate intervention. Examples include patients with a head injury who are alert, and patients with moderate dyspnea or who are experiencing intense pain associated with minor problems;
  - iv. *Less Urgent (Level IV)*: This category defines patients who have conditions that are related to their age or who require intervention or reassurance within 1-2 hours. Examples include patients with minor fractures, sprains or contusions, earaches, and chronic back pain, and;
  - *v. Non Urgent (Level V)*: This CTAS category defines patients who have minor acute conditions or chronic conditions that are stable. Examples include patients with minor lacerations not requiring closure, those with mild abdominal pain, patients with psychiatric symptoms causing minor problems, and those who are frustrated with a lack of alternate healthcare services.
- Disposition (Discharge) Status: Similar to ADT, EDIS defines a patient's discharge status. Disposition options include 'left without being seen' (defines patients who left the ED prior to seeing a physician), 'left against medical advice' (defines patients whose treatment was started by an ED provider but who left before this treatment was completed), 'admitted into hospital', 'transferred to another ED', 'died during the ED visit', and 'sent home'.

4 This standard assessment process helps to ensure that CTAS levels are comparable across ED sites. While triage nurses have the ability to over-ride the computer generated CTAS score, this flag denoting changed CTAS scores was not provided to MCHP as part of the research. From past studies, however (Doupe M. et al., 2008), we know that computer generated CTAS scores were changed by triage nurses during about 5% of ED visits in Winnipeg.

- Time: EDIS reports when key events occur, including the time of registration and triage, when patients transferred from the waiting room to an internal ED treatment area, when treatment was initiated by the main care provider, when this provider 'signed-off' on the patient (indicating the end of active treatment with a disposition status decision), and when the patient actually left the ED. The timing of these events can be used to identify waiting room time (from registration to transfer to an internal treatment area), treatment area waiting time (patient is on an internal treatment area but has not yet been seen by a physician), treatment duration, and post-treatment time. A schematic of these various time components is depicted in Figure 3.1.

Figure 3.1: Components of an ED Visit Captured in EDIS



- Patient Location: Once inside the ED, the physical location (i.e., treatment area ID) of each patient is recorded in EDIS. These data can be used to identify the number of ED locations that are used regularly when caring for patients, and to measure operating capacity (i.e., number of patients on site relative to the number of treatment areas available) and also the patient turnover (i.e., number of daily visits per treatment area).
- Chief Complaints: During triage, each patient is classified into one of 17 chief complaint categories. For our analyses, some of these categories were combined, while some were grouped as 'other' due to small numbers. This resulted in the following categories: Cardiovascular, ENT (ear; nose; throat/mouth/neck), Genitourinary, Gastrointestinal, Mental Health, Neurologic, Obstetrical/Gynecological, Orthopedic, Respiratory, Skin, Substance Misuse, Trauma, and Other (e.g., abdominal pain, cough, eye pain, general and minor issues, headache).
- Diagnostic Tests: Diagnostic tests from EDIS that are used in this research include: x-rays, urine tests, ultrasound tests, nuclear medicine tests, computed tomography (CT) scans, cerebral spinal fluid tests, magnetic resonance imaging (MRI), and cardiovascular tests.[5] These data are marked by their performance times only, and no 'order time' data are available.[6] Also, some diagnostic tests (e.g., MRI) require multiple scans, each of which are recorded separately in EDIS. For the purposes of this research, diagnostic tests repeated on the same patient within 30 minutes of each other were collapsed into one test.
- Blood Tests: All blood tests are time stamped in EDIS. Each component of a given blood test (e.g., red and white blood cell counts for a complete blood count) is recorded in EDIS separately and can be linked back to the overall test, making it feasible to analyze blood test data at various levels. For the purposes of this research, patients were defined as having some or no blood work performed. As one exception, troponin blood tests were measured separately in this research. This test is typically used to determine if patients have had a heart attack. Repeat testing is often required, potentially lengthening visit durations.

5 These consist mainly of angioplasty, angiograms, and catheterizations. From discussions with Advisory Group members, echocardiogram, stress tests, and electrocardiograms are ordered but not performed during ED visits.

6 While order time data are present at some sites, follow-up analysis showed that the order and performance times were identical in many instances (e.g., for 87% of all x-rays, data not shown). This implies that order times are either system or laboratory technician generated, and should not be used to denote when providers actually requested the test.

- ED Providers: EDIS can be used to identify the number and type of providers who cared for a given patient. Provider types include physicians, resident (training) physicians, plus nurse practitioners and physician assistants (collapsed into one group for the purposes of this research). While key research questions can be asked with these data (e.g., What impact do nurse practitioners have on patient flow?), select improvements are needed to optimize their value. Details are provided in the following text.
  i. EDIS does not always differentiate ED physicians from other physicians (e.g., hospital consultants) who may have had input into caring for patients. To avoid over-counting, measuring ED physician supply requires input from Winnipeg stakeholders.
  ii. ED providers can be linked to each patient but not to diagnostic or blood tests. This can be achieved indirectly only when there is one provider assigned to a patient. In 2012/13, multiple physicians were linked to a patient during 17.7% of all ED visits (data not shown). For the remainder of visits, the frequency with which diagnostic and blood tests were ordered could not be compared across physician providers.
  iii. The frequency and nature of nursing care is captured poorly in EDIS. Similarly, medical consults (e.g., for gastrointestinal problems, mental illness) are not captured in EDIS. While our Advisory Group reports that these data are captured at St. Boniface, without input from stakeholders (i.e., going through the list of provider names individually), it is not feasible to differentiate ED physicians from medical consultants. All other types of consultants (e.g., for physiotherapy, home care) are not recorded in EDIS.
- International Classification of Disease (ICD) Codes: While chief complaint data are collected at triage and captured in EDIS, ICD codes are not provided to summarize the physicians' diagnosis. These data would help to clarify the primary reason for ED visits.

Cross Tabulations

As per the STROBE (Benchimol et al., 2015) and RECORD (Nicholls et al., 2015) guidelines for conducting research using observational data, additional tests were conducted to help determine the accuracy of key EDIS measures. In general, these comparisons demonstrate the high quality of the EDIS data.

- As one would expect, ED waiting room time varies by CTAS category.[7] Patients triaged as CTAS 1 had almost negligible waiting room times (median of 6 minutes; 25th and 75th percentile, also called the inter-quartile range or IQR, 6 to 12 minutes[8]). Conversely, patients triaged as CTAS 4&5 had the longest ED waiting room times, with a median of 96 minutes (IQR=42 to 192 minutes). The reverse pattern applies to patient treatment times. CTAS 4&5 patients had the shortest treatment times (median=66 minutes; IQR=24-150 minutes), while CTAS 2 patients had the longest treatment times (median=210 minutes; IQR=108-378 minutes).
- Chief complaint and diagnostic tests data in EDIS generally align (data not shown). For example, patients had urine tests during 81.5% of visits where they were triaged as having genitourinary challenges, versus only 10.2% of visits where they were triaged as having orthopedic challenges. Similarly, patients had x-rays during 63.8% of visits where they were triaged as having orthopedic challenges, during 66.5% of visits where they were triaged as having respiratory challenges, and during only 7.8% of visits where they were triaged as having mental health challenges.
- Left without being seen (LWBS) patients are triaged but leave the ED prior to being seen by an ED physician. In total, 10.2% of all ED visits that were triaged had a disposition status of LWBS in 2012/13 (Table 3.1; 22,139/217,203). As one would expect, this occurred more frequently in lower versus higher acuity patients. Patients were coded as LWBS during 12.1% of visits triaged as CTAS 4&5, versus only 7.2% of visits triaged as CTAS 1-3. Another way to interpret these data is to say that of all visits coded as LWBS, 51.2% (11,346/22,139) were triaged as having the lowest acuity (CTAS 4&5).

7 These data are shown in Chapter 6 of this report (Figures 6.3 through 6.6), and not in this chapter.
8 IQR results mean that CTAS 1 patients had a waiting room time of at most 6.0 minutes during 25% of visits. Conversely, during 75% of visits patients had a waiting room time of no longer than 12.0 minutes.

Table 3.1: Triage Levels Compared to Left Without Being Seen (LWBS) Disposition Status in EDIS
All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

		EDIS: CTAS Triage Level		
		CTAS 1-3	CTAS 4&5	Total
EDIS: Disposition Status	LWBS	8,871	11,346	22,139
	Not LWBS	114,623	82,363	195,064
	Total	123,494	93,709	217,203*

*Excludes 5,267 visits with missing CTAS values.

- In total, 13.8% of all ED visits had no treatment time recorded (Table 3.2). Most of these visits were for LWBS patients; 96.1% of all visits with a disposition of LWBS had no treatment time recorded (i.e., 21,272/22,139) versus, for example, only 4.2% of visits where patients were discharged home, and 5.1% of visits where patients were admitted to hospital. Alternatively, of all ED visits with treatment time missing (N=30,685), 69.3% were for LWBS patients, while 22.9% were for patients who were discharged home.

Table 3.2: Disposition Status Compared to Treatment Time in EDIS
All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

		EDIS: Disposition Status				
		LWBS	Discharged Home	Admitted as In-patient	Else*	Total
EDIS: Treatment Time Recorded	Yes	867	159,831	25,702	5,385	191,785
	No	21,272	7,034	1,373	1,006	30,685
	Total	22,139	166,865	27,075	6,391	222,470

*Includes patients who expired, were transferred to another ED, and left against medical advice.

- Patients were provided with some type of diagnostic test during 51.4% of all visits (Table 3.3). This varied by patients' disposition status; patients who were hospitalized first had some type of diagnostic test during 83.2% of visits. Conversely, during all visits where diagnostic tests were performed, patients were hospitalized only 19.7% of the time.

Table 3.3: Disposition Status Compared to Any Diagnostic Test Performed in EDIS

All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

		EDIS: Disposition Status		
		Admitted to Hospital	Not Admitted to Hospital	Total
EDIS: Any Diagnostic Test Performed	Yes	22,528	91,883	114,411
	No	4,547	103,512	108,059
	Total	27,075	195,395	222,470

- In total, 11.9% of visits in EDIS ended with a patient being hospitalized (Table 3.4). In 97.5% of these visits (26,402/27,075), the hospital abstract file reported that the patient was admitted to hospital on the same day. Alternatively, of all ED visits where same-day hospitalization was reported in the hospital file, 85.5% were coded as in-patients in EDIS, and 6.1% were coded as being discharged home.

Table 3.4: Disposition Status in EDIS Compared to Same Day Hospitalization Recorded in the Hospital Abstract File

All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

		Hospital Abstract: Hospitalization reported on the same day as ED Visit		
		Yes	No	Total
EDIS: Disposition Status	Admitted as In-Patient	26,402	673	27,075
	Discharged Home	1,877	164,988	166,865
	LWBS	217	21,922	22,139
	Else*	2,394	3,997	6,391
	Total	30,890	191,580	222,470

*Includes patients who expired, were transferred to another ED, and left against medical advice.

- Patients were reported to have died during 0.2% of all EDIS visits in 2012/13 (Table 3.5). In 98.0% of these cases, patients were identified as having died on the same day in the Registry file. Alternatively, of all ED patients who were reported by the Registry to have died on the same day as their ED visit, 73.5% were coded by EDIS as dying during the visit, 20.4% were coded as being admitted into hospital, and 2.9% were coded by EDIS as being discharged home.

Table 3.5: Disposition Status in EDIS Compared to Same Day Patient Death Recorded in the Registry File
All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

		Registry Cancellation Code: Patients Who Died on the Same Day as their ED Visit		
		Yes	No	Total
EDIS: Disposition Status	Expired	500	10	510
	Admitted as In-Patient	139	26,936	27,075
	Discharged Home	20	166,845	166,865
	Else*	21	27,999	28,020
	Total	680	221,790	222,470

*Includes patients who were transferred to another ED, left without being seen, and left against medical advice.

- Given the focus of the research (i.e., comparing how throughput versus output factors impact waiting room times), it is important to accurately measure diagnostic tests and blood work. From Table 3.6, 13.8% of all visits were made (according to chief complaint data) for cardiovascular reasons. Troponin blood levels are typically measured on people suspected of having had a heart attack. About two-thirds (63.8%) of all visits made for cardiovascular reasons received at least one blood troponin test, as compared to 10.6% of visits made for all other reasons.

Table 3.6: Chief Complaint Compared to Troponin Blood Tests in EDIS
All Adult Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

		EDIS: Troponin Blood Test		
		Yes	No	Total
EDIS: Chief Complaint	Cardiovascular	19,582	11,119	30,701
	Other	20,363	171,406	191,769
	Total	39,945	182,525	222,470

CHAPTER 4: HISTORICAL TRENDS IN ED USE

Chapter Highlights

MCHP houses several years of ED data. This chapter describes changes in ED use patterns, using the ADT system from 2003/04 through 2008/09, followed by EDIS from 2009/10 through 2012/13. Key findings are summarized in the following text.

- Older adults have disproportionately higher population- and visit-based rates to the ED. In any given year, about 40% of the population aged 85 or older had one or more visits to an ED. These individuals comprised about 2.2% of the Winnipeg population in 2012/13[9] and about 6.0% of all ED visits annually. Conversely, in any given year, about 15% of people aged 25-64 had one or more ED visits. These people comprised about 55% of the Winnipeg population in 2012/13 and 56% of ED visits annually. This pattern of ED use by patient age is stable across time.
- Since 2003/04, ED visit rates have remained disproportionately high among residents living in the Winnipeg core area. For example, in 2012/13, 17.7% of the Winnipeg population lived in the Point Douglas and Downtown core areas, but people from these areas accounted for 22.0% of all ED visits. Similarly, while by definition 20% of people reside in each income quintile, people living in the lowest income areas comprised almost 30% of ED visits annually. These patterns are stable across time, and demonstrate the strong association between socio-economic factors and ED use.
- About 200,000 ED visits were reported in each of the years from 2003/04 (N=195,697 visits) to 2007/08 (N=198,798 visits). EDIS was implemented in 2009/10, and at this time most EDs were renovated in part to increase their treatment area capacity. Commencing this year, the number of ED visits changed substantially. Total visit counts increased by 12.0% (N=222,526 visits) in 2009/10 and have remained at this level thereafter.[10] Despite this increase, the proportion of visits triaged as lower acuity has remained fairly stable across time (e.g., about 39% of all ED visits were triaged as CTAS 4&5 annually from 2003/04 to 2007/08, versus 42% of all visits in 2012/13). Furthermore, the percent of 'incomplete' ED visits (i.e., where patients leave without seeing a physician) has increased steadily with time, ranging from 5.9% of visits in 2004/05, 7.8% of visits in 2007/08, to 10% of visits in 2012/13. From these and other findings, we conclude that further increasing the number of ED treatment areas in Winnipeg would likely have limited benefit.

9 Population counts by age group and Winnipeg community area are not provided in this report, but can be obtained from the following Manitoba Health, Seniors and Active Living website: http://www.gov.mb.ca/health/population/2012/pr2012.pdf.

10 While we cannot unequivocally attribute this increased visit count to the creation of additional treatment areas (versus, for example, visits counted in EDIS and systemically excluded from previous ED data systems), we know from Advisory Group members that about 12% more ED treatment areas were added with the onset of EDIS (data not shown).

Detailed Study Results

Trends in Population-Based Rates

In any given year, ED population-based rates vary substantially by age, geography, and income quintile. These patterns of use have remained stable across time.

- About 15% of the Winnipeg population has one or more visits to an ED annually (Figure 4.1). This varies tremendously by age group, ranging from about 40% of the population aged 85 and older, to about 30% of people aged 75-84 and 15% of the population aged 25-64.
- ED population-based rates are much higher for people living in the lowest income neighborhoods. From Figure 4.2, about 20% of people in the lowest income quintile had one or more visits to an ED annually, as compared to about 11% of people who resided in the highest income areas in Winnipeg. In any given year, ED population-based rates varied by Winnipeg community area (Figure 4.3). This use was consistently highest for people living in Point Douglas (part of the Winnipeg core area; about 20% of people living in this area have one or more ED visits annually), and lowest in River Heights and in Assiniboine South (two of Winnipeg's most affluent communities). About 12% of people living in each of these latter community areas had one or more visits to an ED annually during our ten years of analyses.

Figure 4.1: ED Population-based Rates in Select Years by Age Groups

All Adult ED Sites Combined, Winnipeg, Manitoba

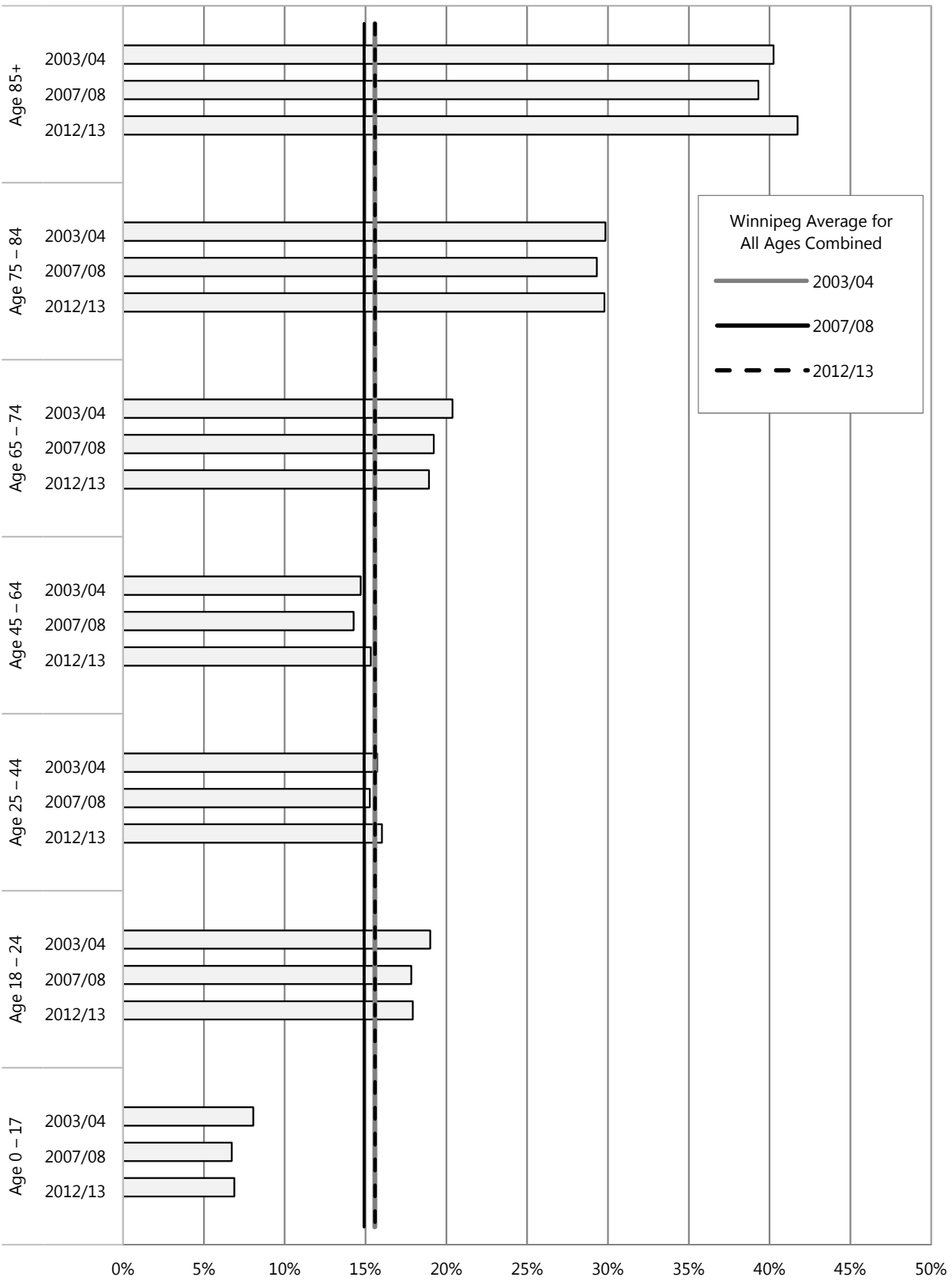


Figure 4.2: ED Population-based Rates in Select Years by Income Quintile Groups

All Adult ED Sites Combined, Winnipeg, Manitoba

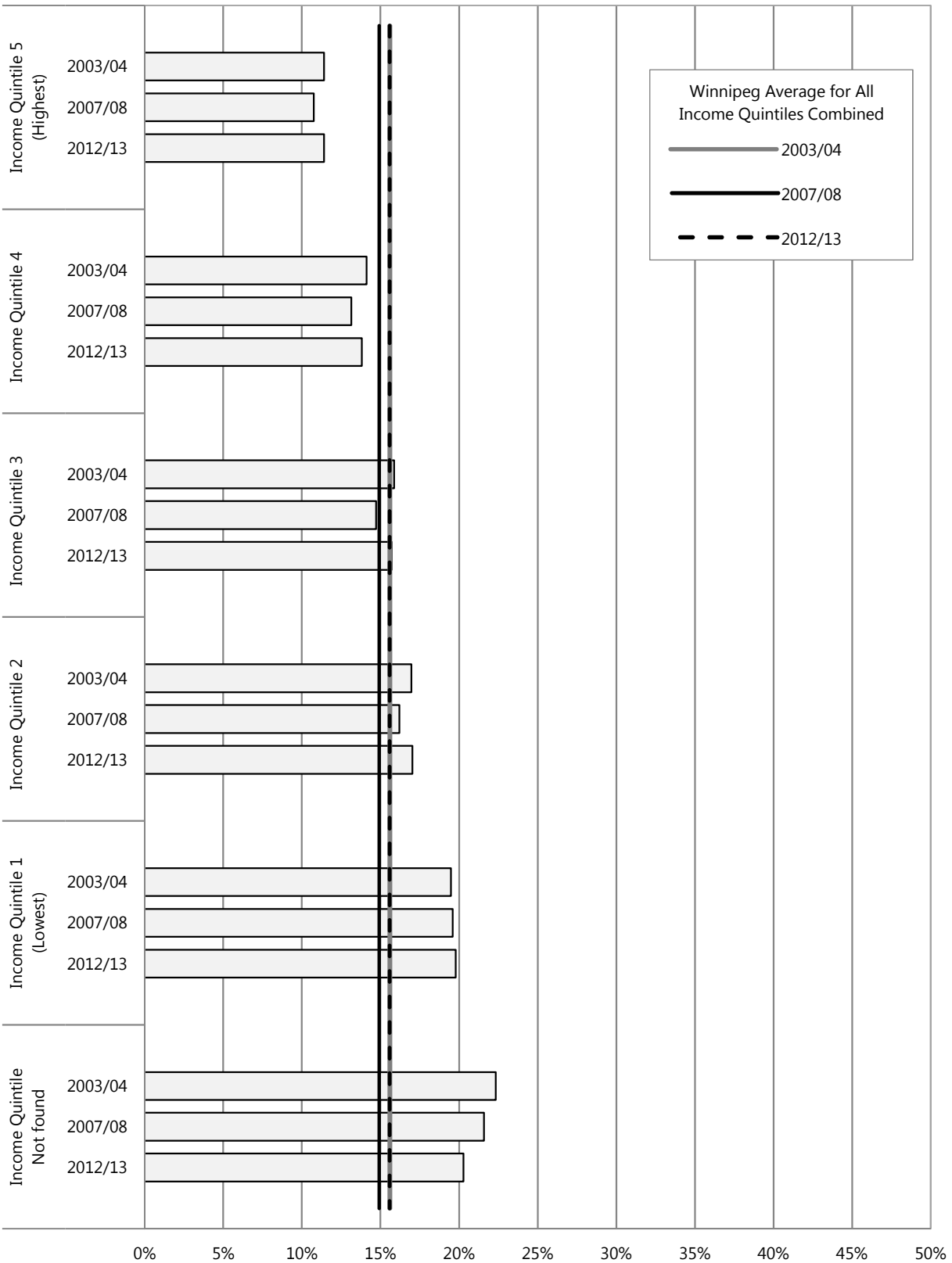
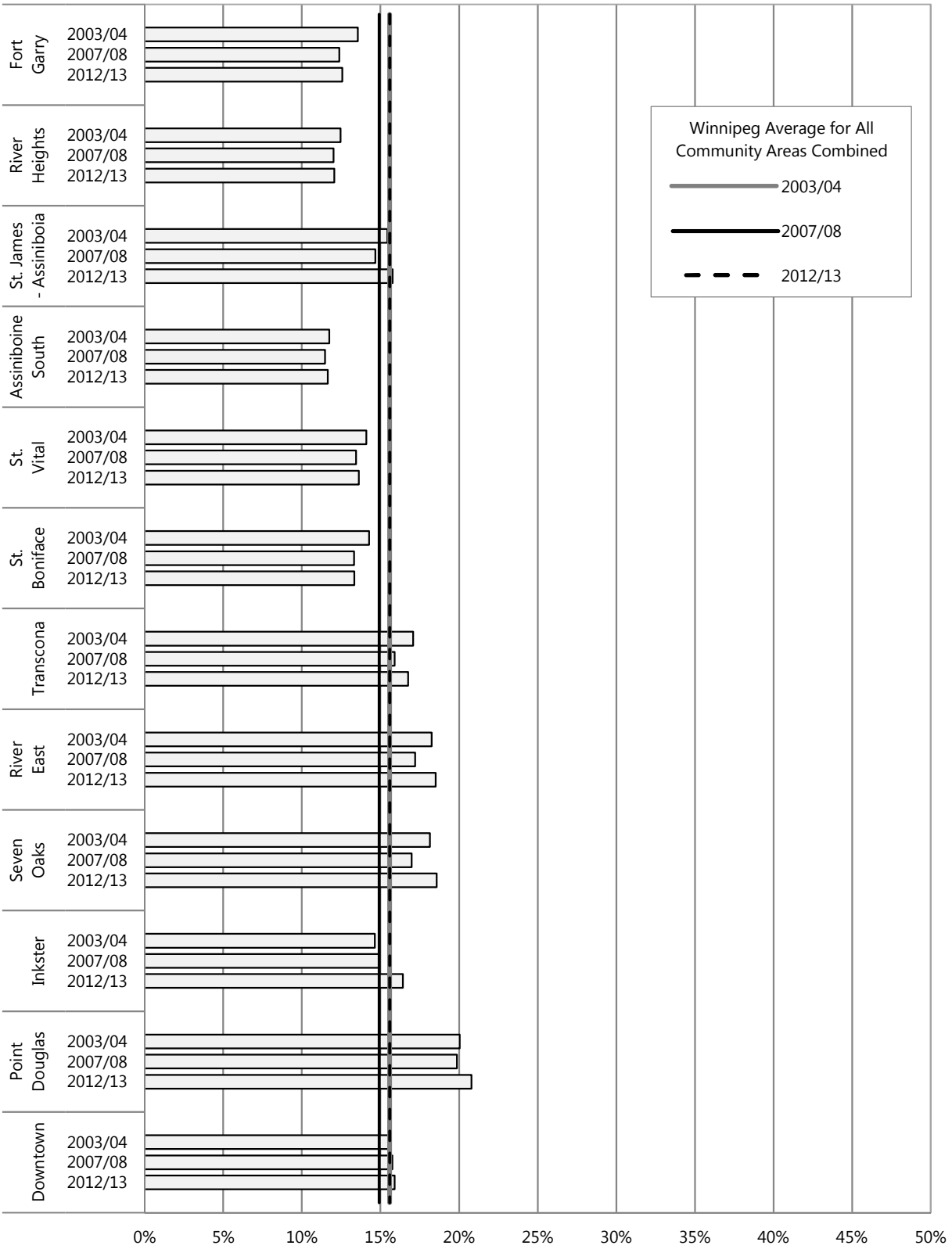


Figure 4.3: ED Population-based Rates in Select Years by Winnipeg Community Area

All Adult ED Sites Combined, Winnipeg, Manitoba



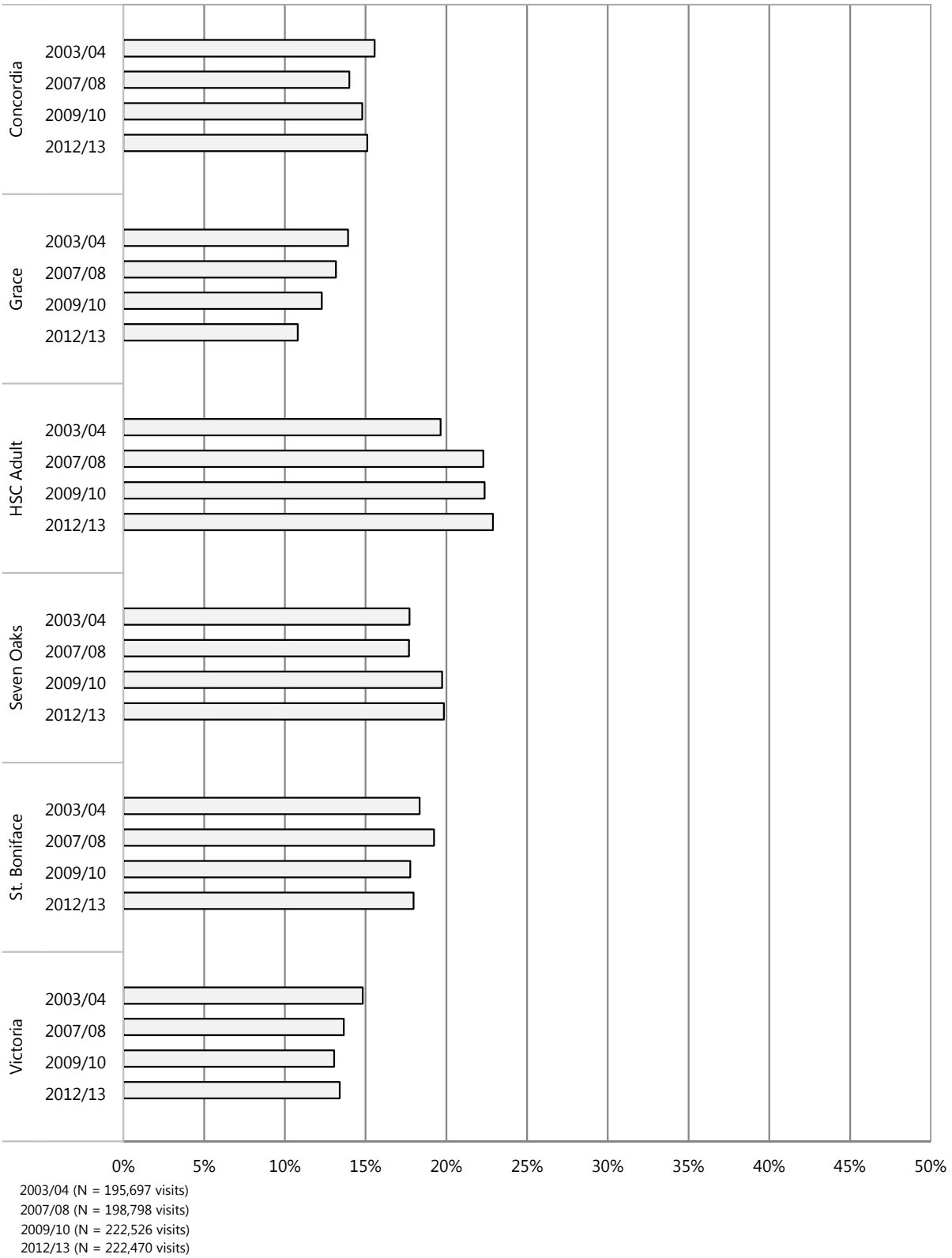
Trends in ED Visit-Based Rates

Overall counts of ED visits are shown across time, stratified by patient demographics, CTAS level, and arrival and discharge status.

- Total ED visit counts had remained steady at about 200,000 visits annually from 2003/04 to 2008/09, but commencing in 2009/10, they increased to about 223,000 visits annually (Figure 4.4). This increase in visit counts coincides with EDIS implementation, at which time most Winnipeg EDs were renovated, partly to include more treatment areas. The increase in visits was most pronounced for the adult HSC site (e.g., 44,307 visits in 2007/08; 50,910 visits in 2012/13) and for Seven Oaks (35,160 visits in 2007/08; 44,166 visits in 2012/13), while Grace experienced a reduction in ED visits during this time (e.g., 26,171 visits in 2007/08; 24,015 visits in 2012/13) (data not shown). Consequently, the proportion of all ED visits occurring at HSC and Seven Oaks has gradually increased with time. By 2012/13, these sites comprised 42.7% of all ED visits.

Figure 4.4: Percent of ED Visits Stratified by Adult ED Site

Winnipeg, Manitoba, Select Years from 2003/04 to 2012/13



2003/04 (N = 195,697 visits)
2007/08 (N = 198,798 visits)
2009/10 (N = 222,526 visits)
2012/13 (N = 222,470 visits)

- Using data from all sites combined, trends in ED visits were stratified by patient age group, income quintile, and Winnipeg community area (Figures 4.5 through 4.7). In any given year, people aged 25-64 accounted for about 56% of all ED visits, while patients aged 85 and older accounted for about 6% of all visits (Figure 4.5).[11] Approximately 20% of people reside in each income quintile, but people in the lowest income quintile comprised almost 30% of ED visits annually, while people in the highest income quintile comprised only 15% of all ED visits annually (Figure 4.6). Last, in each year of the data shown in Figure 4.7, ED visit rates varied depending on where patients lived. For example, in 2012/13, 17.6% of the Winnipeg population lived in the Winnipeg core (i.e., the Downtown and Point Douglas community areas, data not shown). From Figure 4.7, people residing in these communities accounted for about 21% of ED visits in each fiscal year. In all other community areas, the distribution of visits is roughly proportional to the number of people living in the area.

11 While not shown in this report, in 2012/13, people aged 25-64 comprised about 55% of the Winnipeg population, while people aged 85 and older comprised about 2.2% of the population. These data help to illustrate the disproportionate use of EDs by patient age.

Figure 4.5: Percent of ED Visits Stratified by Patient Age Group

All Adult ED Sites Combined, Winnipeg, Manitoba, Select Years from 2003/2004 to 2012/13

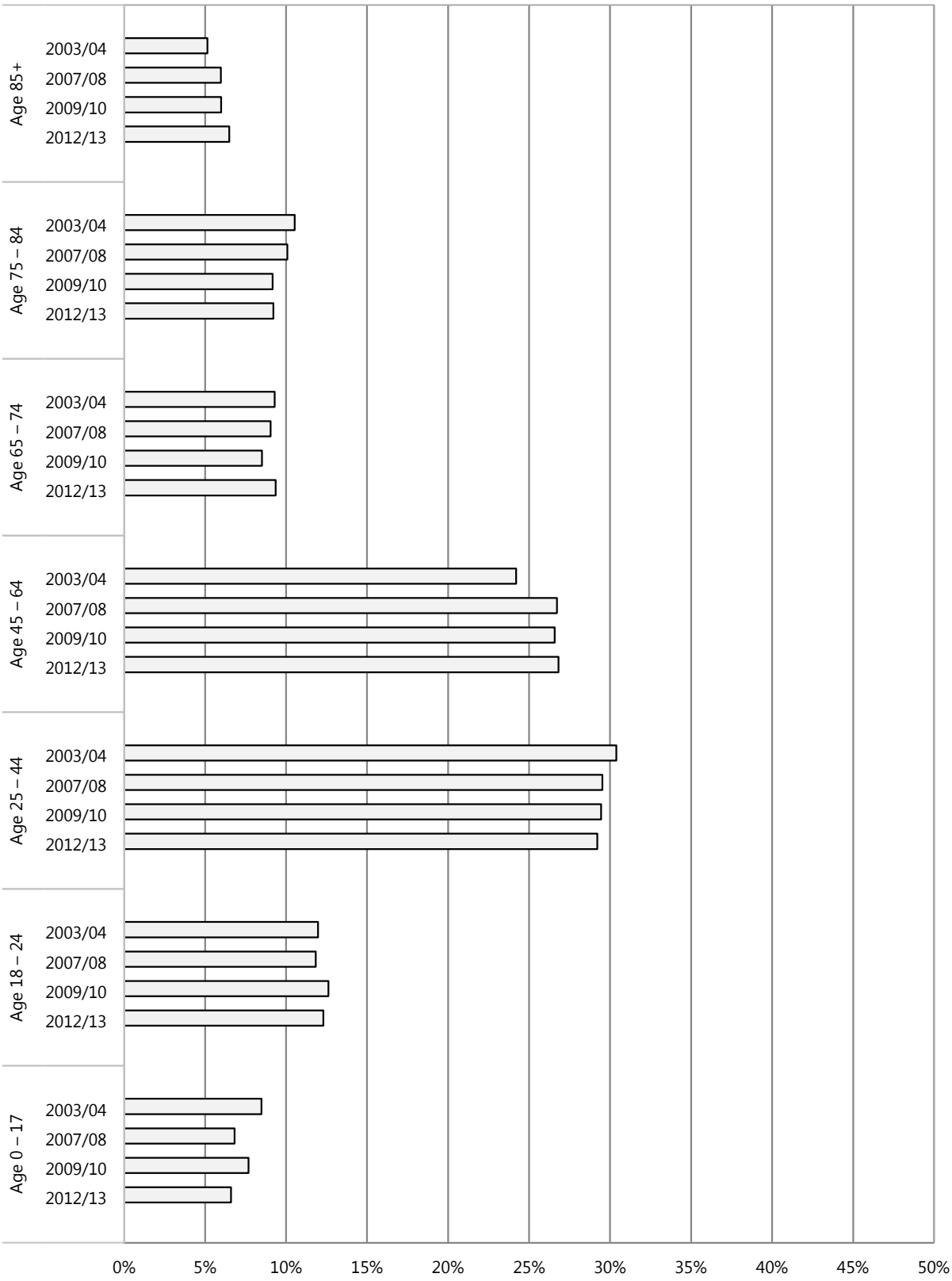


Figure 4.6: Percent of ED Visits Stratified by Patient Income Quintile

All Adult ED Sites Combined, Winnipeg, Manitoba, Select Years from 2003/2004 to 2012/13

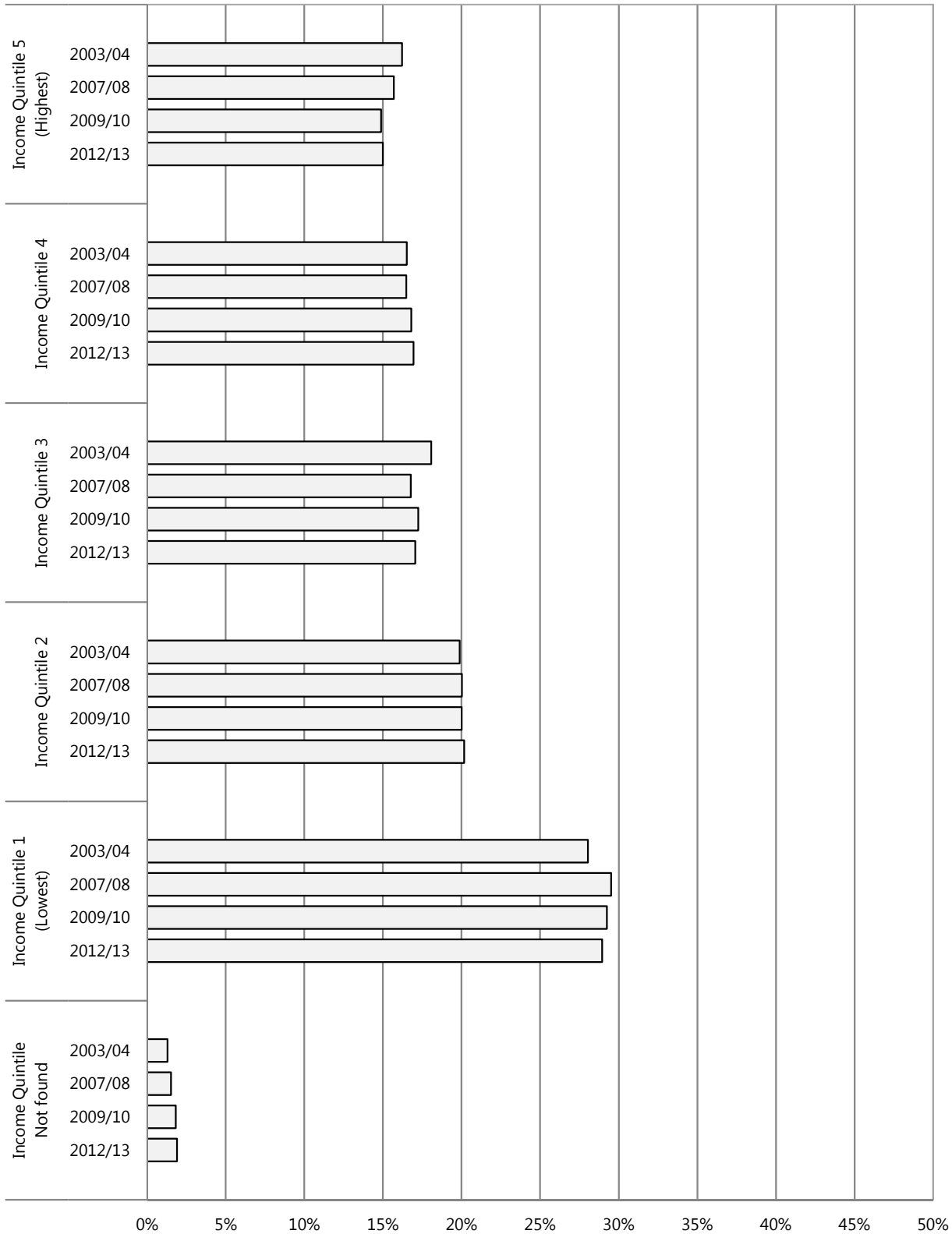
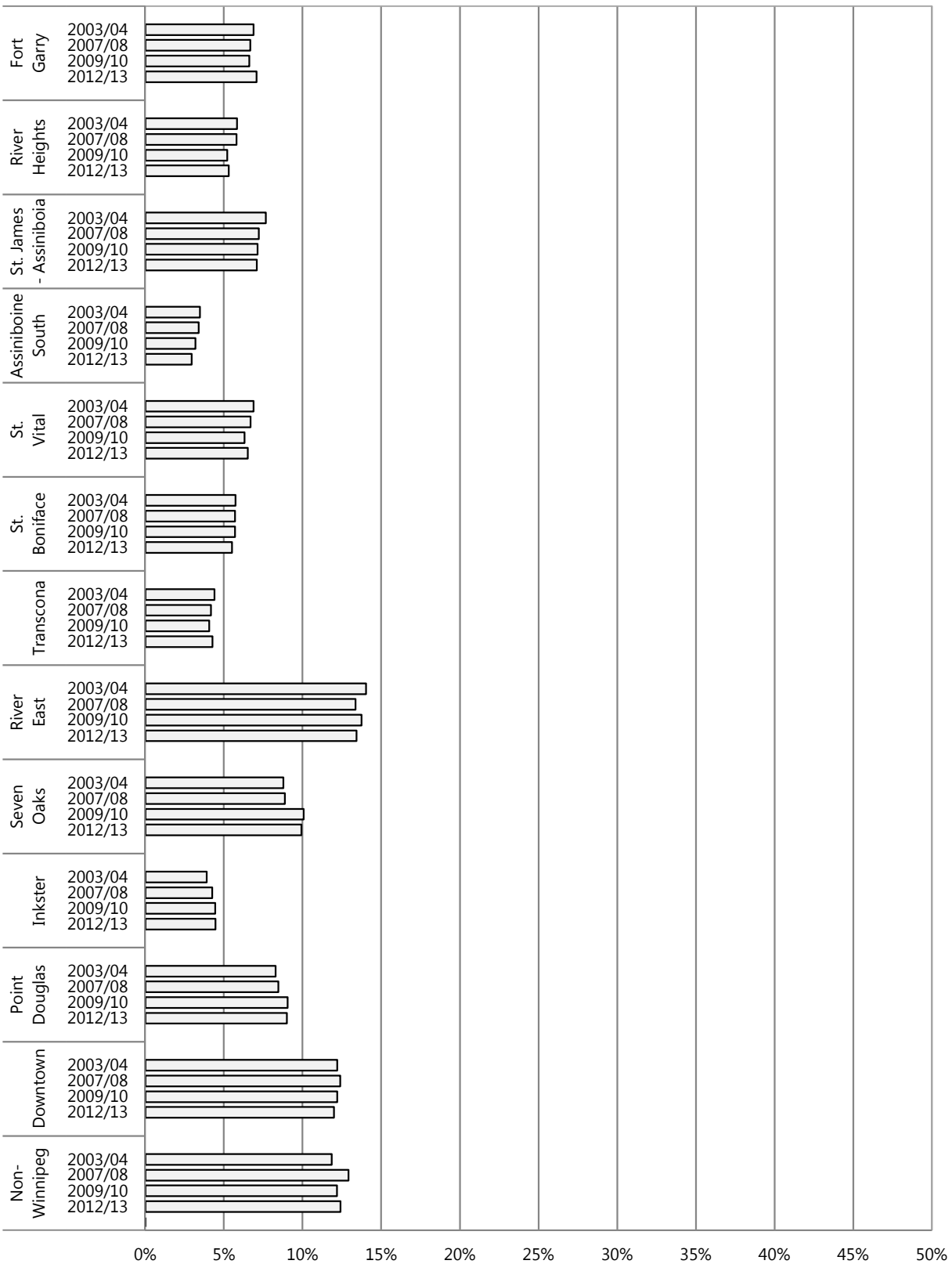


Figure 4.7: Percent of ED Visits Stratified by Community Area

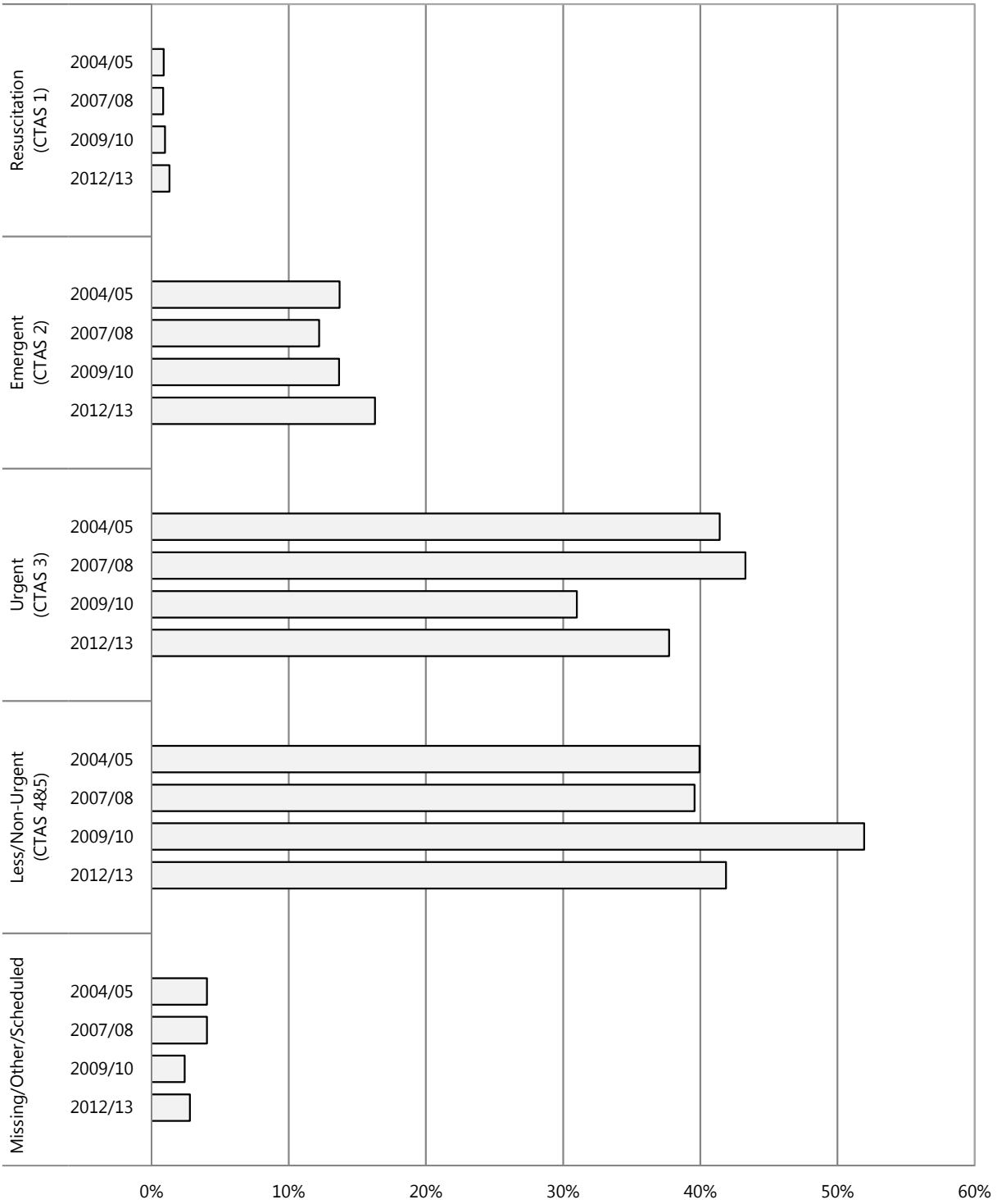
All Adult ED Sites Combined,Winnipeg, Manitoba, Select Years from 2003/2004 to 2012/13



- Annually since 2004/05, less than 1% of ED visits were triaged as highly urgent (i.e., CTAS level 1, resuscitation) (Figure 4.8), and until 2007/08 about 39% of all visits were triaged as less or non-urgent. With the onset of EDIS in 2009/10, the proportion of visits triaged as lowest acuity has remained somewhat stable, ranging from 44.0% of all visits in 2011/12, and 41.9% of all visits in 2012/13. Also, while the proportion of visits by most discharge options has remained quite stable with time (e.g., annually, patients were discharged home after 69% to 75% of visits, Figure 4.9), those where patients who left without seeing a physician has increased steadily with time, ranging from 5.9% of all visits in 2004/05, 7.8% of visits in 2007/08, to 10.0% of visits in 2012/13.

Figure 4.8: Percent of ED Visits Stratified by CTAS Level

All Adult ED Sites Combined, Winnipeg, Manitoba, Select Years from 2004/2005 to 2012/13

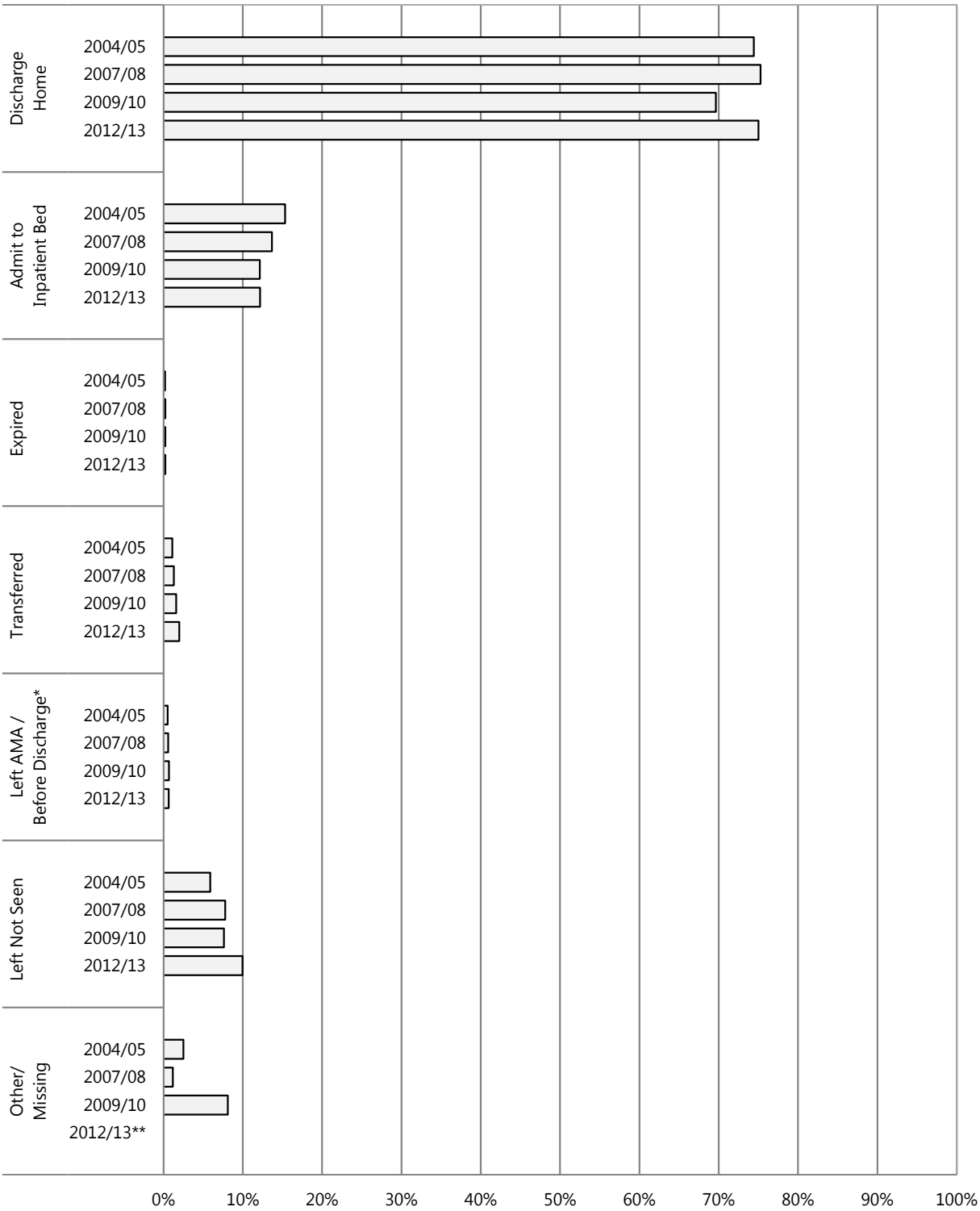


Note: Computer generated CTAS sores were first implemented in 2004/05, permitting fair comparisons across fiscal years.

Note: Scheduled visits comprise between 1% and 4% of all ED visits annually. These visits are assigned a CTAS code in EDIS (commencing 2009/10) but not in the previously used ADT system. For this reason, scheduled visits are combined with 'missing' and 'other' in this figure.

Figure 4.9: Percent of ED Visits Stratified by Disposition Status

All Adult ED Sites Combined, Winnipeg, Manitoba, Select Years from 2004/05 to 2012/13



* AMA refers to Against Medical Advice.

** indicates data suppressed due to small numbers.

Note: Seven Oaks is excluded from 2004/05 since disposition status data were not captured at this site in this year.

SECTION II: AN ANALYSIS OF INPUT, THROUGHPUT, AND OUTPUT FACTORS AFFECTING ED WAITING ROOM TIMES

CHAPTER 5: COMPARING INPUT, THROUGHPUT, AND OUTPUT FACTORS ACROSS ED SITES

Chapter Highlights

Section I of this report demonstrates the high quality of the EDIS data, and importantly, shows how Winnipeg EDs continue to be used disproportionally by socially disadvantaged people, and often for less urgent reasons. The present chapter builds on these results by showing the unique features of Winnipeg EDs, both in terms of their operating capacity (i.e., how full they are at any given time) and patient turnover (i.e., whether they remain full with the same or different patients throughout the day). Sites are also compared by their input (e.g., patient volume by chief complaint category), throughput (e.g., number of diagnostic tests performed), and output (e.g., number of patients admitted to hospital) characteristics. These findings have implications for: i) richly describing the range of ED care environments in Winnipeg, and ii) helping to explain why in some instances waiting room times vary substantially from one ED site to the next.

The unique features of each site are described in the following text.

- During the study period, the Adult Health Sciences Centre had one of the highest operating capacities of all EDs in Winnipeg and one of the highest patient turnover rates. This site also had the youngest and poorest patient clientele as well as the most visits made for mental health, substance misuse, and trauma reasons. Patients at this site were triaged as having highly acute (CTAS 1) needs at a rate of about two visits daily, versus about one such visit daily at St. Boniface, and one such visit every other day at community-based EDs. Patients were admitted into hospital most often at this site.
- St. Boniface was average in terms of its operating capacity and daily patient turnover. Patients were triaged as having cardiovascular problems during the largest proportion of visits at this site, and accordingly, troponin blood tests were performed most frequently at this site.[12] St. Boniface had the highest supply of ED physicians, and was the only ED to report not having nurse practitioners or physician assistants during the study period.
- Grace had the highest operating capacity during the study period but the lowest patient turnover. This site also had the greatest proportion of visits made by older adults, visits where patients arrived by ambulance, and (except for the Victoria ED) visits where patients came from a personal care home. Diagnostic tests (especially x-rays, CT scans, and blood tests of any type) were performed frequently at this site.
- Seven Oaks had the lowest operating capacity of all Winnipeg EDs, but had the highest patient turnover. Patients at this site tended to receive fewer diagnostic tests, and this is especially true for CT scans and all blood tests combined. Patients were admitted to hospital least frequently at this ED. Seven Oaks had an 'average' supply of ED physicians in 2012/13, and had the highest supply of nurse practitioners and physician assistants.
- Victoria and Concordia were similar to most other EDs with a few exceptions. Second only to Grace, the Victoria ED had the largest proportion of visits made by patients 75+ years old, and except for St. Boniface had the lowest supply of nurse practitioners and physician assistants. Concordia had the largest number of visits made for skin and orthopedic reasons.

12 Manitoba's cardiac sciences program is housed at the St. Boniface Hospital. This program integrates cardiac surgery, cardiology, cardiac anesthesia, cardiac intensive care and cardiac rehabilitation resources under one umbrella to improve the coordination and delivery of cardiac services to the people of Manitoba. (http://www.sbgh.mb.ca/patientCare/cardiac.html)

Chapter-Specific Methods

This chapter compares the adult ED sites in Winnipeg by various input, throughput, and output factors. We used 2012/13 data after making Level I exclusions (see Figure 2.2). All results in this chapter are limited to visits that occurred between 8:00 a.m. and 8:00 p.m. daily.

Some results in this chapter are expressed as a proportion of ED physical capacity. This capacity was calculated at each site using the following criteria, developed in consultation with Advisory Group members. First, to be counted as a regularly used treatment area, each site must have been listed as a permanent ED location in EDIS (e.g., omitting triage and waiting room areas, ambulance drop off locations). Second, the location must have been used regularly (at least 150 days) during the study period, for an average minimum of four hours during these days of use. Third, at least 60% of the total time allocated to each location had to have been marked as 'treatment in progress' in EDIS. These criteria omit ED locations that are considered as internal waiting rooms (e.g., so that patients with mental health challenges can wait to be seen by a provider in a quieter space), but include other locations (e.g., designated hallway locations at Grace, minor treatment areas and suture rooms at most sites) besides traditional ED beds. Using these criteria, the number of regularly used treatment areas at each site is provided in Table 5.1. These data were used in this chapter to calculate: i) the median ED operating capacity (i.e., how full EDs were; expressed as a ratio of the number of existing patients when a new patient showed up to the total number of regularly used treatment areas); ii) daily patient turnover (expressed as a ratio of the number of daily visits to the total number of regularly used treatment areas); and iii) provider supply (number of providers reported within one hour of each patient's registration time; expressed per 10 regularly used treatment areas).

Detailed Chapter Results

Operating Capacity and Visit Turnover Rates

Patients made 146,898 ED visits to the six ED sites in Winnipeg between the hours of 8:00 a.m. and 8:00 p.m. in 2012/13 (Table 5.1). EDs operated at a median capacity of 128.1% during these daytime hours (i.e., for 50% of all visits, when people showed up at the ED there were 28.1% more existing patients present than treatment areas available). This median operating capacity was highest at the Grace (142.4%) and the adult HSC (137.2%) ED, and lowest at Seven Oaks (118.8%).

Data on patient turnover provide further detail (Table 5.1). Grace is defined as a "full" ED but had the lowest patient turnover during the study period (median of 1.3 visits per treatment area per day). In other words, Grace tended to be consistently full, but mostly with the same patients on any given day. By comparison, patient turnover was highest at Seven Oaks during the study period, at a median of 2.4 visits daily per treatment area.

Table 5.1: Operating Capacity and Daily Visit Turnover

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

	Number of ED Visits	Number of Regularly Used Treatment Areas*	Operating Capacity - Median (Inter-Quartile Range)**	Daily Turnover - Median (Inter-Quartile Range)†
All Sites	146,898	212	128.1 (105.9–152.9)	1.9 (1.5–2.2)
Concordia	22,725	29	120.7 (100.0–144.8)	2.1 (1.9–2.3)
Grace	15,798	33	142.4 (121.2–160.6)	1.3 (1.1–1.4)
HSC Adult	32,752	43	137.2 (114.0–160.5)	2.0 (1.8–2.2)
Seven Oaks	29,103	32	118.8 (93.8–143.8)	2.4 (2.3–2.7)
St. Boniface	27,016	41	129.3 (104.9–153.7)	1.8 (1.6–1.9)
Victoria	19,504	34	123.5 (105.9–147.1)	1.5 (1.4–1.7)

*Calculated in conjunction with Advisory Group members, and includes traditional ED beds and other locations (e.g., designated hallway spaces, minor treatment areas, suture rooms) meeting criteria as defined in the Methods section of this chapter.

**Operating Capacity: A measure of how full EDs were. This outcome was created by counting the number of existing ED patients present when a new patient showed up, and expressing this as a percent of regularly used treatment areas. The denominator for this calculation is the visit (total N=146,898) overall and for each ED site.

†Daily Turnover: Counts the number of visits between the hours of 8:00 a.m. & 8:00 p.m. daily expressed relative to the number of regularly used treatment areas. The denominator for this calculation is the day (N=365) overall for each ED site.

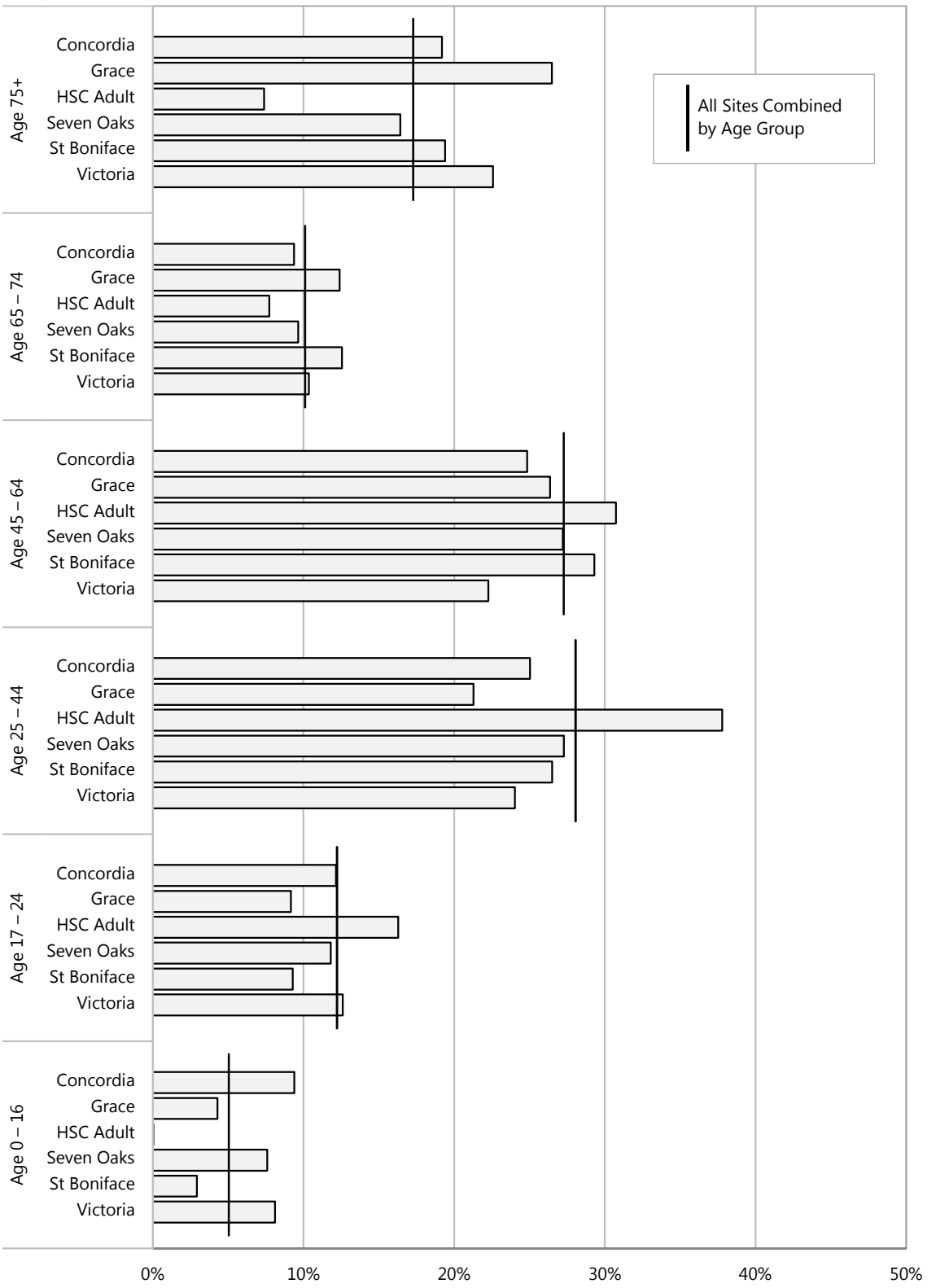
Input Factors

Winnipeg ED sites are also compared by their patients' demographic profile and by additional input factors (arrival status, CTAS levels, and chief complaints). These results are summarized in the following text:

- Across all sites combined, 55.3% of ED visits in Winnipeg were made by people 25-64 years old, while 17.3% of visits were made by people 75 years and older (Figure 5.1). This varies by ED site; HSC had the largest proportion of visits (68.5%) made by people 25-64 years old, while Grace (26.5% of all visits) and Victoria (22.6% of all visits) had the most visits made by people 75+ years old.

Figure 5.1: Percent of ED Visits Stratified by Patient Age

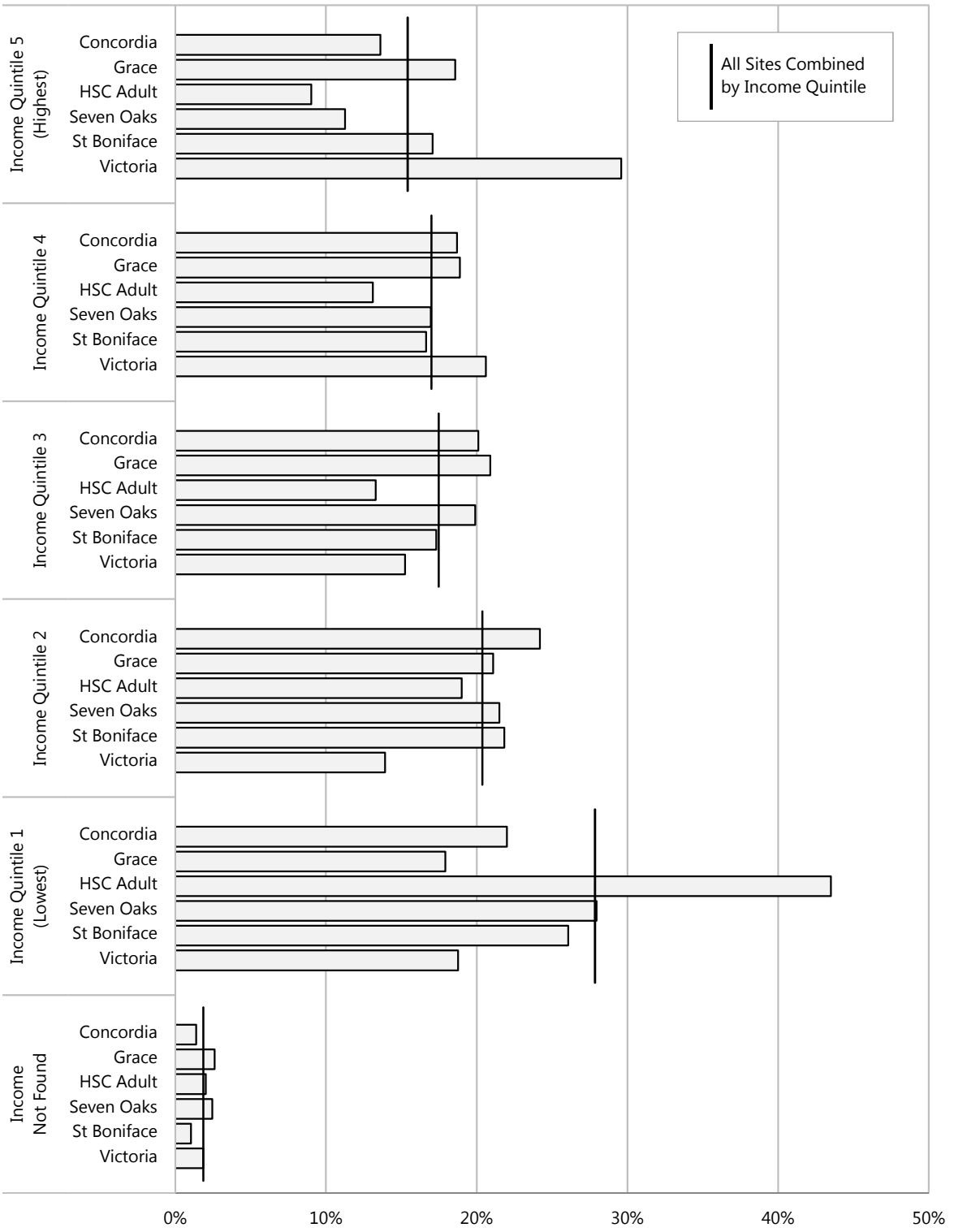
ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



- Site differences are also reported by income quintile (Figure 5.2). HSC had by far the highest proportion of visits (43.5%) made by people living in the lowest income neighborhoods. Similarly, 42.9% of all visits to HSC were made by people living in the Downtown and Point Douglas community areas (i.e., the Winnipeg core) (data not shown).

Figure 5.2: Percent of ED Visits Stratified by Patient Income Quintile

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



- ED sites varied substantially by patient arrival status (Figure 5.3). Patients arrived by ambulance most frequently to Grace (27.0% of visits), versus for about 15% of visits at each of the Concordia, Seven Oaks, and St. Boniface sites. Patient triage scores also varied considerably across sites (Figure 5.4). HSC had the highest proportion of visits triaged as CTAS level 1 (1.9%), while St. Boniface had the highest proportion of visits triaged as emergent (CTAS 2, 23.8%). Conversely, Concordia had the highest proportion of visits (51.9%) triaged as less or non-urgent (CTAS 4&5), while St. Boniface had the smallest proportion of these lowest acuity visits (34.2%).

Figure 5.3: Percent of ED Visits Stratified by Patients Who Arrived by Ambulance

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

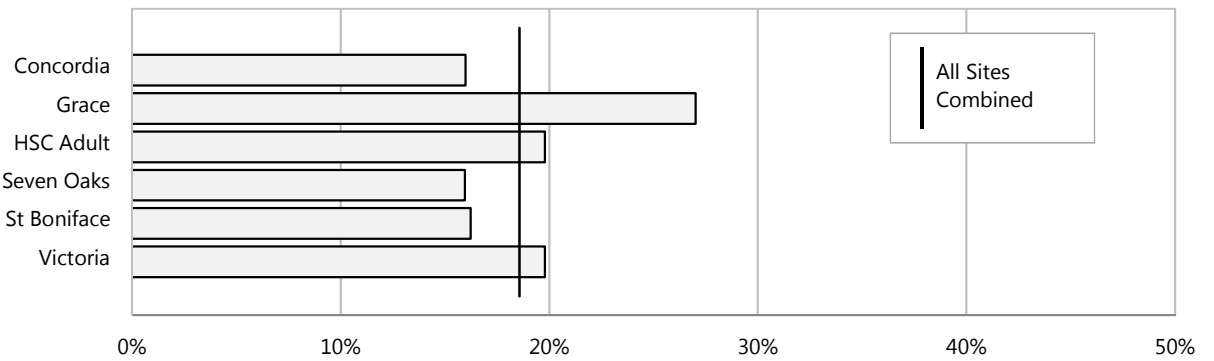
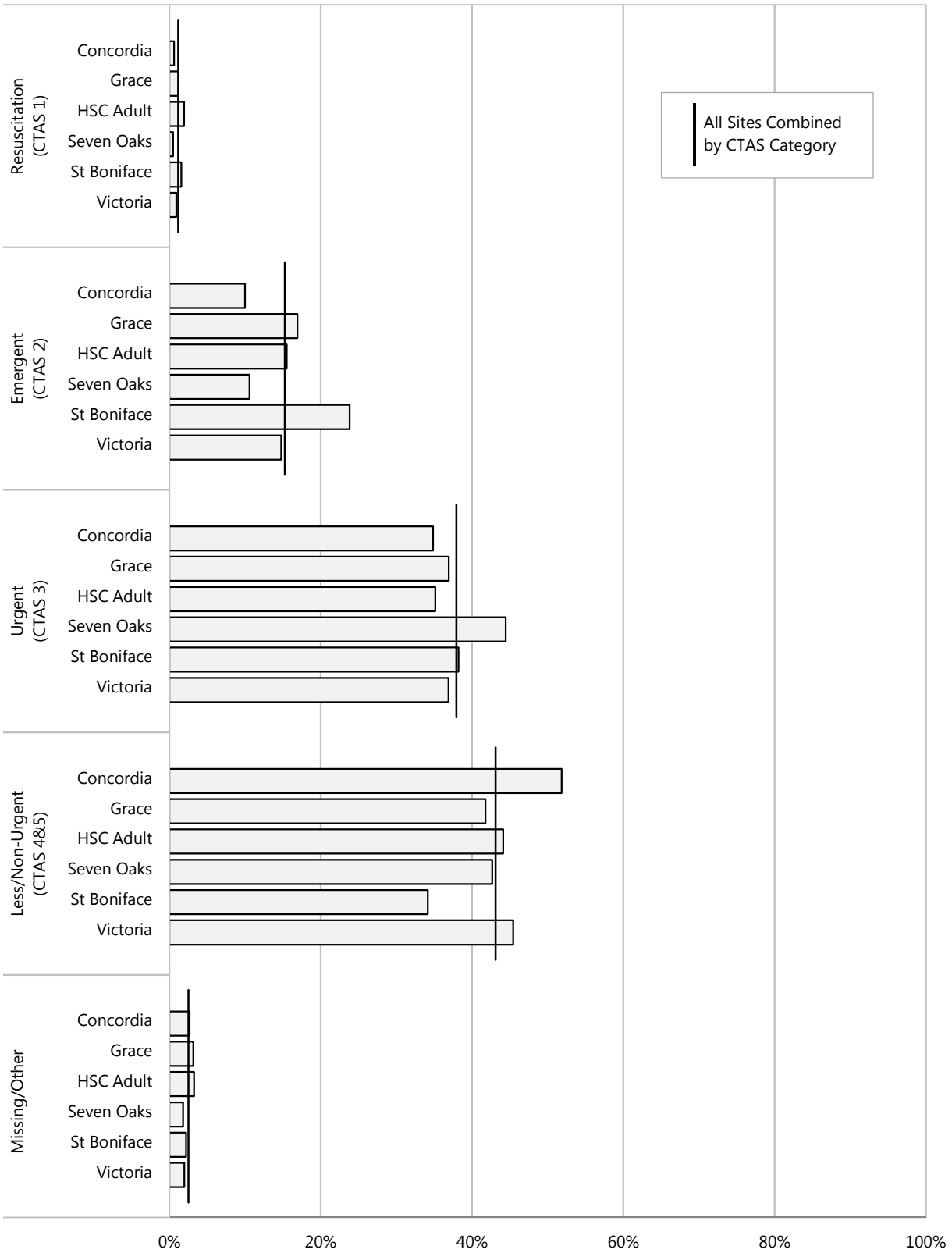


Figure 5.4: Percent of ED Visits Stratified by Patient CTAS Level

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



- Using the EDIS chief complaint data, we found that about 15% of visits to all sites were made for each of orthopedic, cardiovascular, and gastrointestinal reasons (Figure 5.5). This distribution of visits varied by site, with about 1 in 5 visits at Concordia and Seven Oaks made for orthopedic reasons (versus, for example, only 10.0% of all visits at St. Boniface). Conversely, 22.3% of all visits at St. Boniface were made for cardiovascular reasons, versus only about 11% of visits at each of Concordia, Seven Oaks, and the adult HSC. HSC had the greatest proportion of visits (3.7%) made for trauma-related reasons (versus one percent of visits or less made to all other sites), and also for patient mental health (4.8% of all visits) and substance misuse challenges (3.1% of all visits). These findings coincide with other measures of chronic disease using physician diagnostic codes (data not shown). While a similar proportion of visits (approximately 30%) at each site were made by people diagnosed with two or more chronic physical diseases, patients with two or more mental illnesses comprised a much greater proportion of visits to HSC (22.7%) compared to all other sites combined (fewer than 15% of visits).

Figure 5.5: Percent of ED Visits Stratified by Chief Complaint

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

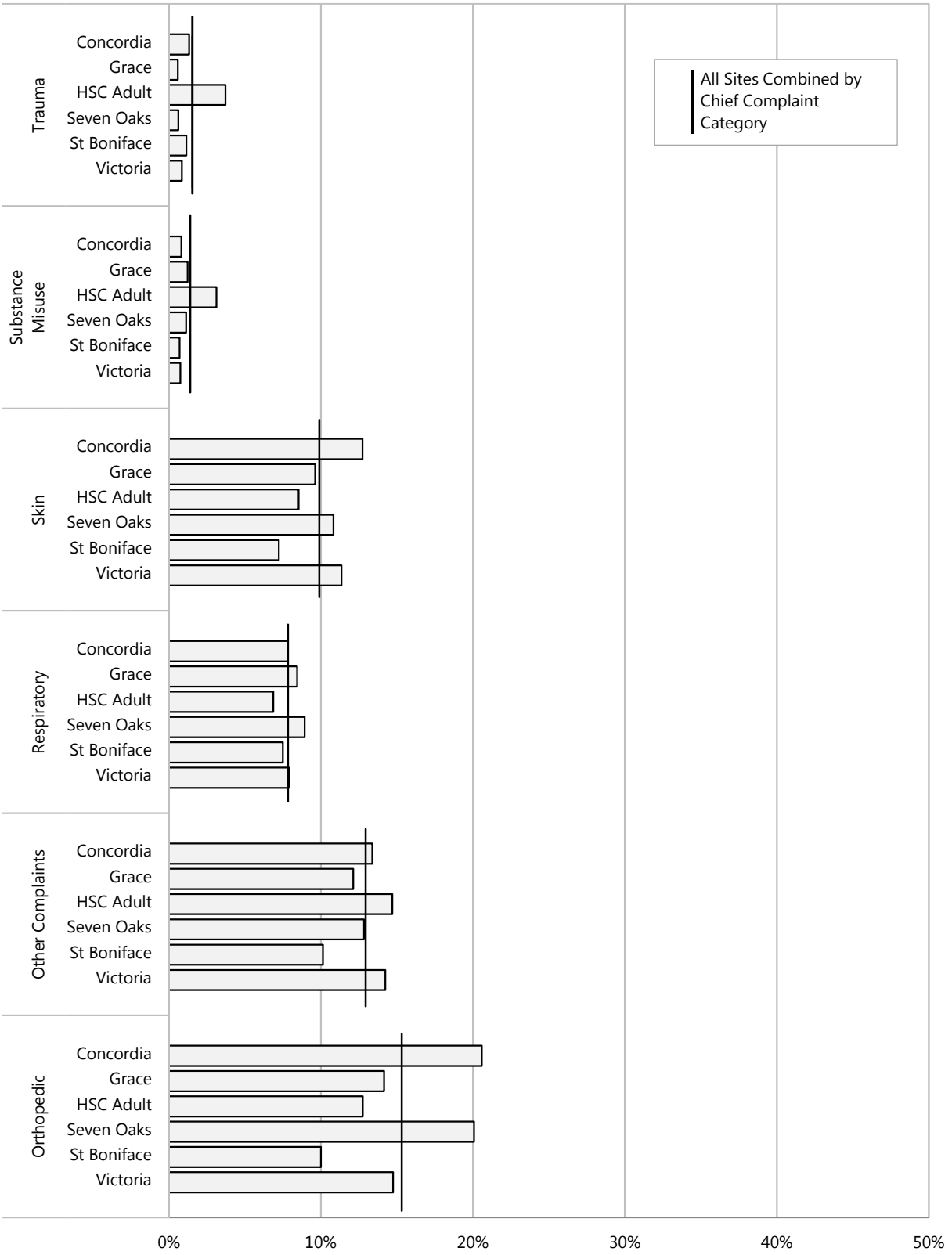
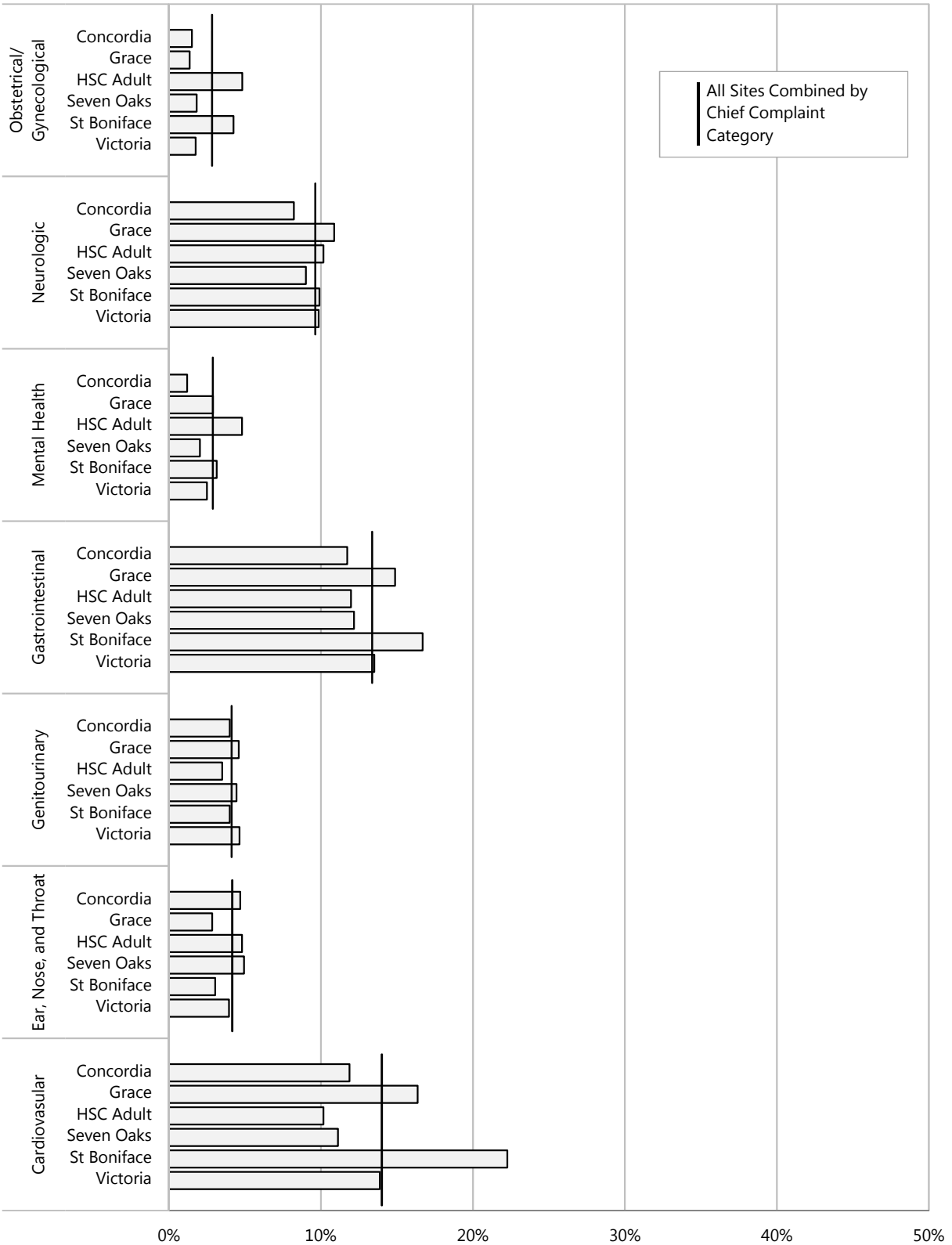


Figure 5.5: Continued



Throughput Factors

The list of diagnostic tests captured in EDIS and used in this report includes x-rays, urine tests, ultrasound tests, nuclear medicine tests, computed tomography (CT) scans, cerebral spinal fluid tests, magnetic resonance imaging (MRI), and cardiovascular tests (consisting mainly of angioplasty, angiograms, and catheterizations). While diagnostic tests were conducted during about 52% of visits at each ED (data not shown), the frequency with which some individual tests were performed varied considerably across sites.

- Cardiovascular tests were reported only at the St. Boniface (during 186 or 0.7% of all visits) and at the adult HSC (during 0.1% of all visits) sites. MRI tests were also reported only at these sites, during 1.0% and 0.5% of all visits made to the HSC and St. Boniface EDs, respectively (data not shown).
- X-rays were performed most frequently (during 35.8% of all ED visits) during the study period (Figure 5.6). This, however, varied by site, ranging from about 40% of all visits made at the Grace and Concordia EDs, to only 30.9% of all visits made at HSC. Similarly, the frequency of urine tests varied considerably by site, ranging from about 25% of all visits at each of the Grace, HSC, and Victoria EDs, to about 20% of visits at Concordia and Seven Oaks (Figure 5.7). CT scans were also performed during about 15% of all visits made to each of the Grace, adult HSC, and St. Boniface EDs, compared to only 6.2% of all visits made to Seven Oaks (Figure 5.8).
- All remaining diagnostic tests were performed less frequently, again however, with some variation by site (data not shown). For example, while patients had an ultrasound test during 2.5% of all ED visits, this occurred most often at each of Grace and St. Boniface (during about 3% of visits at each site), and during about 1.5% of all visits at each of Seven Oaks and Victoria. Similarly, nuclear medicine tests were performed during only 0.1% of all ED visits, although most often at the Grace and Victoria EDs (about 0.3% of visits at each site) and very rarely elsewhere. Cerebral spinal fluid tests were also performed during 0.3% of visits to all ED sites, and most frequently at the adult HSC (during 0.4% of all visits to this site).

Figure 5.6: Percent of ED Visits with one or more X-Rays Performed

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

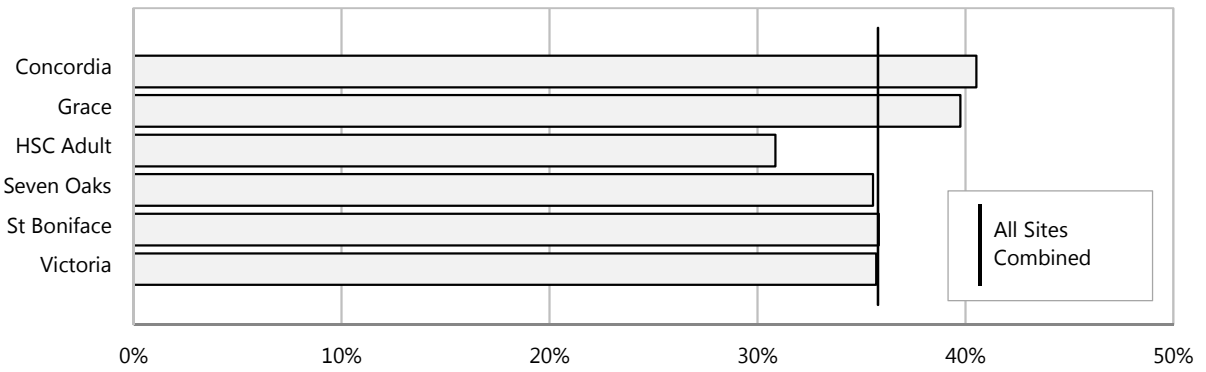


Figure 5.7: Percent of ED Visits with one or more Urine Tests Performed

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

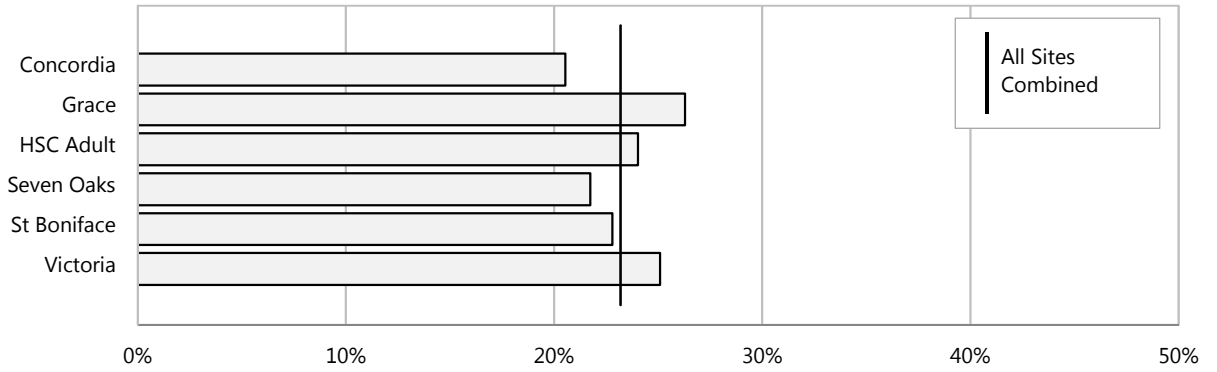
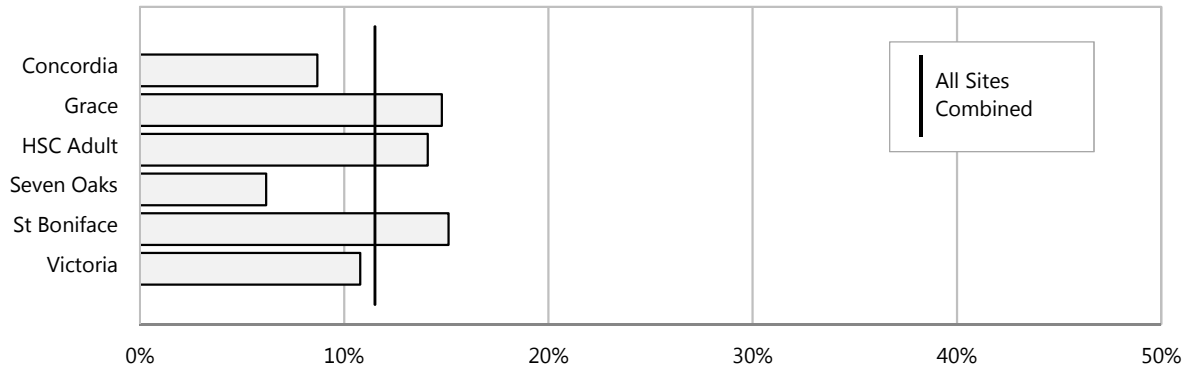


Figure 5.8: Percent of ED Visits with one or more Computed Tomography Scans Performed

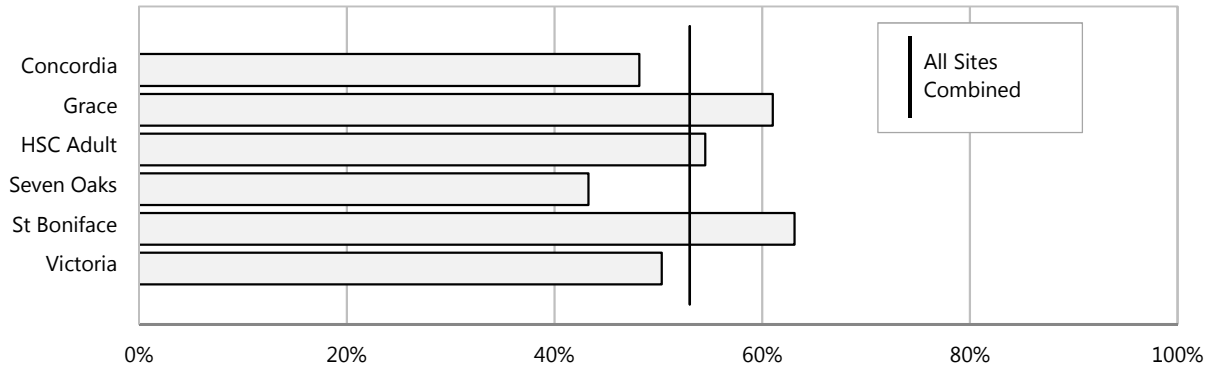
ED Visits between8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



- The frequency of blood tests (all types combined) is provided in Figure 5.9. Across all sites, blood work of any type was performed during 53.0% of visits. This however, varied by site, ranging from more than 60% of visits at each of Grace and St. Boniface, to only 43% of all visits at Seven Oaks. As one type of blood test, troponin levels were measured during 30.4% of visits at St. Boniface, during about 22% of visits at each of Grace and Victoria, and during only 8.2% of visits made at Seven Oaks (data not shown).

Figure 5.9: Percent of ED Visits with one or more Blood Tests Performed

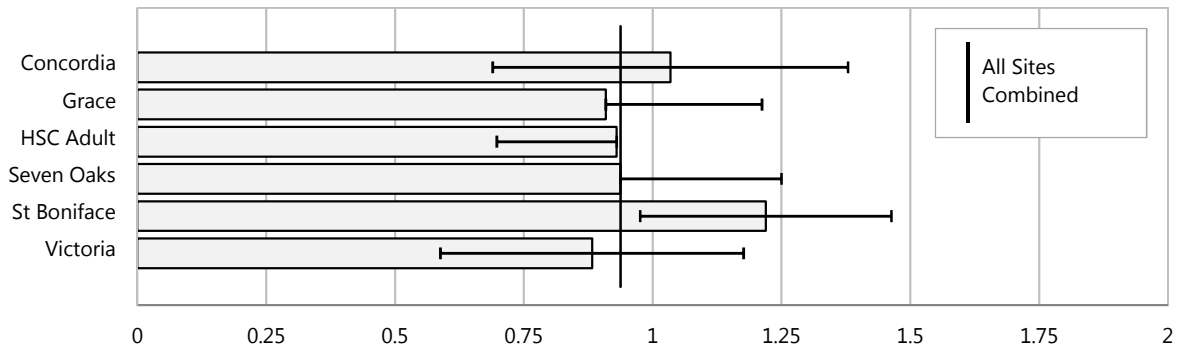
ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



- Provider supply was calculated as the number of professionals (i.e., physicians, nurse practitioners, and physician assistants) who were actively treating patients within one hour of their registration time, and expressed per 10 regularly used ED treatment areas. St. Boniface was reported to have the greatest supply of ED physicians during the study period (1.2 physicians per 10 regularly used treatment areas) (Figure 5.10), while physician supply was lowest at each of the Grace (0.91 physicians per 10 regularly used treatment areas) and the Victoria (0.88 physicians per 10 treatment areas) EDs. Conversely, the supply of nurse practitioners and physician assistants was greatest at the Seven Oaks ED (median of 0.94 providers per 10 regularly used treatment areas) and Grace EDs (median of 0.61 providers per 10 treatment areas), and negligible at the St. Boniface and Victoria EDs (data not shown).

Figure 5.10: ED Physician Supply (Number of Providers per 10 Regularly used Treatment Areas)

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Values are expressed as median (50th percentile) and inter-quartile range values (25th and 75th percentiles). Based on 146,898 ED visits.

Output Factors

Output factors (the number of patients placed on hold[13] and waiting for admission into hospital) also varied considerably across ED sites.

- Patients were placed on hold during 7.6% of all visits during the study period (Figure 5.11). This occurred during a much greater proportion of visits at the Grace (16.1% of all visits) and Victoria (14.5%) EDs, and during less than 6% of all visits at each of the HSC, Seven Oaks, and St. Boniface sites. Patients were admitted to hospital after about 16.0% of all visits made to each of the HSC and St. Boniface sites, after 12.4% of all visits at the Grace, and after only 8.7% of all visits at Seven Oaks (Figure 5.12).

Figure 5.11: Percent of ED Visits Where Patients Were Placed on Hold

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

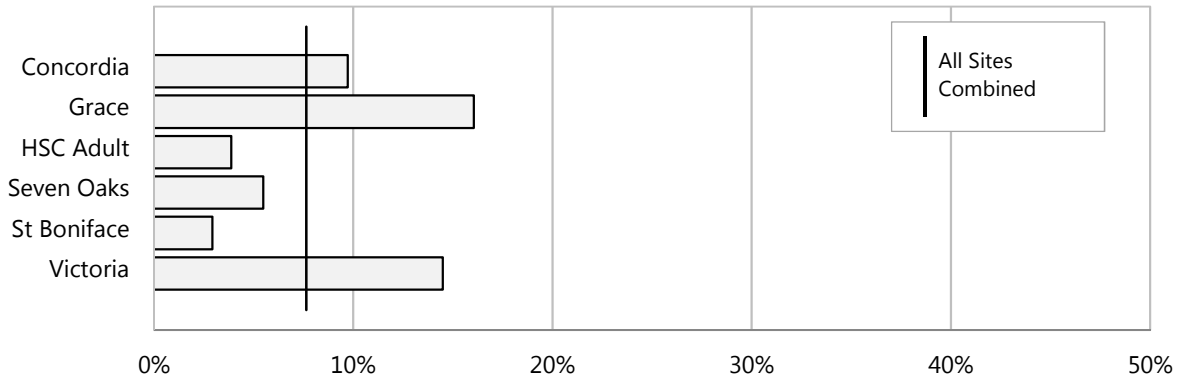
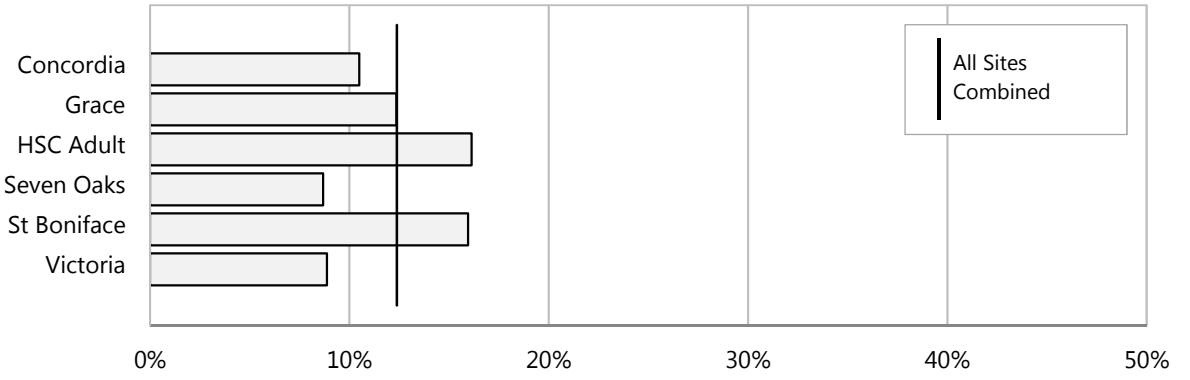


Figure 5.12: Percent of ED Visits Where Patients Were Admitted to Hospital

ED Visits between 8:00 a.m. and 8:00 p.m., Overall and by Adult ED Site, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



13 ED patients can be placed on hold at any time during their visit for a number of reasons, mainly to ensure that they are stabilized or to confirm their diagnosis and follow-up care plan.

CHAPTER 6: FACTORS INFLUENCING WAITING ROOM TIMES: ALL ED SITES COMBINED

Chapter Highlights

Using data from the six ED sites combined, this chapter first describes the duration of different ED visit components (e.g., waiting, treatment, and boarding times). Using multivariate statistical techniques, we then describe how select input, throughput, and output factors impact ED waiting room times for patients with different CTAS levels. Highlights from these analyses are as follows:

- The median duration of all 'daytime' ED visits in 2012/13 was 5.1 hours. This duration was longest for CTAS 1 (median 6.1 hours) and CTAS 2 (median 7.3 hours) visits, and was shortest for CTAS 4&5 visits (median 4.0 hours). These visit durations, however, varied tremendously. As an example, while 10% of CTAS 2 visits during the study period lasted at most 2.8 hours, an additional 10% lasted at least 26.0 hours. Similarly, one-quarter of all CTAS 4&5 visits lasted at least 6.7 hours in 2012/13.
- Patients spent their time differently in EDs depending on their CTAS level. In general, CTAS 2 patients spent shorter periods of time waiting for care (e.g., median waiting room time=42 minutes) and longer periods receiving it (median treatment time=3.5 hours). The opposite pattern exists for lower acuity patients; in 2012/13 CTAS 4&5 patients spent a median of 1.6 hours in the waiting room, and only a median of 1.1 hours receiving treatment. In all instances, however, these general patterns varied substantially. For example, while the median waiting room time for CTAS 2 patients was only 42 minutes, during 10% of CTAS 2 visits patients remained in the waiting room for at least 4.7 hours (282 minutes). Also, the median post-treatment time (from the end of physician treatment to patient disposition) for CTAS 4&5 patients was 0 minutes, but it was at least 1.6 hours (96 minutes) for 10% of these patients.
- The remaining analyses in this chapter identify factors affecting ED waiting room times.
  i. No set of input, throughput, or output factors strongly influenced CTAS 1 waiting room times. In other words, the highest acuity ED patients were consistently seen by a provider almost immediately. These patients, however, comprised only about 1% of all ED visits.
  ii. Higher volumes of incoming people (i.e., input factors) generally did not impact the waiting room times of CTAS 2 patients. Instead, waiting room times for these patients were more strongly influenced by higher volumes of both output (i.e., the volume of patients waiting to be admitted into hospital) and throughput (i.e., the volume of patients waiting for diagnostic tests) factors. To illustrate, EDs had periods of time where 5% to 45% of treatment areas were filled with patients waiting to be hospitalized, and in these scenarios median adjusted CTAS 2 waiting room times ranged from 20.5 minutes to 138.7 minutes. Similarly, during periods where 5% to 45% of treatment areas were filled with patients waiting for urine tests, adjusted median CTAS 2 waiting room times ranged from 30.4 minutes to 115.2 minutes.
  iii. These same findings generally exist for all other (CTAS 3-5) patients, with one exception: after adjustment for all other factors, greater numbers of incoming higher acuity (e.g., CTAS 2) people lengthened the waiting room times of lower acuity (e.g., CTAS 4&5) patients. This impact, however, was fairly small as compared to the impact of output and especially throughput factors. From these and other results we conclude that the strategies to reduce waiting room times should focus primarily on ED- and hospital-related factors.
- We also investigated the relationship between ED boarding time (from physician decision to hospitalize a patient to the patient's actual hospital admission) and hospital capacity. Our results show that hospitals were less than 90% full when two-thirds of ED patients were waiting for hospital admission. On these occasions, median ED boarding times increased by only 3.4 minutes for every 1% increase in hospital capacity. Similarly, hospitals were between 5% and 15% filled with alternate level of care (ALC) patients when two-thirds of ED patients were waiting for a hospital bed. On these occasions median ED boarding time increased by only 2.4 minutes for every 1% increase in the proportion of hospital beds occupied by ALC patients. While these

increases were much greater at higher levels of hospital occupancy (e.g., median boarding time increased 4.4 hours when hospitals went from 91% to 100% full), overall from these results we conclude that — to the extent that output factors influence ED waiting room times — reform strategies should focus on transition processes and not simply creating additional hospital capacity.

Chapter-specific Methods

Chapter results were created using a summarized dataset where each ED visit (i.e., index visit) is linked to a set of existing visits. The study outcome is the median waiting room time of each index visit. Risk factors affecting this outcome were created from each set of existing visits (e.g., by defining how many of these existing patients were waiting for diagnostic tests, how many were waiting for hospital admission).

Each index ED visit was defined by its registration time, a 30-minute period preceding this time,[14] and its waiting room time (Figure 6.1). This time is referred to as 'Period A' for each index visit. Existing visits were linked to each index visit using the following rules:

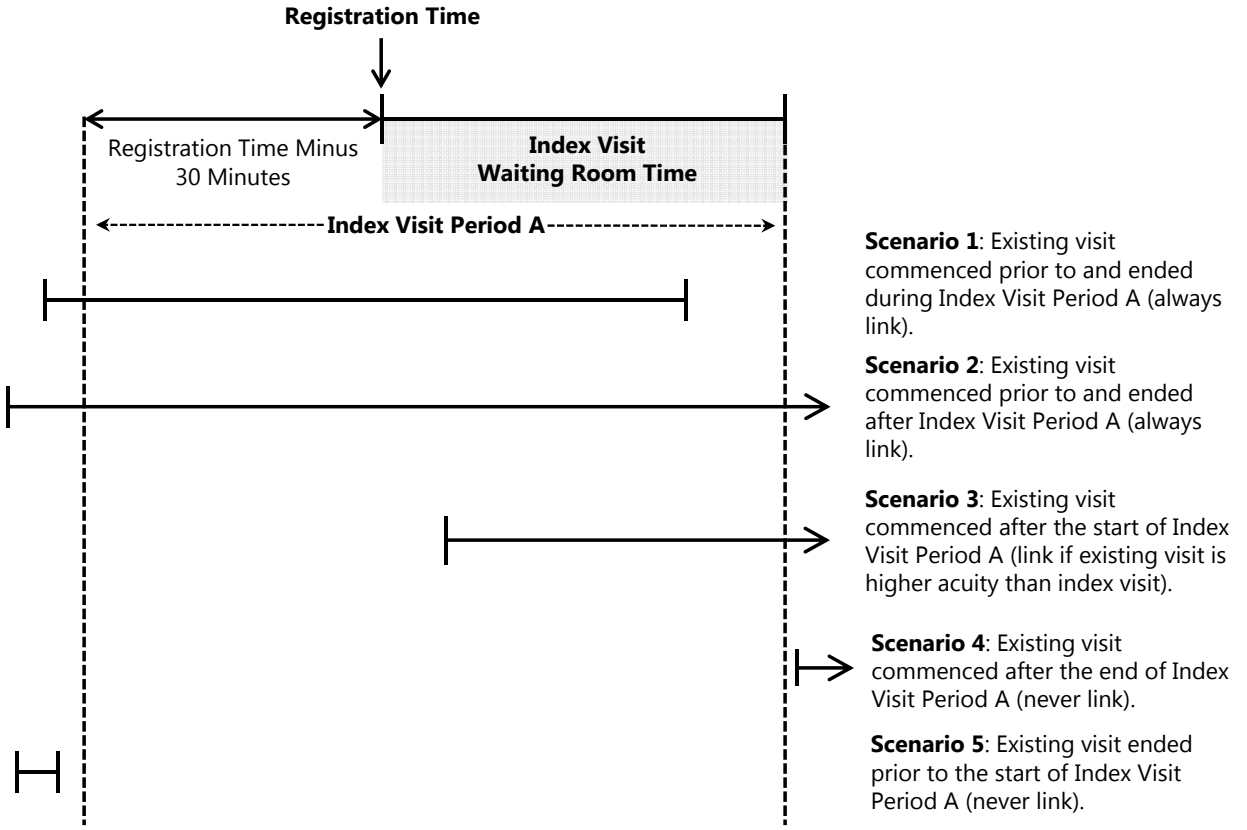
- Existing visits that **commenced prior to Period A** were linked to an index visit if they were either completed during or after this period (scenarios 1 and 2 in Figure 6.1);
- Existing visits that **commenced during Period A** were linked to an index visit only if the existing visit was triaged as being more urgent (using CTAS; scenario 3). This reflects CTAS queuing strategies, where more acutely ill patients (e.g., CTAS 2) would normally get priority treatment over people who are less acutely ill (CTAS 5).
- Existing visits that were **completed either prior to or started after Period A** were not linked to an index visit (scenarios 5 and 4).

Strategies were also developed to describe existing patients. These patients were labeled as in-patients if their boarding time overlapped with Period A (Figure 6.1), and as ED-hold patients if their ED-hold time overlapped with this period. The start of physician treatment was used as a surrogate for the order time of all diagnostic and blood troponin tests. Existing patients were labeled as having had a diagnostic test if their 'wait time' for this test overlapped with the index visit Period A.[15] 'Percent of Capacity' values in this chapter (e.g., x-axis of Figure 6.7) therefore represent the number of treatment areas occupied by patients waiting for diagnostic tests (or for hospital admissions) during an index patient's waiting room time. People waiting for these tests may not have been doing so simultaneously.

14 This was suggested by Advisory Group members as the average time required to prepare a treatment area for a new patient.

15 This process helps to ensure that throughput and output factors are measured similarly for modeling results, and in the absence of a true order time, provides a conservative result for these tests.

Figure 6.1: Schematic for Linking Existing Visits to Index Visits



A summary score was created for each set of existing visits that were linked to an index visit, based on combining the existing visits' characteristics. This value was expressed as a proportion of the number of regularly used ED treatment areas, allowing us to fairly make comparisons across ED sites. The following variables were created:

- Input Factors: Existing visits with a CTAS score of 1-3 were counted separately, while counts of CTAS 4&5 existing visits were combined.
- Throughput Factors: Based on interim analysis,[16] diagnostic tests were grouped as follows to help simplify analyses: a) MRIs, nuclear medicine tests, ultrasounds, cerebral spinal tests, and cardiovascular tests were combined into one group called 'complex tests', b) x-rays, urine tests, computed tomography tests, and troponin blood tests were each analyzed separately.
- Output Factors: Existing visits were defined by their ED-hold and in-patient status.

16 Curvilinear estimates for individual tests were combined when they were of similar size.

ED visit durations are typically skewed to the right.[17] Quantile regression was therefore used to analyze the data in this chapter. This technique was used to examine how strongly risk factors affect the 50th percentile (median) value of waiting room time.[18] Second order (curvilinear) estimates were included when they were statistically significant. These estimates depict the change in median waiting room time (in minutes) for every one percent increase in ED capacity of existing visits. More detail on how to interpret these results is provided in the following text, using Figure 6.8 as an example (for CTAS 2 index visits).[19]

- The y-axis of this figure shows the adjusted median waiting room time of CTAS 2 index visits (in minutes), while the x-axis describes the existing visit characteristics, expressed as a percent of ED capacity. The length of lines in this figure represent how often different events occurred. For example, during the time that CTAS 2 patients were in waiting rooms, our results show that EDs were at most 10% filled with existing CTAS 1 patients. Alternatively, up to 45% of regularly used treatment areas were filled with patients getting x-rays, and 50% were filled with patients waiting for hospital admission. The effect of risk factors on waiting room time is therefore a combination of the height of the line at any given percent capacity, and also the length of the line. In addition to our exclusion criteria provided in Chapter 2 of this report (Figure 2.2), it is important to note that the length of each line is suppressed when fewer than 75 observations were reported at all sites combined (e.g., while CTAS 2 patients were in waiting rooms, EDs were 10% filled with existing CTAS 1 patients at least 75 times in the year, or just over once per week). In other words, line length represents commonly occurring events.
- Each of the lines in this figure shows the adjusted relationship between a given factor and the median waiting room time of CTAS 2 patients. For existing CTAS 4&5 patients, 'adjusted' means that we are looking at the unique effect of these lower acuity patients, after considering that some of them may have had diagnostic tests or were admitted to hospital. The horizontal line for existing CTAS 4&5 in Figure 6.8 means that higher volumes of these lower acuity patients had very little impact on CTAS 2 waiting room times.
- A different picture emerges for x-rays (as an example). After adjustment for all other measures (i.e., considering that some patients getting x-rays also were admitted to hospital), the line for this measure curves steeply upward. In other words, as EDs became fuller with patients getting x-rays, the adjusted median waiting room time of CTAS 2 patients increased sharply.
- Comparing the adjusted slope of these lines helps us to determine the relative importance of input, throughput, and output factors. Commencing at about 20% ED capacity, the slope is much steeper for throughput factors like x-rays and CT scans than it is for output factors like the volume of patients waiting to be admitted into hospital.

17 Data that are skewed to the right typically have a small number of cases with excessively large values. In this instance, arithmetic averages do not represent the mid-point of a dataset, and median values are more appropriate to use.

18 Ordinary least squares (traditional) regression is based on average outcome values and assumes that data are distributed normally. This method is used to talk about the average relationship between an independent and outcome variable, or in prediction to talk about the average outcome pending the characteristics of independent variables. Quantile regression can be used to talk about the median relationship (i.e., that which exists 50 percent of the time) between risk factors and waiting room time, or in prediction to talk about median waiting room times (those that occur 50 percent of the time) depending on the characteristics of different input, throughput, and output factors.

19 All modeling results are provided in graphic format only, and the actual model estimates are available from the first author of this report.

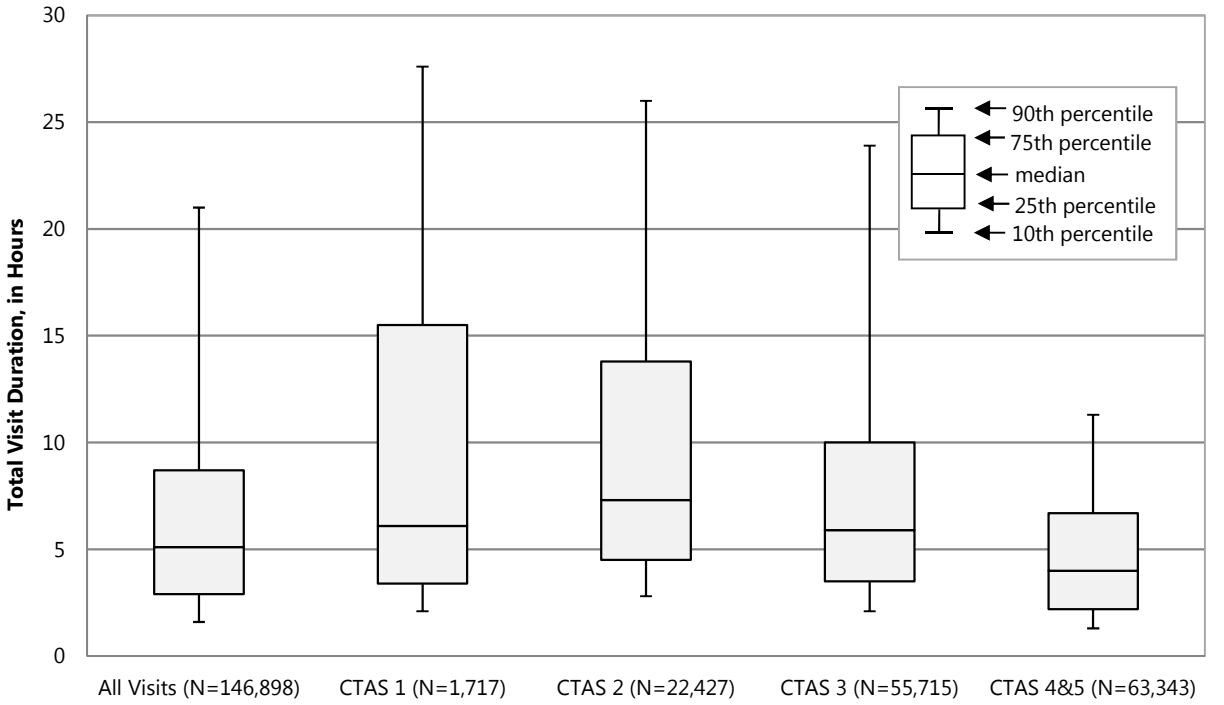
Detailed Chapter Results

ED Visit Durations

The distribution of ED visit duration (between 8:00 a.m. and 8:00 p.m.) is provided in Figure 6.2. Across all sites combined, the median total visit duration was 5.1 hours (306 minutes). This duration varied by CTAS level, and was typically shortest for CTAS 4&5 patients (median of 4.0 hours), and longer for both CTAS 1 (median of 6.1 hours) and CTAS 2 (median of 7.3 hours) patients. At each CTAS level however, total visit durations were skewed substantially to the right, with ten percent of all visits lasting longer than 11.3 hours (CTAS 4&5 visits), or longer than 23 hours (for visits at all other CTAS levels).

Figure 6.2: Distribution of ED Visit Durations, Overall and by CTAS Level

ED Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



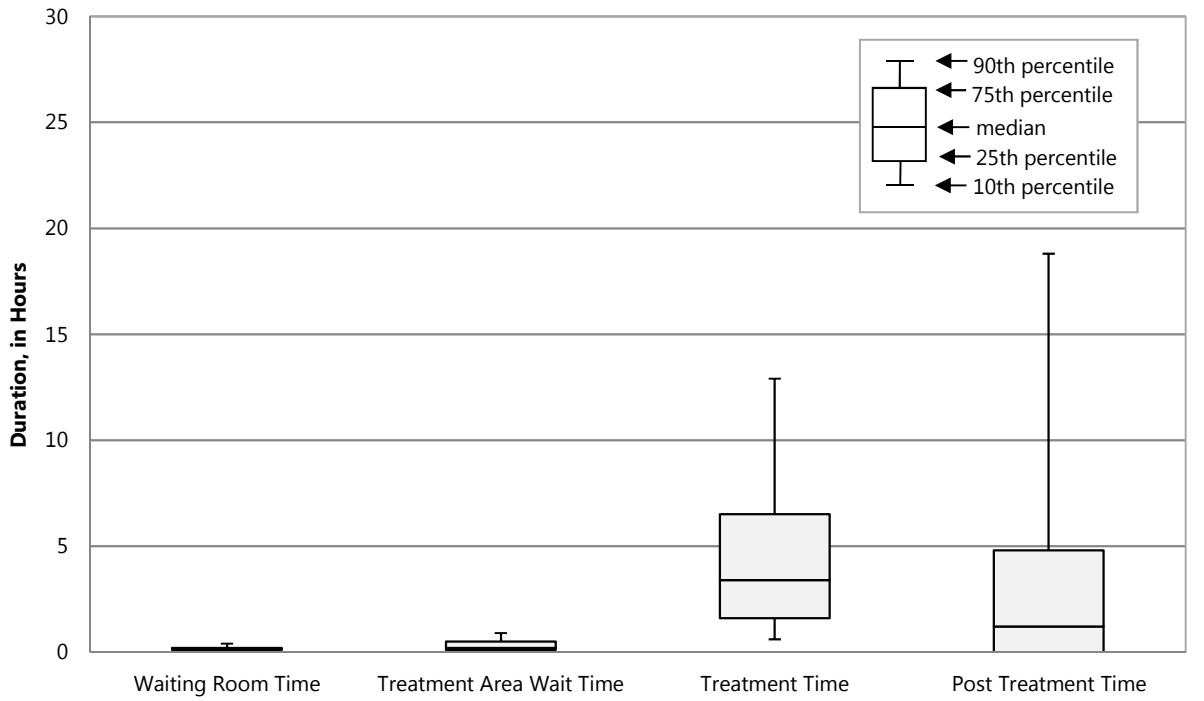
Note: Results are based on Level 1 exclusion criteria (see Figure 2.2). Results for 'All Visits' include those with unknown CTAS scores.

Each component of ED visit duration varied substantially by CTAS level (Figures 6.3 to 6.6):

- More urgent visits tended to have much shorter wait times followed by longer treatment and post-treatment durations. For example, the median waiting room time for CTAS 1 visits was 0.1 hours (6 minutes), while the median treatment time for these visits was 3.4 hours (Figure 6.3). In contrast, during CTAS 4&5 visits, patients spent a median of 1.6 hours in the waiting room, and a median of 1.1 hours being treated (Figure 6.6).
- The degree of visit duration skewness also differs by CTAS level. While highly urgent (CTAS 1) patients consistently had short wait times (Figure 6.3), their treatment and especially post-treatment times tended to vary greatly, with post-treatment times lasting at least 18.8 hours during 10% of visits. The opposite pattern is shown for the least urgent (CTAS 4&5) patients (Figure 6.6); waiting room times were more highly skewed than treatment and post-treatment times. These data illustrate the need to study the individual components of ED visit durations by CTAS level.

Figure 6.3: Distribution of Wait, Treatment, and Post Treatment Times for CTAS 1 Visits

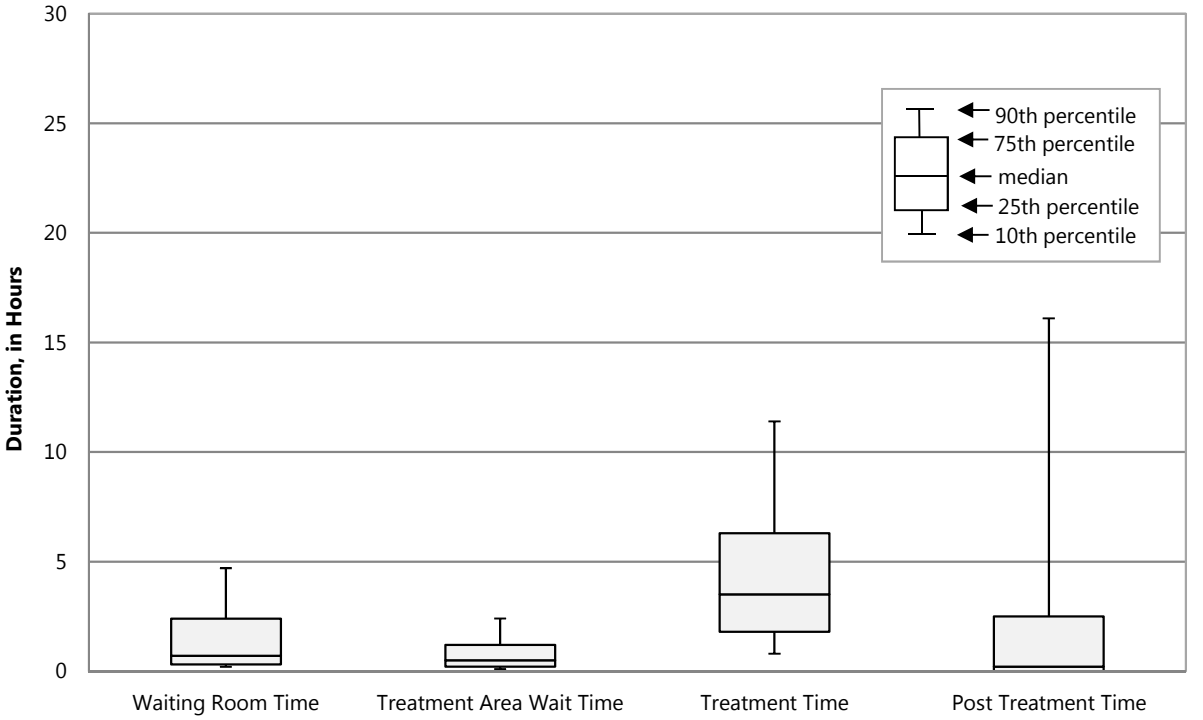
Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 6.4: Distribution of Wait, Treatment, and Post Treatment Times for CTAS 2 Visits

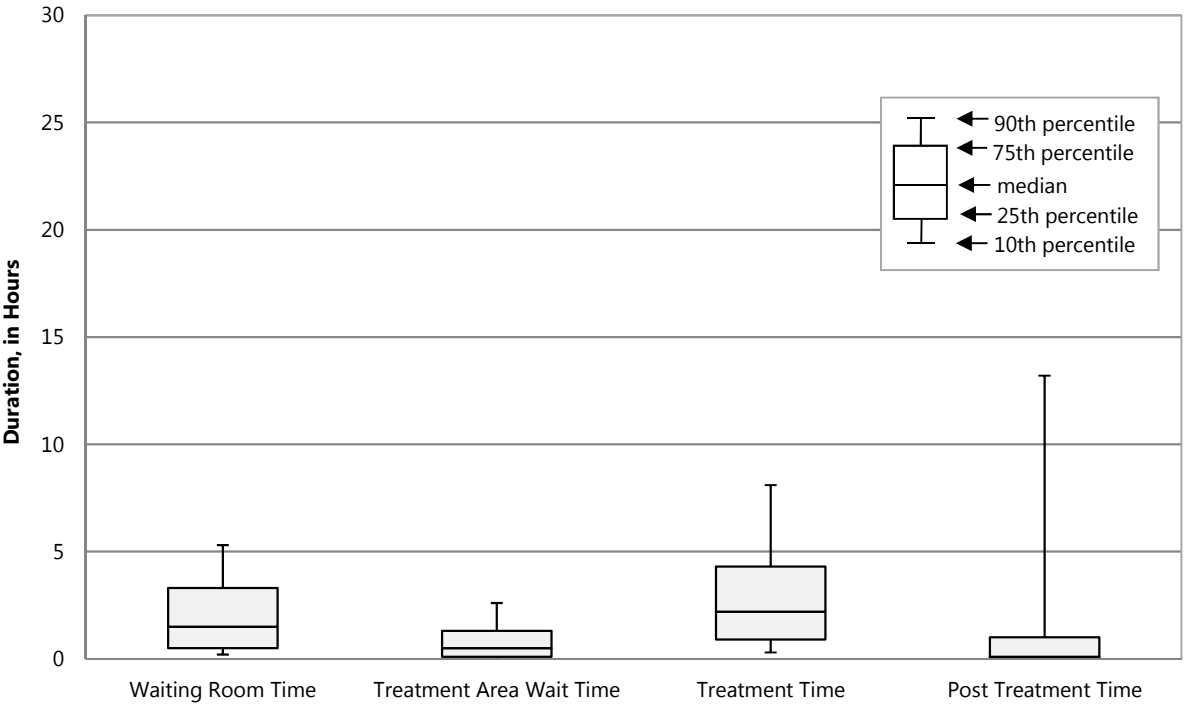
Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 6.5: Distribution of Wait, Treatment, and Post Treatment Times for CTAS 3 Visits

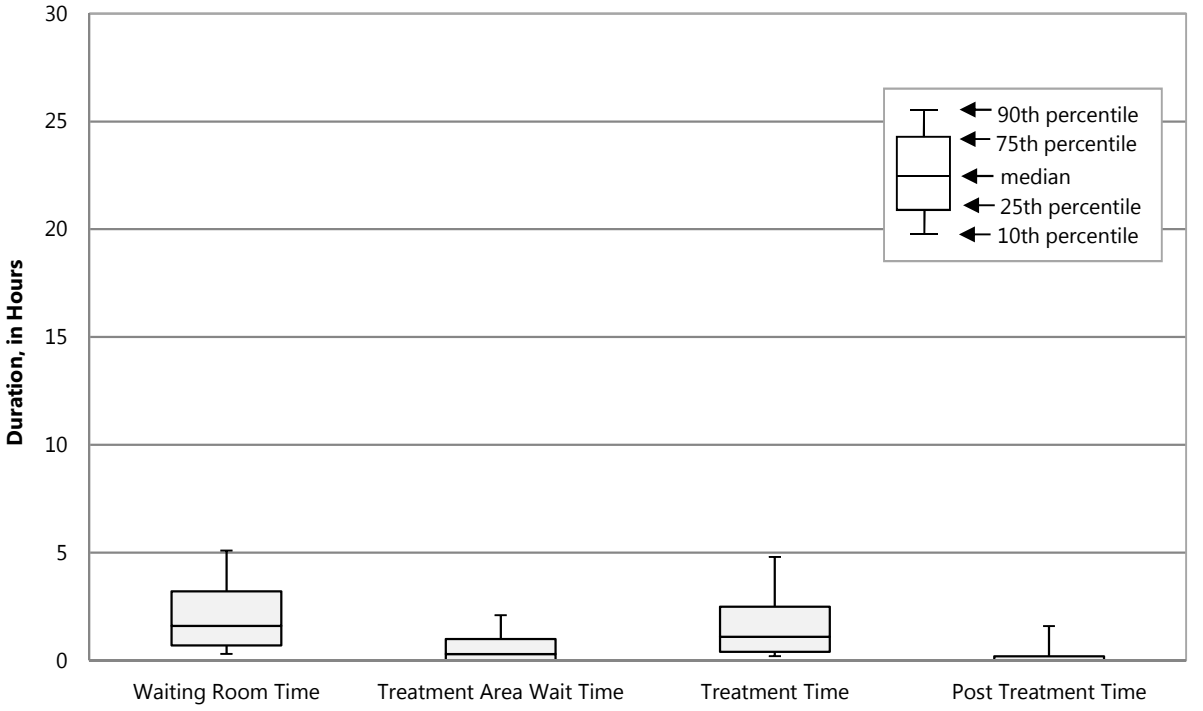
Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 6.6: Distribution of Wait, Treatment, and Post Treatment Times for CTAS 4&5 Visits

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

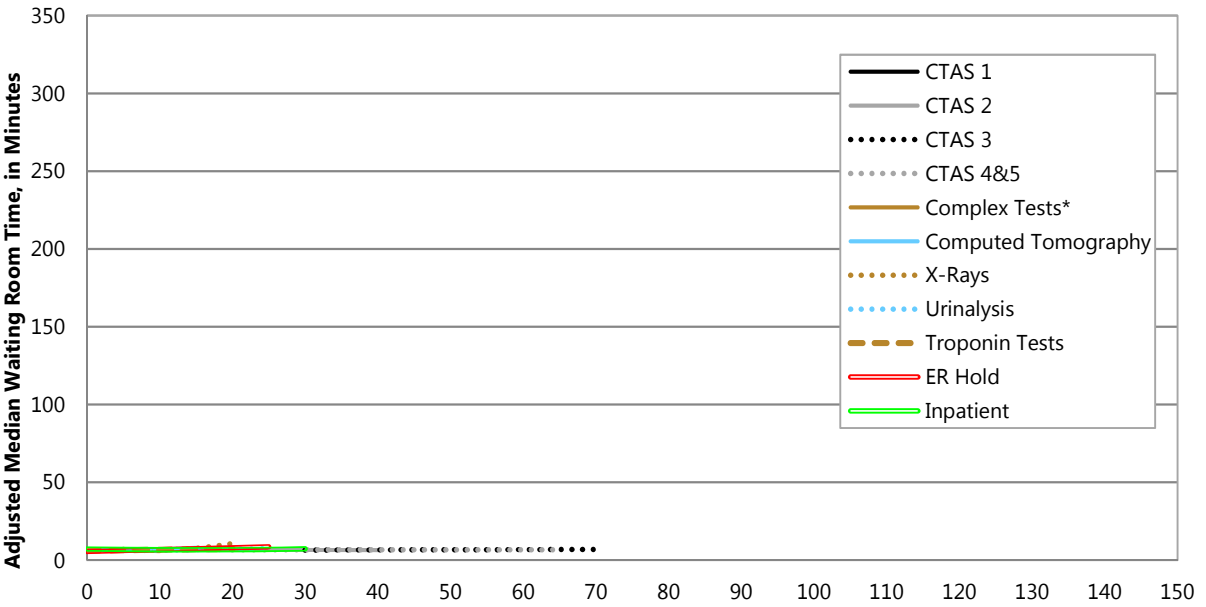
Determinants of Waiting Room Time

CTAS 1 visits: The factors affecting CTAS 1 waiting room time are described as follows (Figure 6.7):

- Waiting room time was investigated for 1,712 CTAS 1 visits; this time was at most 0.1 hours (6 minutes) during 50% of these visits, and 12 minutes or longer for 25% of these visits.
- Multivariate regression shows that very few factors influence CTAS 1 waiting room times (Figure 6.7). This figure shows that input, throughput, and output factors had virtually no impact on adjusted median CTAS 1 waiting room times (i.e., all lines are horizontal). For example, in scenarios where EDs had no patients waiting for hospital admission, adjusted median CTAS 1 waiting room times were 7.2 minutes. This median time changed to 7.3 minutes when EDs were 30% filled with existing patients waiting to be hospitalized. Overall therefore, CTAS 1 patients clearly get priority, irrespective of the type and volume of existing patients linked to these visits.
- Pseudo R^2 values are provided to estimate how strongly each set of input, throughput, and output factors influenced waiting room time (larger values = stronger influence). Consistent with our previous explanation, the overall model explains only 3.9% of the differences in median CTAS 1 waiting room times, and the unique influence of each risk factor group is very small (see Figure 6.7).

Figure 6.7: Effect of Input, Throughput, and Output Factors on Adjusted Median CTAS 1 Waiting Room Times

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



*includes MRIs, nuclear tests, ultrasounds, cerebral spinal fluid tests, and cardiovascular tests.

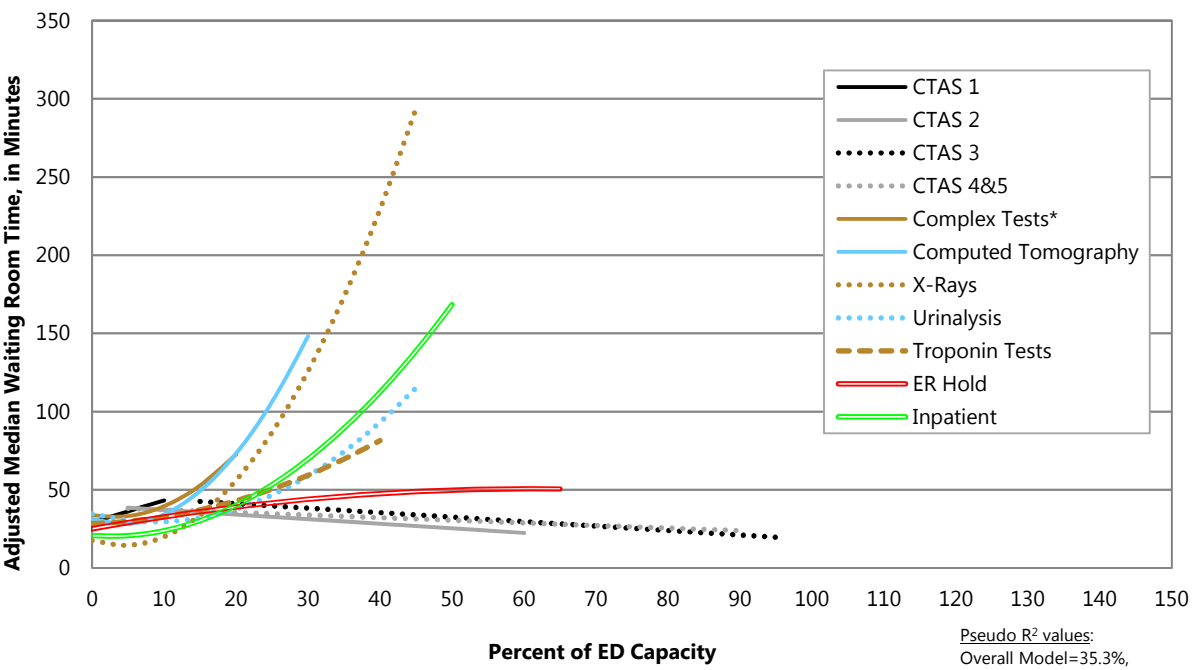
Pseudo R^2 values:
Overall Model=3.9%,
Input Factors=0.05%,
Throughput factors=1.8%,
Output factors=1.5%

CTAS 2 visits: Patients were triaged as CTAS 2 during 22,260 visits in the study period, and were in the waiting room for a median of 42 minutes (Figure 6.4). During 5,565 of these visits (about 15 visits per day; the 75th percentile in Figure 6.4) patients were in the ED waiting room for at least 144 minutes. About six times per day (N=2,226 visits; the 90th percentile in Figure 6.4), CTAS 2 patients remained in the waiting room for at least 282 minutes, or 4.7 hours. Factors affecting these waiting room times are explained in the following text.

- After adjustment for all other risk factors, higher volumes of existing patients are shown to minimally impact the median waiting room time of CTAS 2 patients. This relationship between input factors and waiting room time is depicted by the horizontal lines in Figure 6.8 (showing no increase in waiting room time due to higher volumes of patients).
- A different story emerges for both throughput and output factors. After adjustment for all other risk factors, the median waiting room time for index CTAS 2 patients ranged from 20.5 minutes during periods when 5% of treatment areas had patients waiting to be hospitalized, to 138.7 minutes when 45% of treatment areas had patients waiting to be hospitalized. Somewhat similar results are shown for troponin tests and urine tests (e.g., adjusted median waiting room times ranged from 30.4 minutes when 5% of treatment areas had patients waiting for urine tests, to 115.2 minutes when 45% of treatment areas had patients waiting for urine tests). The effect of x-ray tests and CT scans on this outcome is shown to be especially strong; adjusted median wait times ranged from 14.5 minutes when EDs had 5% of patients waiting for x-rays, to 293.8 minutes during periods when 45% of treatment areas had patients waiting x-rays. From these results were conclude that both output and throughput factors significantly influence CTAS 2 waiting room times. Pseudo R^2 values reflect these conclusions (see footnote of Figure 6.8), with values smallest for input factors, at medium size for output factors, and largest for throughput factors.

Figure 6.8 : Effect of Input, Throughput, and Output Factors on Adjusted Median CTAS 2 Waiting Room Times

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



*includes MRIs, nuclear tests, ultrasounds, cerebral spinal fluid tests, and cardiovascular tests.
Note: Results for input factors (CTAS 1, CTAS 2, CTAS 3, CTAS 4&5) are based on first order (linear) estimates only.

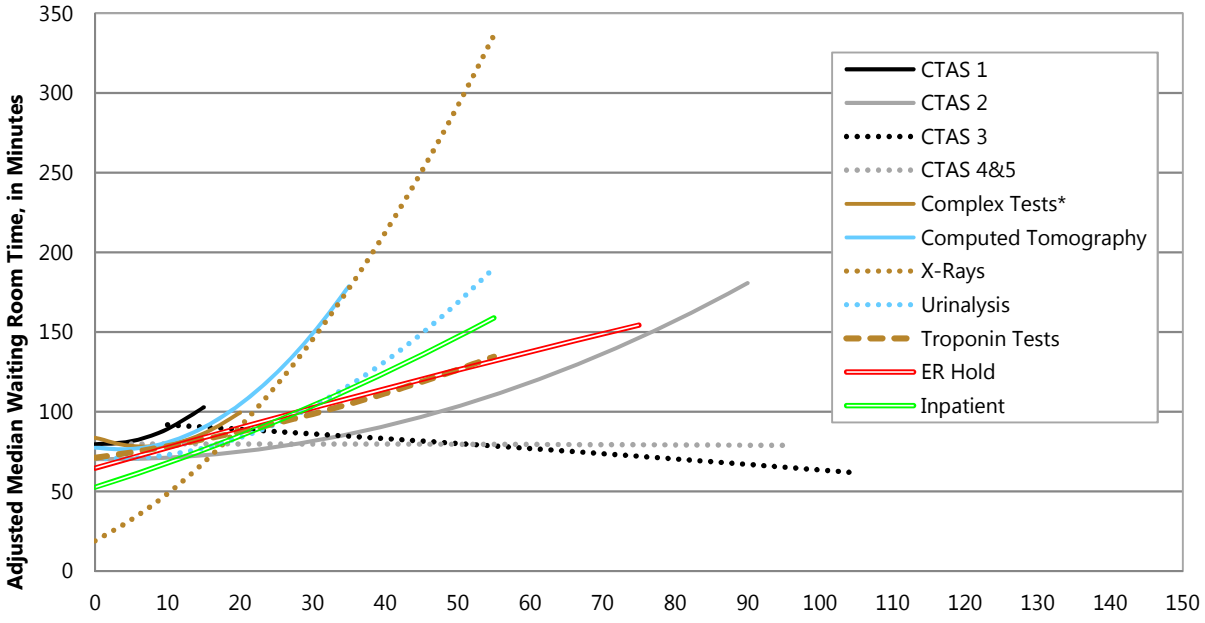
Pseudo R^2 values:
Overall Model=35.3%,
Input Factors=0.6%,
Throughput factors=17.1%,
Output factors=3.2%

CTAS 3 visits: Data were analyzed on 55,198 CTAS 3 visits. Patients spent at most 1.5 hours (90 minutes) in the waiting room during 50% of these visits. During 25% of these visits (about 38 visits per day), patients spent at least 3.3 hours in the waiting room.

- Factors affecting these times are similar to those discussed previously. After adjustment for all measures, median CTAS 3 waiting room times were strongly impacted by both throughput and output factors (Figure 6.9). For example, this adjusted time was 291.8 minutes during periods where 50% of treatment areas had patients waiting for x-rays, and 147.0 minutes during periods where 50% of treatment areas had patients waiting to be hospitalized. Further, while greater numbers of lower acuity (CTAS 4&5) patients minimally impacted these adjusted waiting room times, greater numbers of higher acuity patients had some influence. For example, adjusted CTAS 3 waiting room times ranged from 70.4 minutes to 103.3 minutes, during periods where 5% to 50% of treatment areas had existing CTAS 2 patients. Pseudo R^2 values demonstrate that throughput factors most strongly impacted CTAS 3 waiting room times, followed by output factors and to a smaller extent input factors.

Figure 6.9: Effect of Input, Throughput, and Output Factors on Adjusted Median CTAS 3 Waiting Room Times

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Pseudo R^2 values:
Overall Model=42.9%,
Input Factors=0.8%,
Throughput factors=15.8%,
Output factors=2.4%

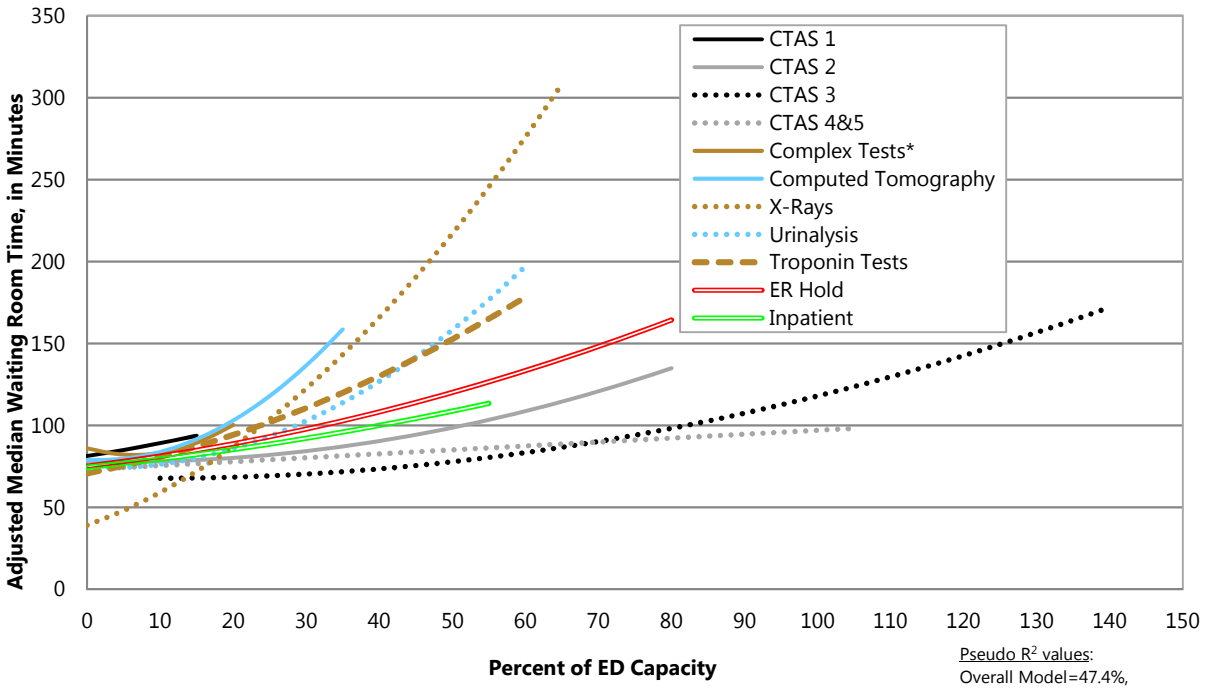
*includes MRIs, nuclear tests, ultrasounds, cerebral spinal fluid tests, and cardiovascular tests.

CTAS 4&5 visits: Similar results are shown for these visits. Data were analyzed on N=62,247 CTAS 4&5 visits (about 171 visits daily). These patients had a median waiting room time of 1.6 hours. During 25% of these visits (N=15,562, 43 daily), patients spent at least 3.2 hours in the ED waiting room.

After adjustment for all other risk factors, output and especially throughput factors most strongly influenced these waiting room times (Figure 6.10). For example, this adjusted time was 245.5 minutes during periods where 55% of treatment areas had patients waiting for x-rays, 165.1 minutes when 55% of treatment areas had patients waiting for troponin tests, and 113.5 minutes during periods where 50% of treatment areas had patients waiting to be hospitalized. Also, the effect of input factors varied by CTAS level. The adjusted median waiting room time remained quite stable (75.5 minutes to 91.1 minutes) during periods when 10% to 75% of treatment areas were occupied by CTAS 4&5 patients, and increased more substantially during periods when 10% to 75% of treatment areas had CTAS 2 patients (78.1 minutes to 127.6 minutes).

Figure 6.10: Effect of Input, Throughput, and Output Factors on Adjusted Median CTAS 4&5 Waiting Room Times

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Pseudo R^2 values:
Overall Model=47.4%,
Input Factors=1.5%,
Throughput factors=12.9%,
Output factors=1.2%

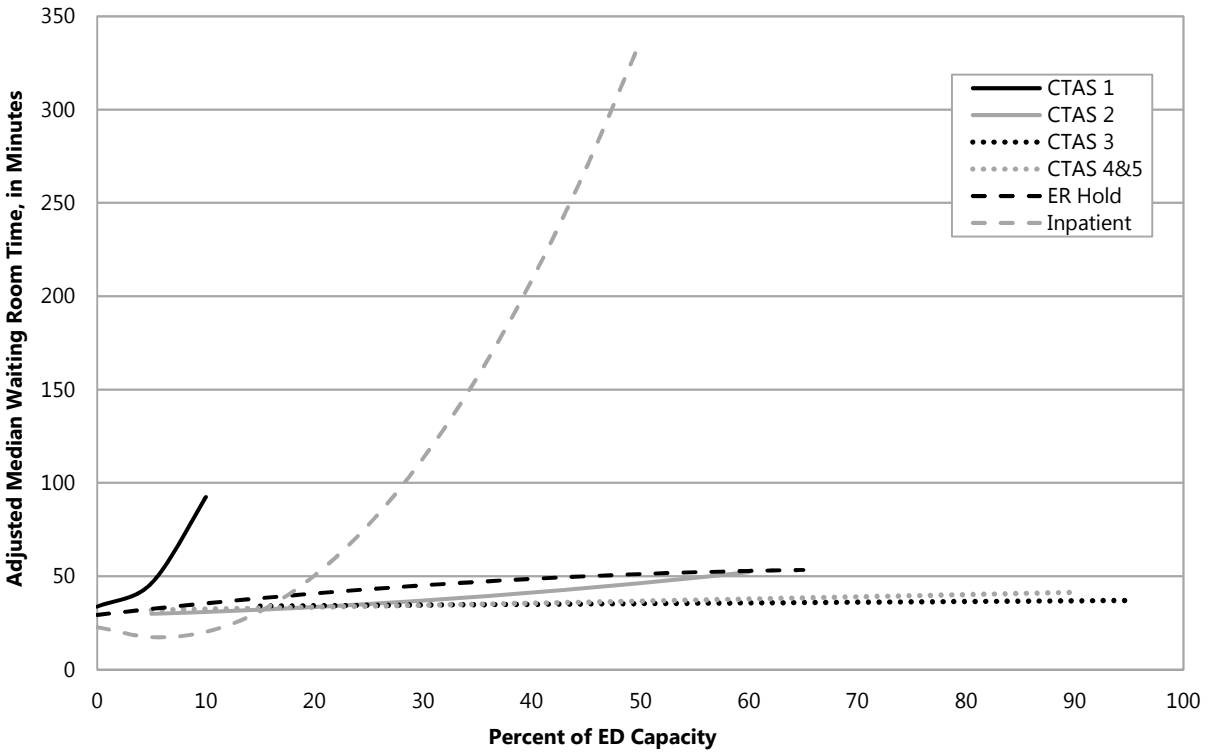
*includes MRIs, nuclear tests, ultrasounds, cerebral spinal fluid tests, and cardiovascular tests.

Additional Analyses

Most literature investigates how output factors affect ED wait times without adjustment for throughput factors (Arkun et al., 2010; Doupe M. et al., 2008; Fatovich et al., 2005; Lucas et al., 2009; Rathlev et al., 2012; Vermeulen et al., 2009; White et al., 2013; Wiler et al., 2012; Ye et al., 2012). In addition, the literature links existing to index visits quite broadly (e.g., during an eight hour ED shift) (Rathlev et al., 2007; Schull et al., 2006). Given our unique methodological approach (linking patients at the visit level) and the findings presented, an additional model was constructed using only input and output factors (Figure 6.11, for CTAS 2 patients). Consistent with the academic literature, we found that without considering the effect of diagnostic tests, adjusted median CTAS 2 waiting room times increased dramatically when EDs were fuller with patients waiting to be hospitalized. Two conclusions were reached from this model. First, as this model provides findings similar to the academic literature, we conclude that our unique strategy of linking existing to index visits has not biased study results. Second, by comparing the results from Figures 6.8 and 6.11 in this report, we propose that much of the academic literature is at least somewhat confounded, where the effect of wait times attributed to output factors may be instead at least partially due to throughput factors.[20]

Figure 6.11: Adjusted Effect of Input and Output Factors on Median CTAS 2 Waiting Room Times

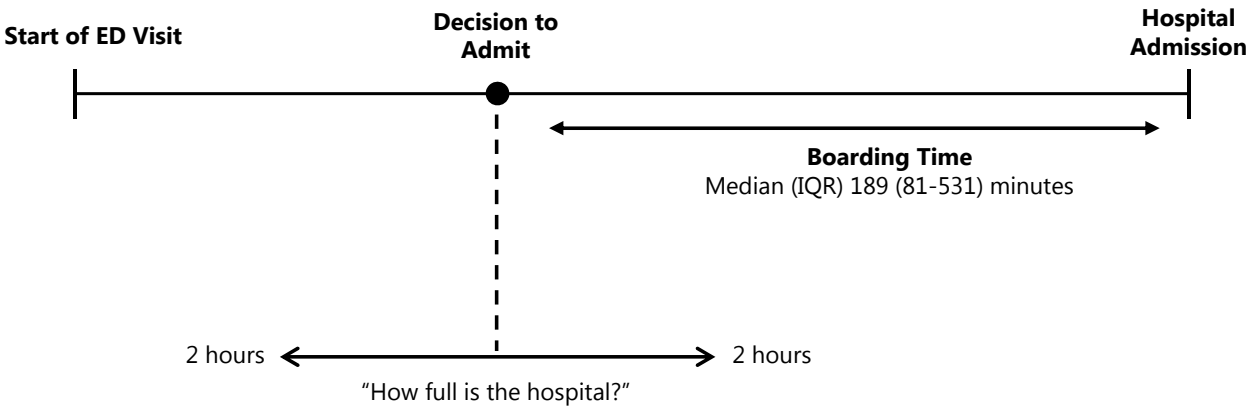
Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



20 From Table 3.3 of this report, 83.2% of all visits where patients were subsequently hospitalized first had some type of diagnostic test. Similarly, 47.1% of CTAS 1 visits ended in hospitalization during the study period, versus only 5.4% of CTAS 4&5 visits (data not shown). These examples illustrate the need to adjust for these different associations.

We also investigated the relationship between ED boarding times and hospital capacity (Figure 6.12). Across all ED sites combined, patients were admitted into hospital during 17,878 visits between the hours of 8:00 a.m. and 8:00 p.m., with a median (inter-quartile range) boarding time of 189 (81-531) minutes (data not shown). At the time of decision to admit these patients, the hospital data were reviewed to identify: a) the number of hospital in-patients, expressed as a proportion of total known hospital beds (i.e., hospital capacity),[21] and b) the proportion of hospital beds housing alternate level of care (ALC) patients (i.e., those who are no longer acutely ill and could be discharged from hospital).

Figure 6.12: Schematic Demonstrating How ED Boarding Time and Hospital Capacity were Linked



The relationship between ED boarding time and hospital capacity is shown in Figure 6.13. Hospitals were between 73% and 90% full when two-thirds of ED patients were waiting to be hospitalized. On these occasions, ED patients' median boarding time increased by only 3.42 minutes for every 1% increase in hospital capacity. This relationship changed significantly when hospitals were at least 90% full. On these occasions the median boarding time of ED patients increased 4.4 hours when hospitals were 91% versus 100% full.

Similar results exist when comparing the association between ED boarding times and the percent of hospital beds filled with ALC patients (Figure 6.14). Hospitals were between 5% and 15% filled with ALC patients when two-thirds of ED patients were waiting to be hospitalized. On these occasions, ED patients' median ED boarding increased by only 2.4 minutes for every 1% increase in hospital ALC capacity. These increases were substantially greater when hospitals were more full with ALC patients. Commencing at 16% hospital capacity, for every 1% additional increase in ALC patients, the median boarding time of ED patients increased by 10.3 minutes. From the results of Figure 6.13 and 6.14, we conclude that – to the extent that ED waiting room times are adversely affected by higher volumes of patients waiting to be hospitalized – it is unlikely that these challenges with transitioning patients is due to a lack of hospital capacity alone.

21 Counts of hospital patients were obtained from the hospital abstract file, which has both date and time stamped information. However, counts of hospital beds are only available in an aggregate form, meaning that it is not feasible to: i) identify the number of hospital beds normally unavailable to ED patients (e.g., Obstetrics), and ii) link the currently hospitalized patients to these beds. Given this limitation, we recognize that our capacity of hospital beds to accept ED patients is over-estimated.

Figure 6.13: ED Boarding Times Compared to Hospital Capacity

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

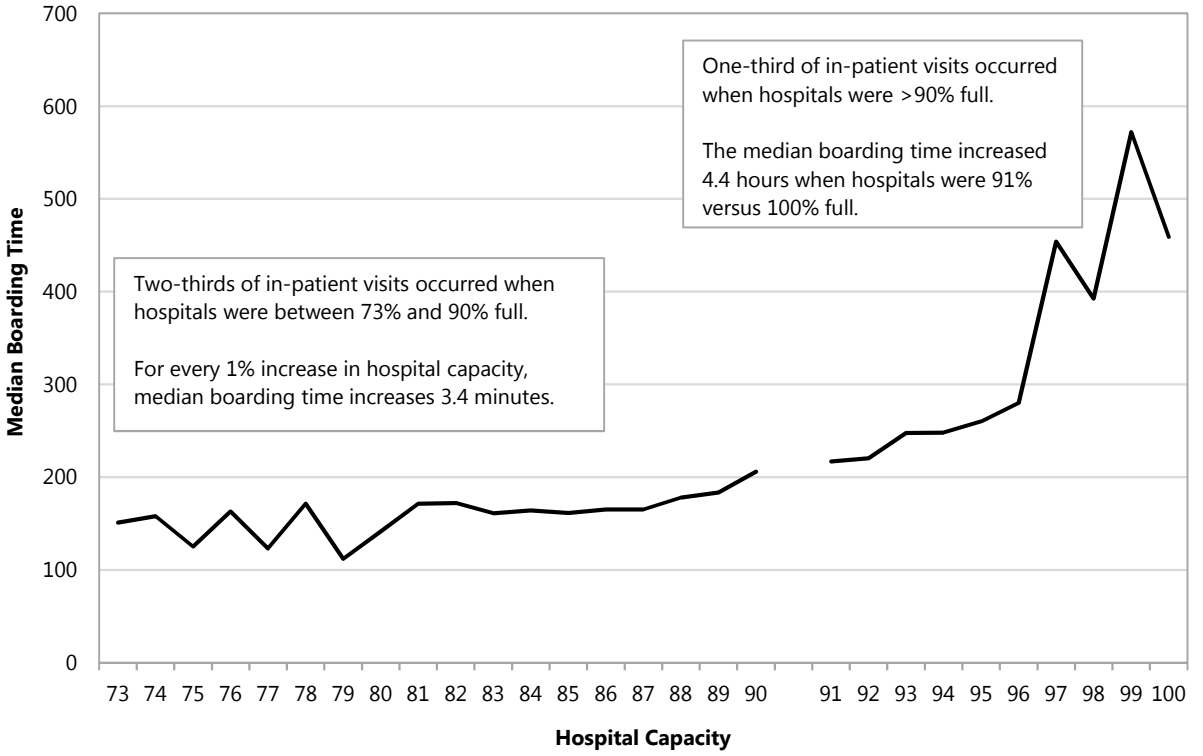
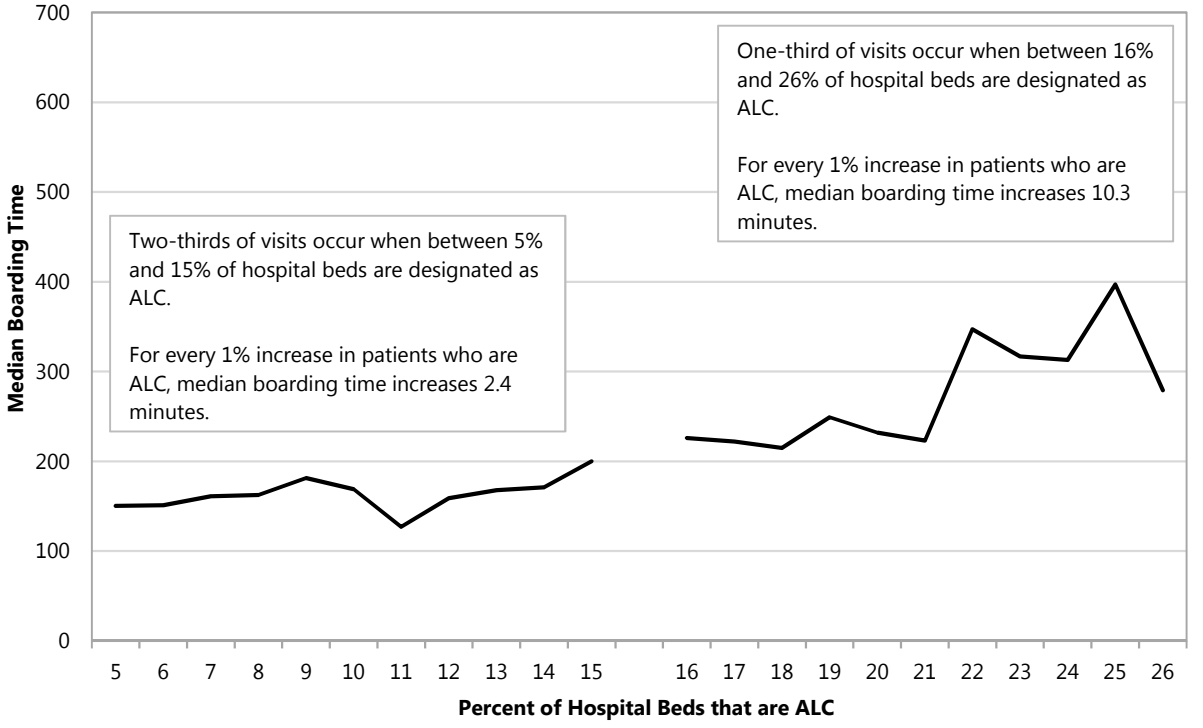


Figure 6.14: ED Boarding Times Compared to Percent of Hospital Beds filled with Alternate Level of Care (ALC) Patients

Visits between 8:00 a.m. and 8:00 p.m., All Adult ED Sites Combined, Winnipeg, Manitoba, April 1,2012 to March 31, 2013



CHAPTER 7: A COMPARISON OF WAITING ROOM TIMES ACROSS ADULT ED SITES IN WINNIPEG

Chapter Highlights

This chapter compares the six adult sites in Winnipeg by their visit duration and also by the factors influencing their waiting room times.

- For all visits and for each CTAS level, median visit durations were typically shortest at the Seven Oaks ED and longest at Grace. While durations were typically skewed substantially at each site, this is especially the case at Grace for CTAS 3-5 visits.
- No set of input, throughput, or output factors significantly influenced CTAS 1 waiting room times at any site. That is, the most urgent patients receive treatment with virtually no delay at all sites, under all circumstances.
- Throughput factors influenced CTAS 2 median waiting room times similarly at each site. For example, during periods where 45% of treatment areas had patients waiting for diagnostic tests (all types of tests combined), adjusted CTAS 2 median waiting room times ranged from 89.6 minutes at St. Boniface, to 107.2 minutes at Concordia, and 123.8 minutes at Victoria. However, the effect of having more patients waiting to be hospitalized influenced CTAS 2 waiting room times more strongly at Grace versus all other sites. On occasions where 25% of treatment areas had patients waiting to be hospitalized, adjusted median CTAS 2 waiting room times were 104.8 minutes at Grace versus less than 74 minutes at all others sites.
- These unique results for Grace are more pronounced for CTAS 4&5 patients. During periods when 50% of treatment areas had patients waiting for diagnostic tests, these adjusted median waiting room times were 186.3 minutes at Grace versus between 110 (St. Boniface) and 138 minutes (Victoria) at all other sites. Similarly, when 25% of treatment areas had patients waiting for hospitalization, these adjusted waiting room times ranged from 71.5 to 108.8 minutes at all other sites, versus 206.0 minutes at Grace.

Chapter-specific Methods

The methods used in this chapter (e.g., exclusion criteria, strategies for linking existing to index visits, strategies for measuring risk factors) are identical to those discussed in Chapter 6. The graphical display of results in this chapter (from quantile regression models) should also be interpreted in the same manner as Chapter 6. However, while each figure in Chapter 6 contains the results for different risk factors (allowing us to directly compare how throughput versus output factors impact waiting room times), each figure in the present chapter contains the results for one risk factor only, but with data for each site.

Each regression model in this chapter contains the same set of input, throughput, and output factors that were used in Chapter 6. Interaction terms were added to each model, to compare the effect of risk factors on waiting room times across sites.[22] This means that the site-specific comparisons in this chapter cannot be attributed to factors such as their different volumes of patients, to the number of diagnostic tests they performed, or to the number of patients that were admitted into hospital.[23] Also like Chapter 6, line lengths for each ED site (i.e., representing percent capacity) were curtailed when fewer than 75 observations were reported, meaning that all results in this chapter are based on regularly occurring events.

22 This was done by creating a series of different models, each including all main effect variables plus an interaction term between one variable and ED site.

23 During interim analyses, models were also adjusted for patient age and sex. Adjustment for these measures did not significantly influence study results. For simplicity, these measures were excluded from the models presented in this report.

Detailed Chapter Results

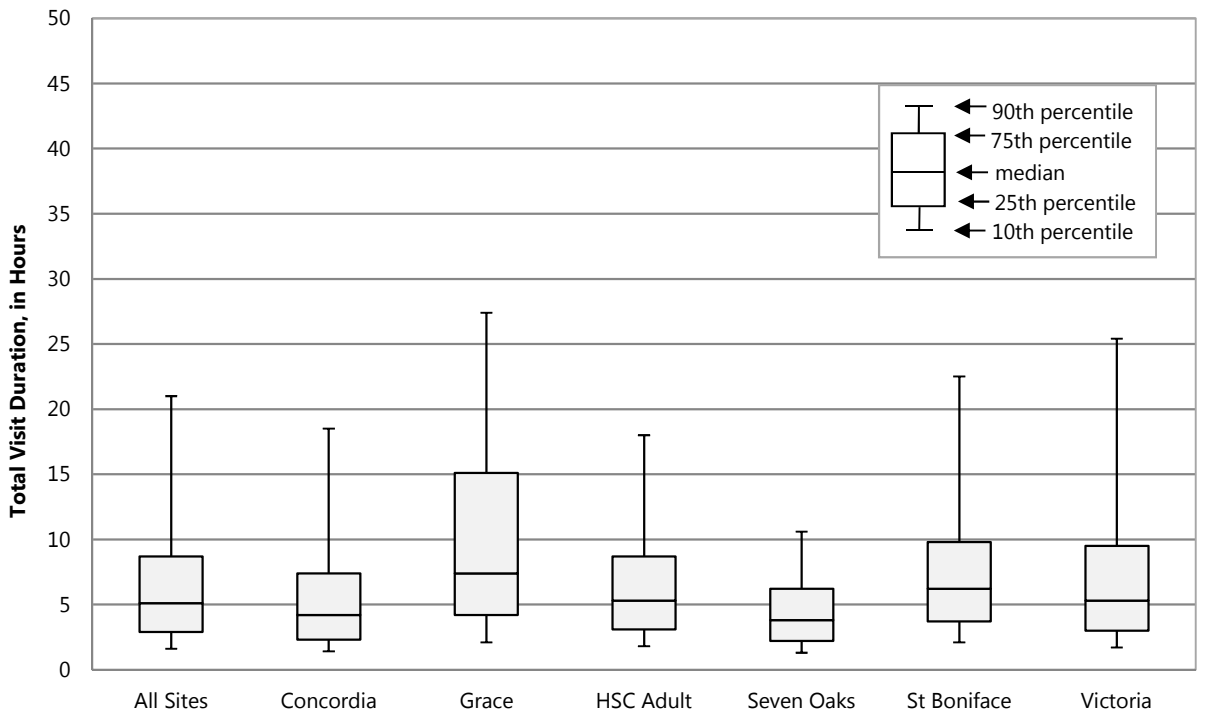
Comparing Total ED Visit Durations

Total ED visit durations (all CTAS levels combined) were compared across sites (Figure 7.1). Median visit durations were shortest at the Seven Oaks (3.8 hours) and Concordia (4.2 hours) EDs, and longest at Grace (7.4 hours). With the exception of CTAS 1 visit durations that were fairly similar across sites (Figure 7.2), median visit durations by CTAS level tended to be longest at Grace. For example, CTAS 2 visit durations were shortest at the Concordia (6.9 hours) and Seven Oaks EDs (5.8 hours), and longest at Grace (9.0 hours) (Figure 7.3). This same pattern exists for CTAS 3 (Figure 7.4) and CTAS 4&5 (Figure 7.5) visits. The median visit duration for CTAS 4&5 visits was shortest at Concordia (3.2 hours) and Seven Oaks (2.9 hours), and longest at Grace (6.2 hours).

The skewness of visit durations was also in most instances largest at Grace; 25% of all CTAS 2 visits lasted at least 20.3 hours at Grace, versus less than 15 hours at most other sites (Figure 7.3). These site differences are most pronounced for CTAS 4&5 visits (Figure 7.5); 10% of these visits lasted at least 24 hours at Grace in 2012/13 versus less than 15 hours at other sites.

Figure 7.1: Total ED Visit Durations, Overall and by Adult ED Site

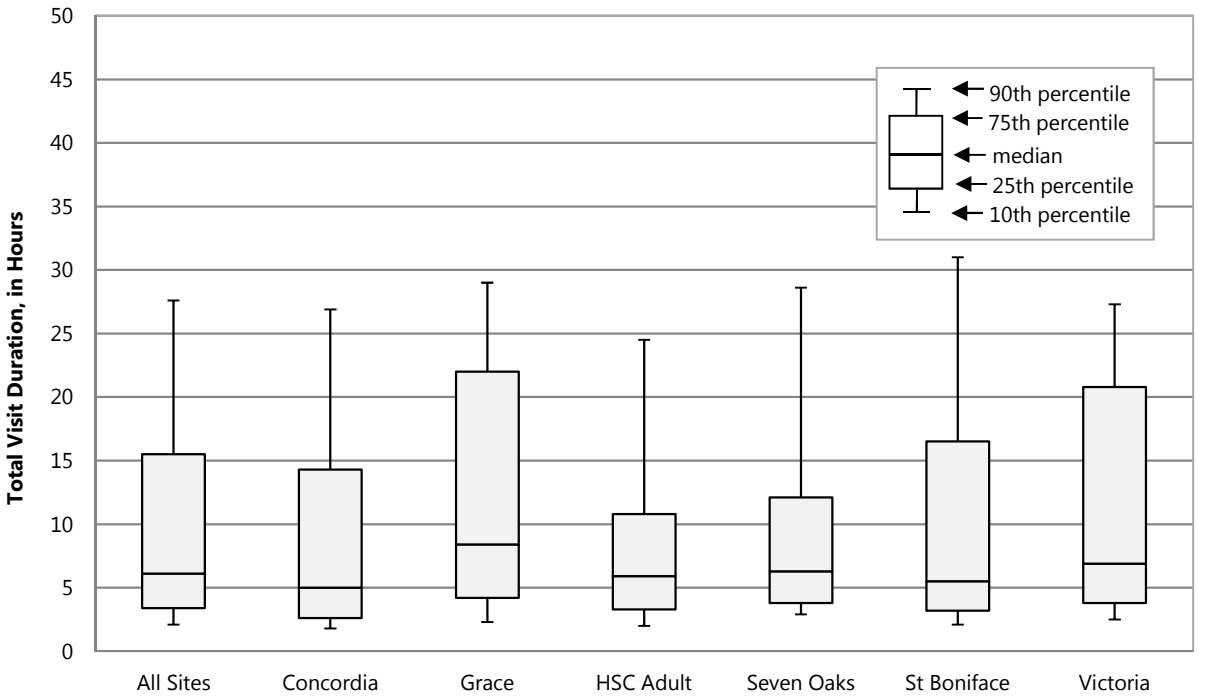
Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.2: CTAS 1 Visit Durations, Overall and by Adult ED Site

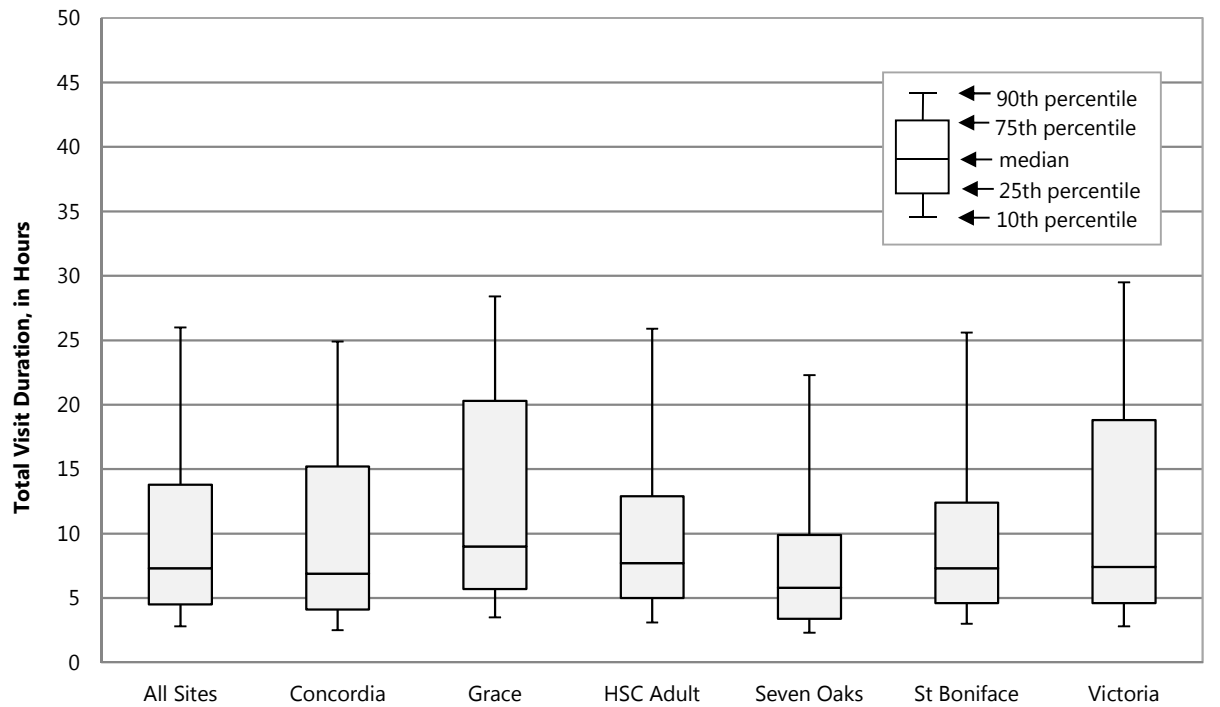
Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.3: CTAS 2 Visit Durations, Overall and by Adult ED Site

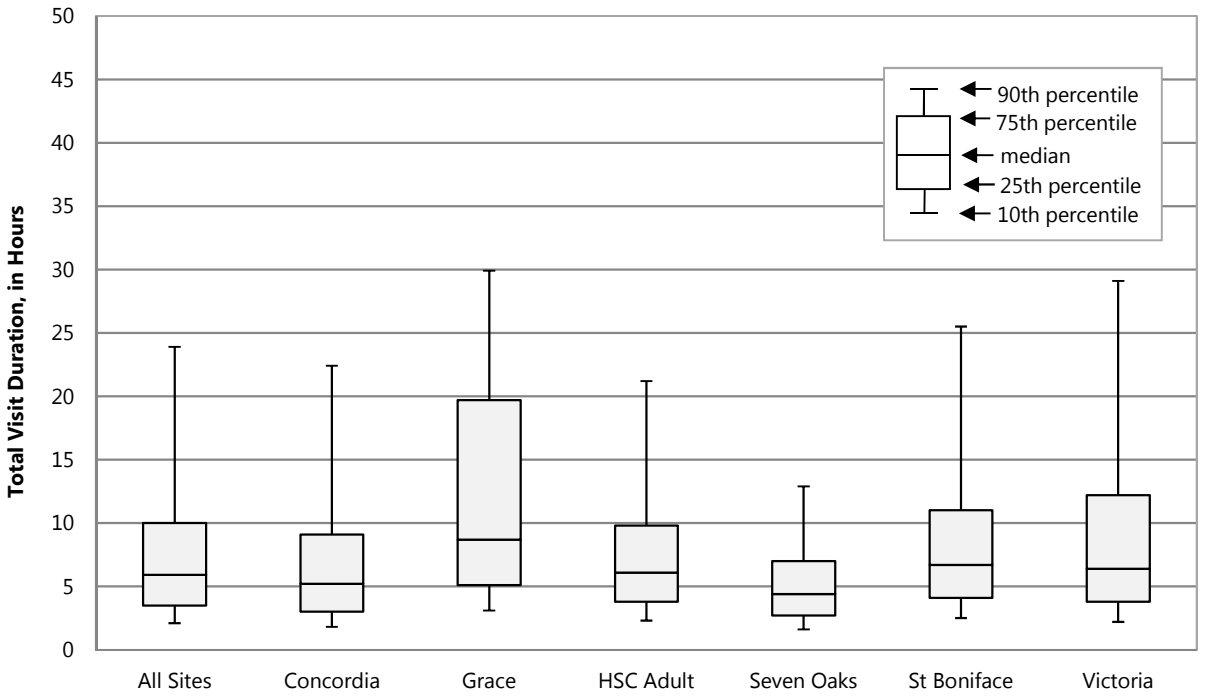
Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.4: CTAS 3 Visit Durations, Overall and by Adult ED Site

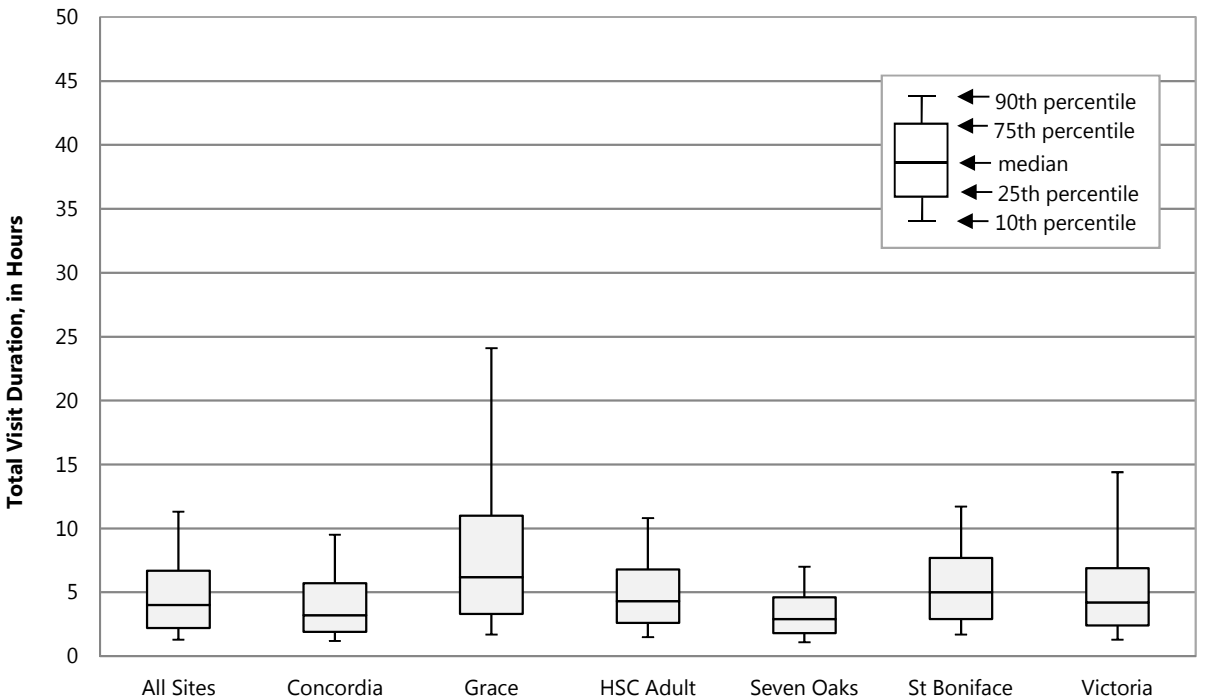
Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013.



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.5: CTAS 4&5 Visit Durations, Overall and by Adult ED Site

Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



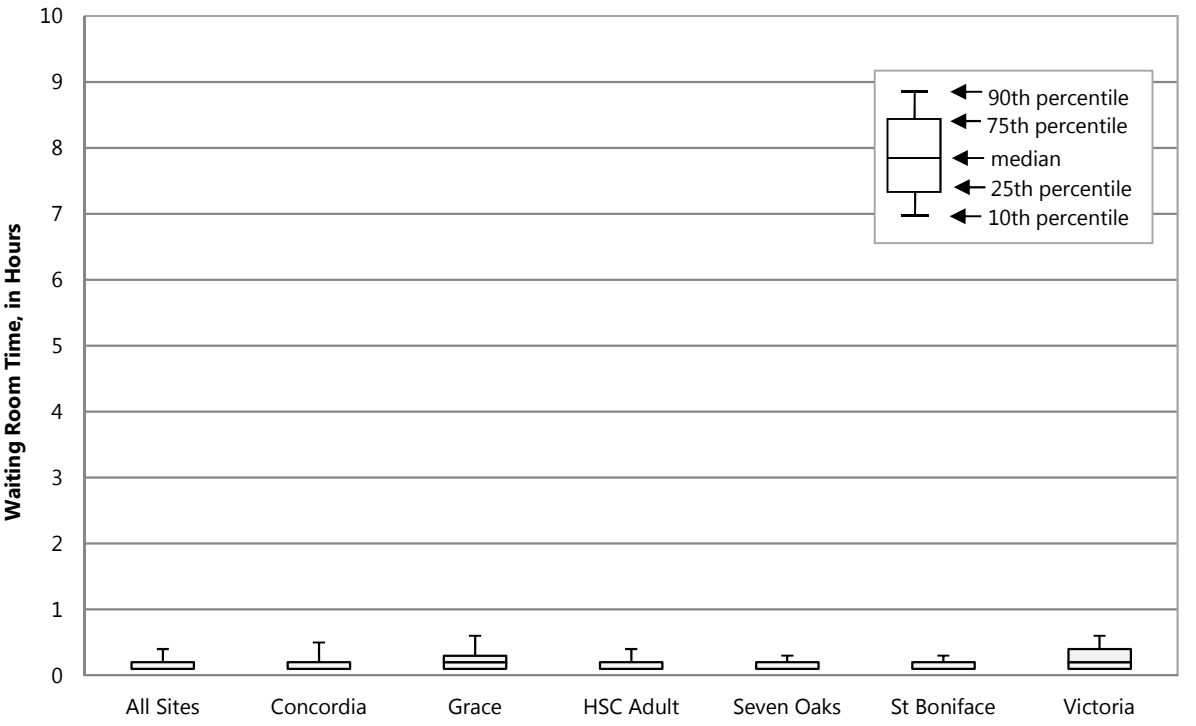
Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Comparing how Factors Affect Waiting Room Times across ED Sites

CTAS 1 Patients: The median waiting room time for CTAS 1 patients was very small at each ED site (12 minutes or less; Figure 7.6). Site-specific differences in how input, throughput, and output factors affect these times are also negligible (data not shown). From these findings, we conclude that CTAS 1 patients were consistently prioritized across Winnipeg EDs, irrespective of which site they visited.

Figure 7.6: Median CTAS 1 Waiting Room Times, Overall and by Adult ED Site

Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



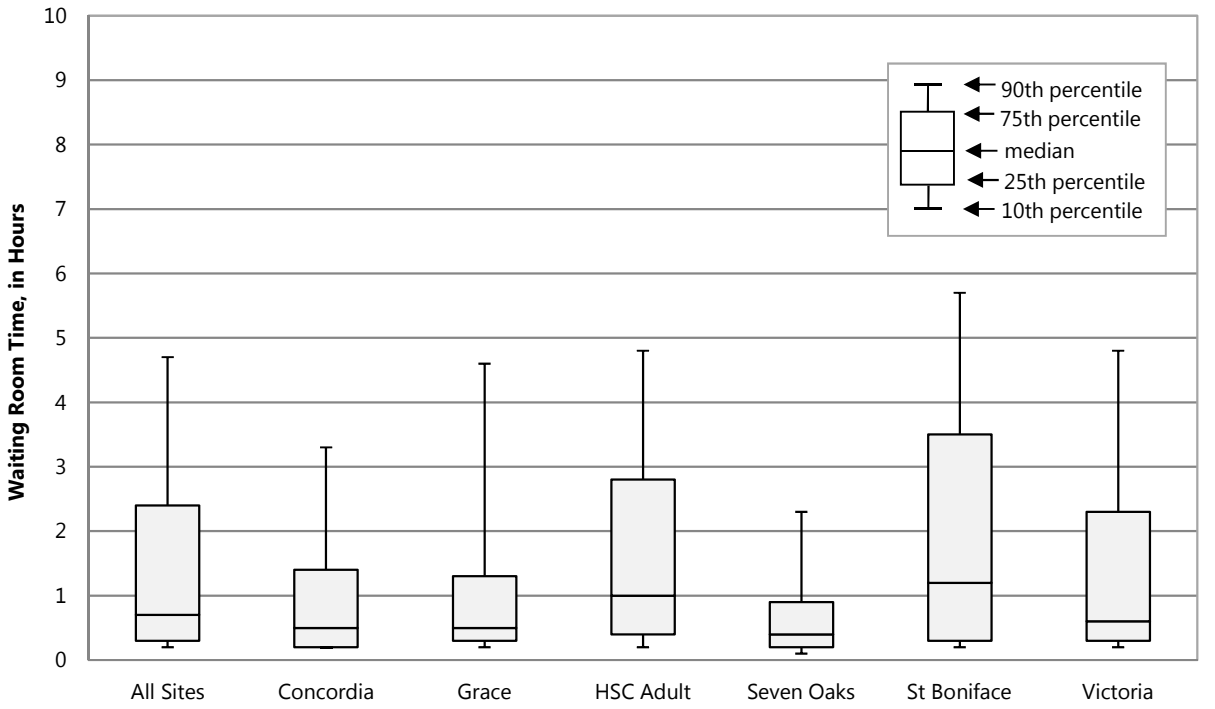
Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

CTAS 2 Patients: The median waiting room time for CTAS 2 patients varied considerably across sites, ranging from 24 minutes at the Seven Oaks ED, to 60 and 72 minutes at HSC and St. Boniface, respectively (Figure 7.7). Factors affecting these differences across sites are discussed.

- After adjustment for other measures, at each site higher volumes of input factors had no discernable impact on median CTAS 2 waiting room times. An example is shown in Figure 7.8, where changes in the number of existing CTAS 2 patients did not affect the (adjusted) median waiting room time of index CTAS 2 patients. During periods where 10% of treatment areas were filled with existing CTAS 2 patients, adjusted median waiting room times varied from 40.5 minutes (Victoria) to 50.9 minutes (adult HSC). These adjusted times changed minimally during periods where 35% of treatment areas were filled with existing CTAS 2 patients (e.g., 43.6 minutes at Victoria, 37.0 minutes at HSC). Similar results were found for all other input factors (data not shown).

Figure 7.7: Median CTAS 2 Waiting Room Times, Overall and by Adult ED Site

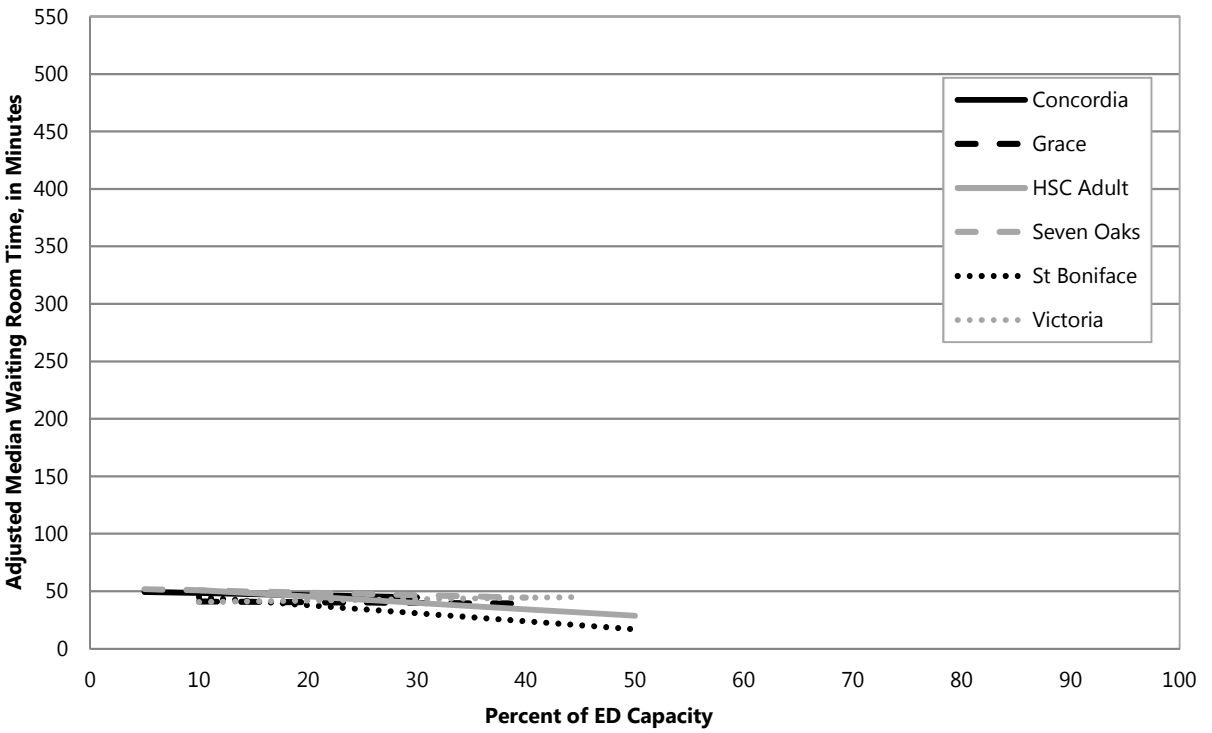
Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.8: Effect of Existing CTAS 2 Visits on Adjusted Median CTAS 2 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on first order (linear) estimates only. Input lines are curtailed at 50%.

- The effect of diagnostic tests on CTAS 2 waiting room times is also similar across ED sites (Figure 7.9). During periods where 20% of treatment areas had patients waiting for tests, adjusted median waiting room times ranged from 10.2 minutes (St. Boniface) to 22.5 minutes (Seven Oaks). Similarly, during periods where 45% of treatment areas had patients waiting for diagnostic tests, the adjusted median waiting room time for CTAS 2 patients remained similar across sites (e.g., ,89.6 minutes at St. Boniface, 95.9 minutes at Seven Oaks). Commencing at about 45% capacity, it is important to note that the adjusted effect of diagnostic tests on CTAS 2 waiting room times was somewhat stronger at the Victoria ED compared to most other sites (e.g., at 45% capacity, adjusted median waiting room times ranged from 89.6 minutes at St. Boniface to 107.2 minutes at Concordia, and 123.9 minutes at Victoria).
- A different story emerges when comparing the effect of in-patients on CTAS 2 waiting room times across sites (Figure 7.10). After adjustment for other risk factors, higher volumes of patients waiting to be hospitalized more negatively affected CTAS 2 waiting room times at Grace compared to all other sites. During periods where 10% of treatment areas were filled with patients waiting to be hospitalized, adjusted median CTAS 2 waiting room times were quite similar across sites (i.e., ranging from 29.4 minutes at St. Boniface to 40.2 minutes at Seven Oaks). However, during periods where 25% of treatment areas were filled with patients waiting to be hospitalized, adjusted median CTAS 2 waiting room times ranged from less than 65 minutes at most ED sites (except Victoria, which had an adjusted median waiting room time of 74.0 minutes), to 104.8 minutes at Grace.

Figure 7.9: Effect of Existing Diagnostic Tests on Adjusted Median CTAS 2 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

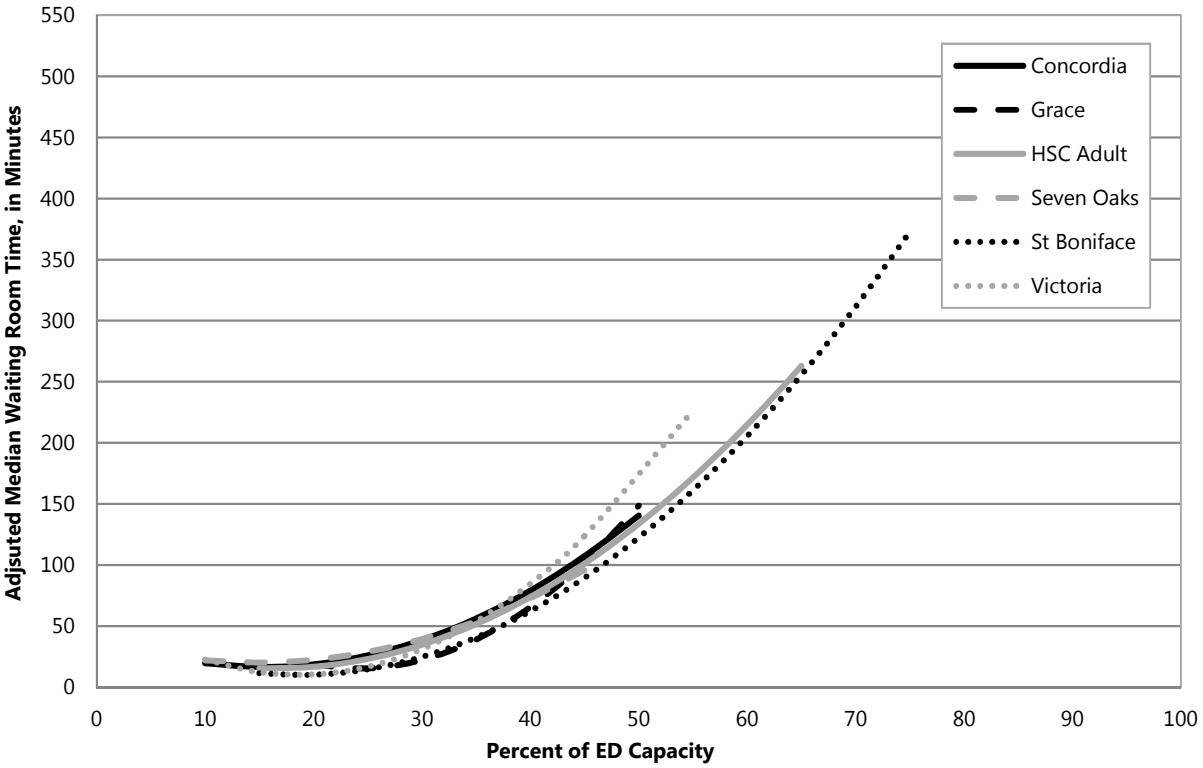
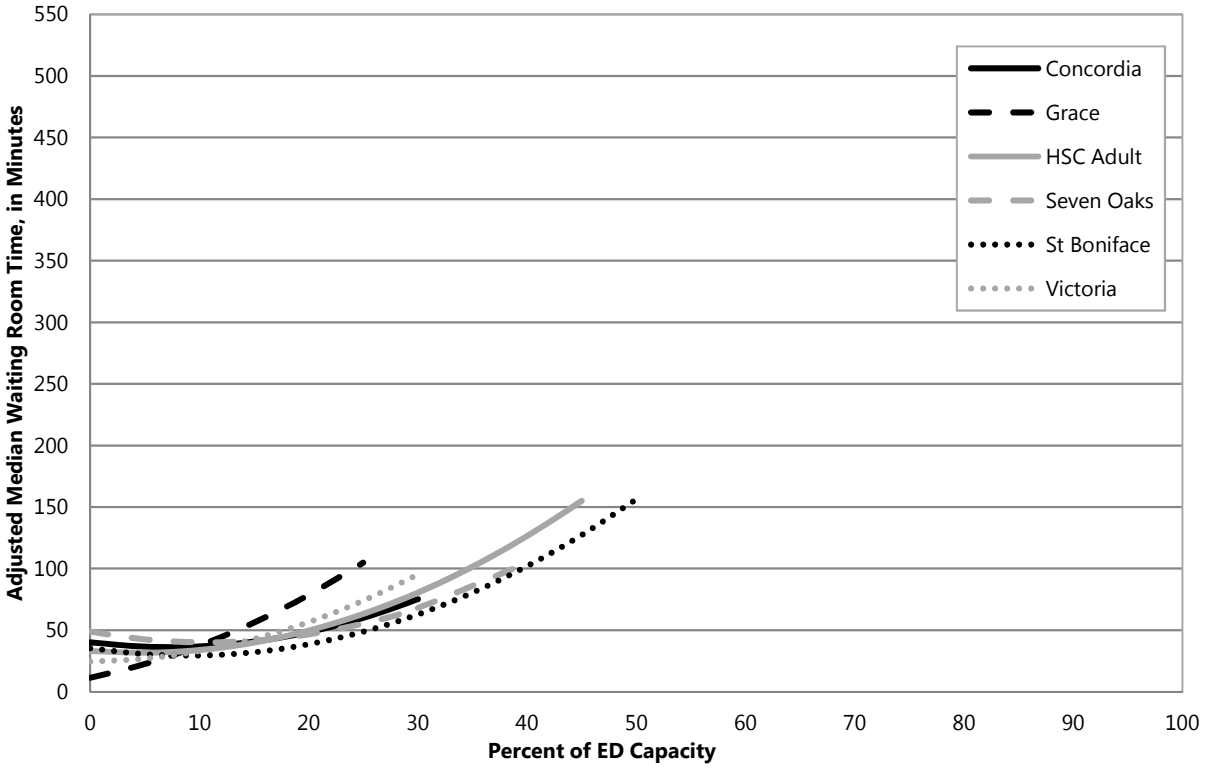


Figure 7.10: Effect of Existing Patients Waiting for Hospital Admission on Adjusted Median CTAS 2 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

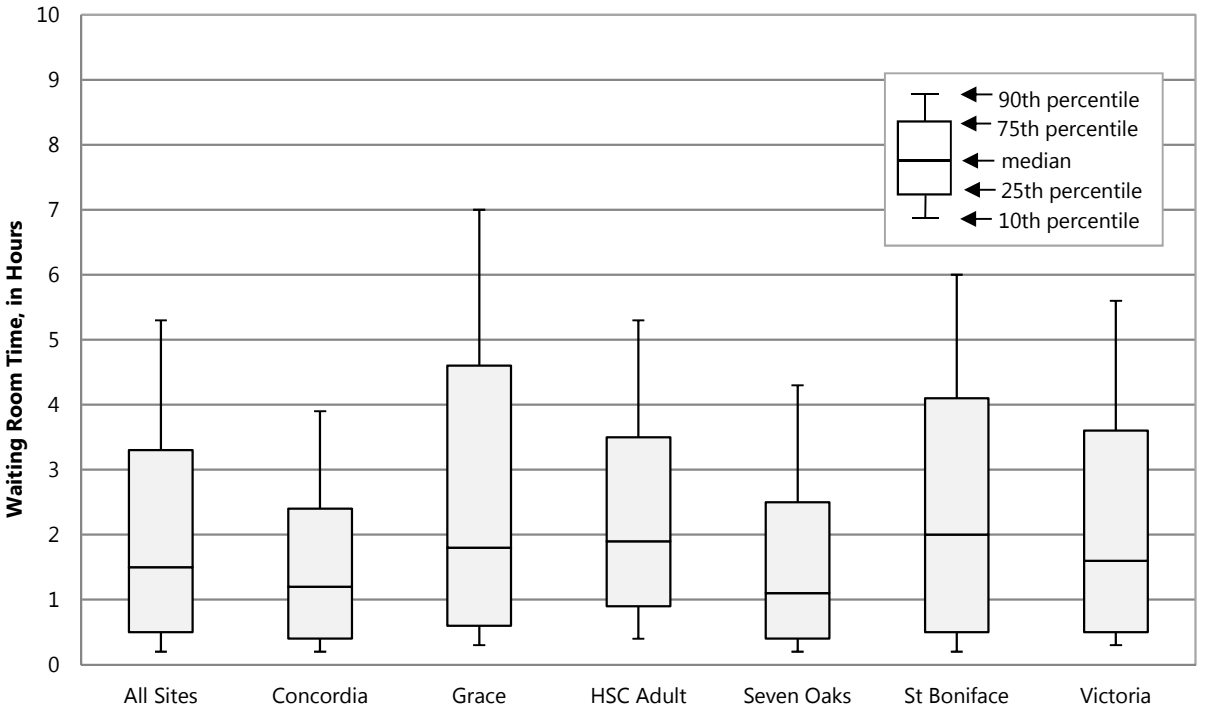


CTAS 3 Patients: Similar to the findings for CTAS 2 patients, the median waiting room times for CTAS 3 patients was also lowest at Seven Oaks (66 minutes) and highest at the HSC (114 minutes) and St. Boniface (120 minutes) EDs (Figure 7.11). Factors affecting these differences across sites are discussed.

- After adjustment for other measures, we observed that higher volumes of input factors impacted median CTAS 3 waiting room times. An example is shown in Figure 7.12, where the effect of existing CTAS 2 patients on CTAS 3 waiting room times was similar for the community-based EDs (Concordia, Grace, Seven Oaks, and Victoria), but lower for the HSC and St. Boniface sites. This same pattern of results exists when comparing the adjusted effect of diagnostic tests on CTAS 3 waiting room times (Figure 7.13). In scenarios where EDs were 50% filled with patients getting diagnostic tests, these waiting room times varied from 167.7 minutes to 202.4 minutes at the community-based sites, versus 136.2 minutes at HSC and 103.6 minutes at the St. Boniface ED. Last, in scenarios where EDs were 25% filled with in-patients, adjusted median waiting room times ranged from a low of 53.1 minutes at the St. Boniface ED, to a high of 202.0 minutes at the Grace ED (Figure 7.14).

Figure 7.11: Median CTAS 3 Waiting Room Times, Overall and by Adult ED Site

Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.12: Effect of Existing CTAS2 Visits on Adjusted Median CTAS 3 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

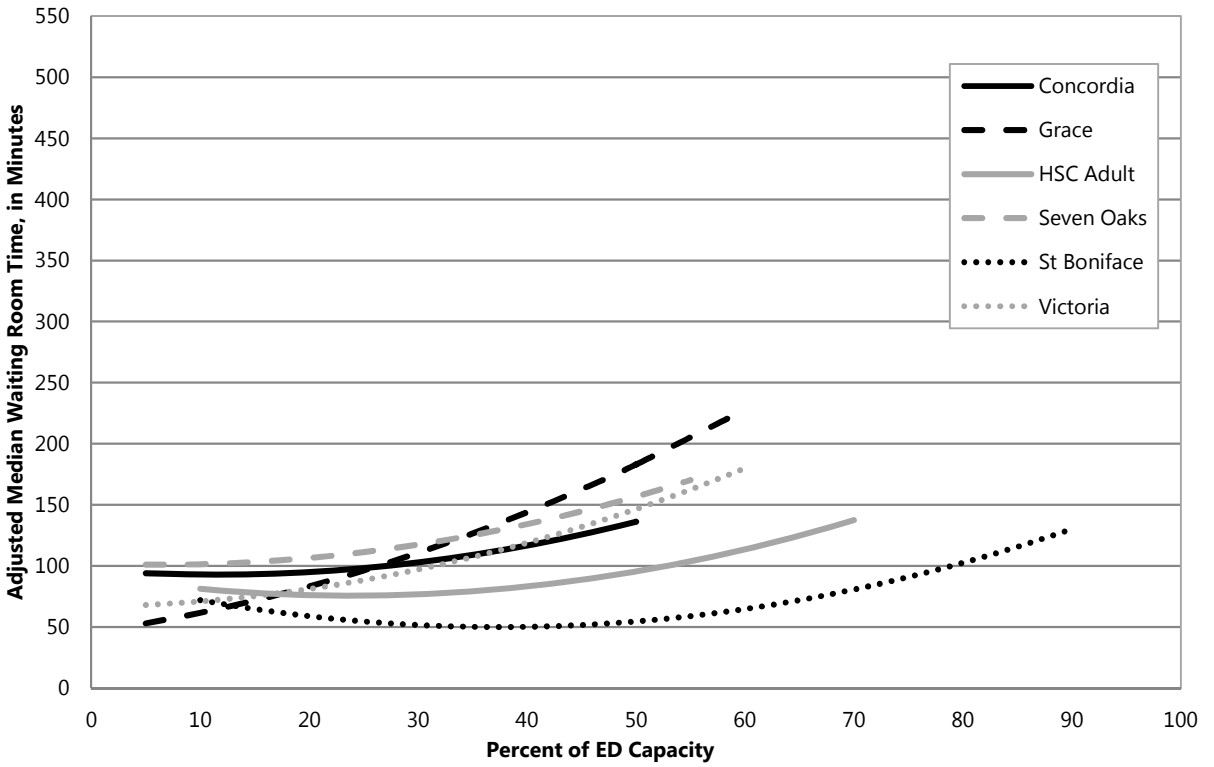


Figure 7.13: Effect of Existing Diagnostic Tests on Adjusted Median CTAS 3 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

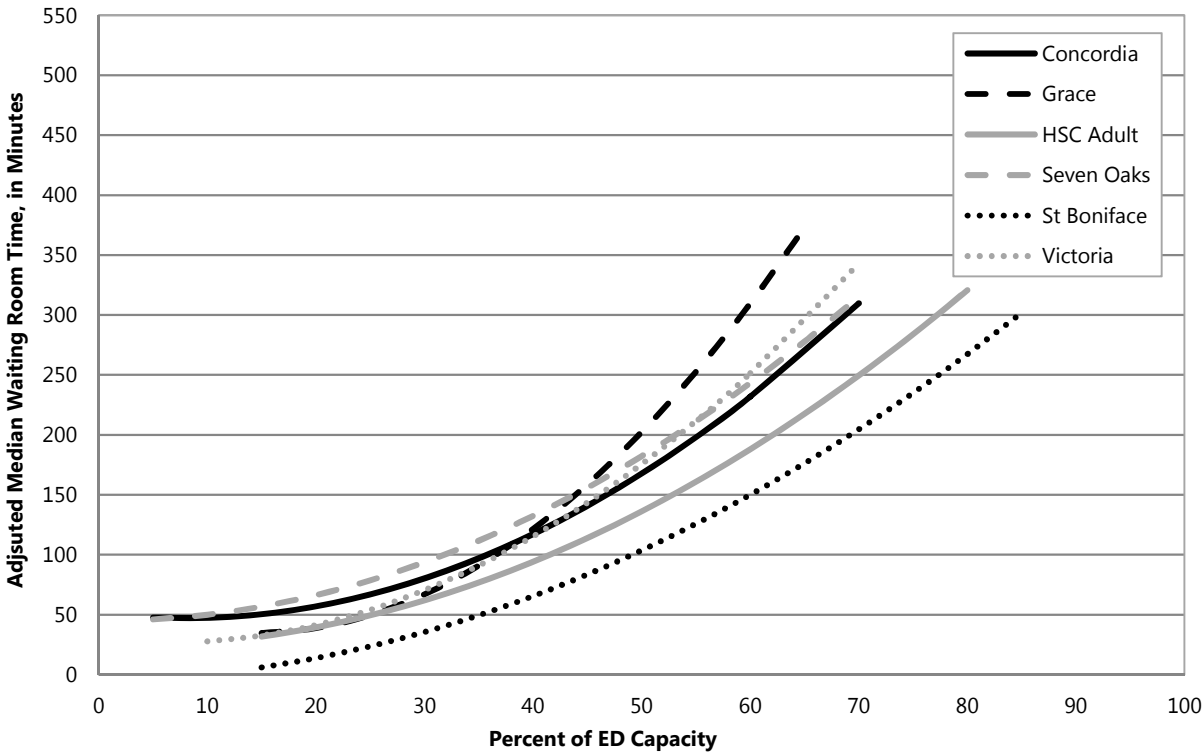
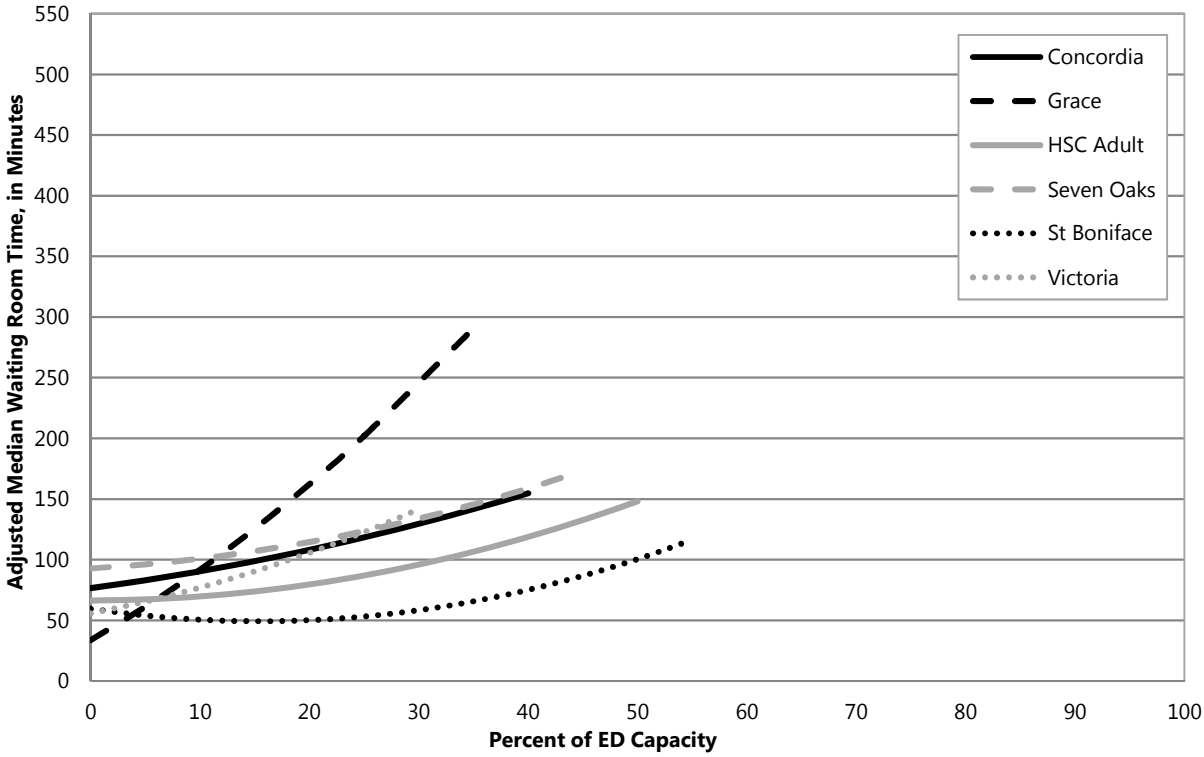


Figure 7.14: Effect of Existing Patients Waiting for Hospital Admission on Adjusted Median CTAS 3 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



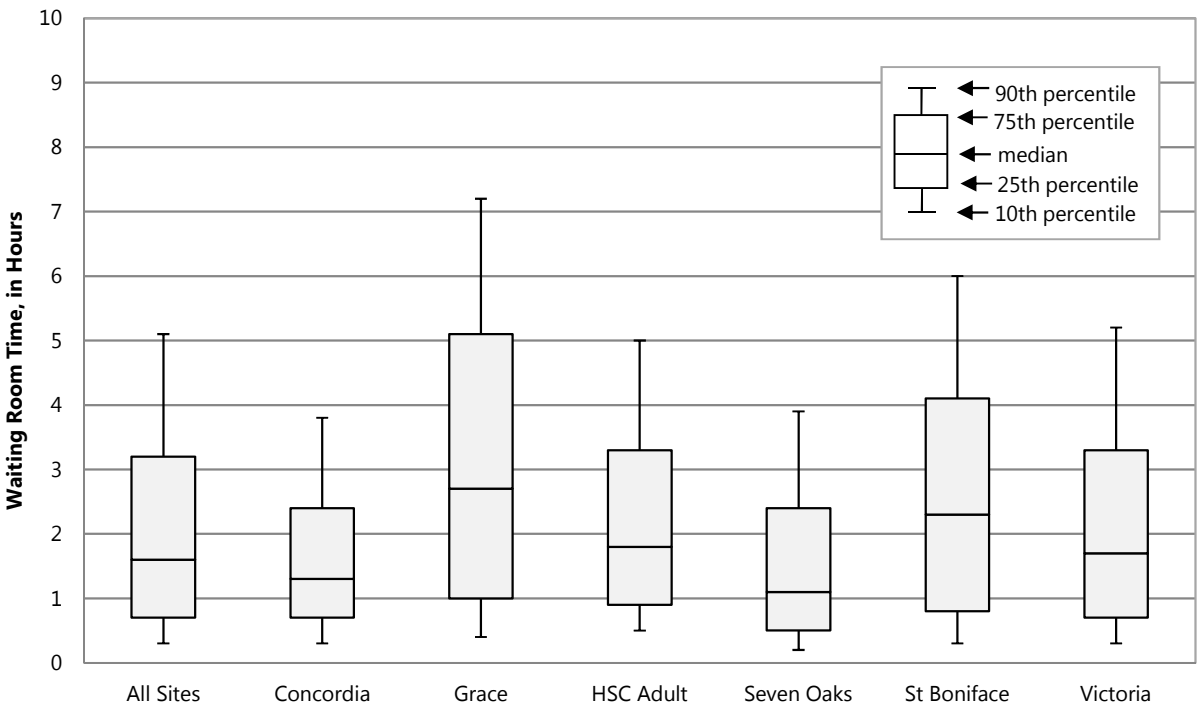
CTAS 4&5 Patients: The median waiting room time for CTAS 4&5 patients was almost two-fold higher at Grace (2.7 hours) versus at some other sites (e.g., 1.7 hours or less at each of Concordia, Seven Oaks, and Victoria) (Figure 7.15). During 10% of these visits, patients remained in the waiting room for at least 7.2 hours at Grace, as compared to at least 5.1 hours at all sites combined.

The effect of input, throughput, and output factors on these waiting room times was stronger at Grace versus at most other sites.

- In scenarios where EDs were 10% filled with existing CTAS 2 patients, the adjusted median waiting room time for CTAS 4&5 patients was somewhat similar across sites, ranging from 74.2 minutes at Victoria to 92.4 minutes at Seven Oaks (Figure 7.16). Higher volumes of existing CTAS 2 patients impacted these waiting room times moderately at most other sites, and quite substantially at Grace. In scenarios where EDs were 45% filled with existing CTAS 2 patients, adjusted median wait times for CTAS 4&5 patients ranged from 71.1 minutes (St. Boniface) to 115.8 minutes (Victoria) across ED sites, and 176.0 minutes at Grace.
- Diagnostic tests also influenced CTAS 4&5 waiting room times more strongly at Grace versus other sites (Figure 7.17). During periods where 20% of treatment areas had patients waiting for diagnostic tests, these adjusted median waiting room times ranged from 33.8 minutes to 62.1 minutes across ED sites. This changed dramatically during periods where 45% of treatment areas had patients waiting for diagnostic tests. In these scenarios, the adjusted median waiting room time for CTAS 4&5 patients ranged from 94.7 minutes (St. Boniface) to 116.9 minutes (Victoria) at other ED sites, and 155.3 minutes at Grace. This same pattern of results exists for in-patients (Figure 7.18). During periods where 25% of treatment areas had patients waiting to be hospitalized, the adjusted median wait time for CTAS 4&5 patients ranged from 71.5 (St. Boniface) to 108.8 minutes (Victoria) at most ED sites, and 206.0 minutes at Grace.

Figure 7.15 : Median CTAS 4&5 Waiting Room Times, Overall and by Adult ED Site

Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



Note: Results are based on Level 1 exclusion criteria (see Figure 2.2).

Figure 7.16: Effect of Existing CTAS 2 Patients on Adjusted Median CTAS 4&5 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

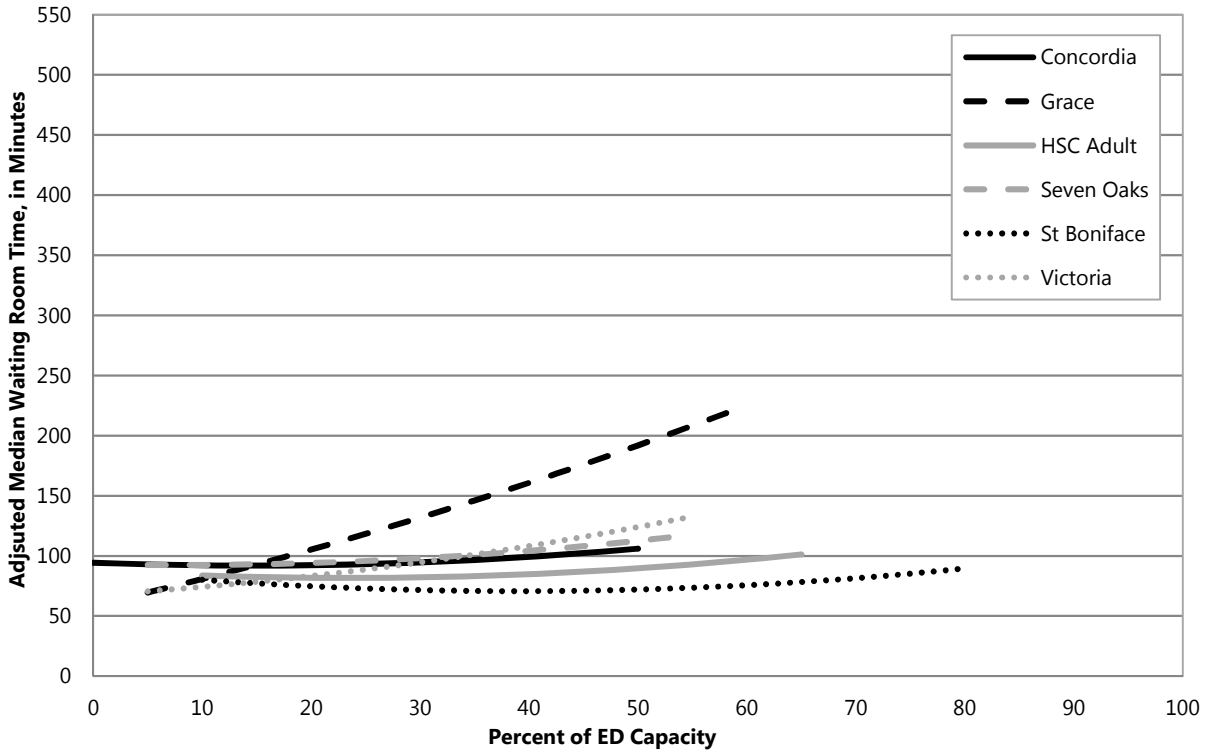


Figure 7.17: Effect of Existing Patients Waiting for Diagnostic Tests on Adjusted Median CTAS 4&5 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013

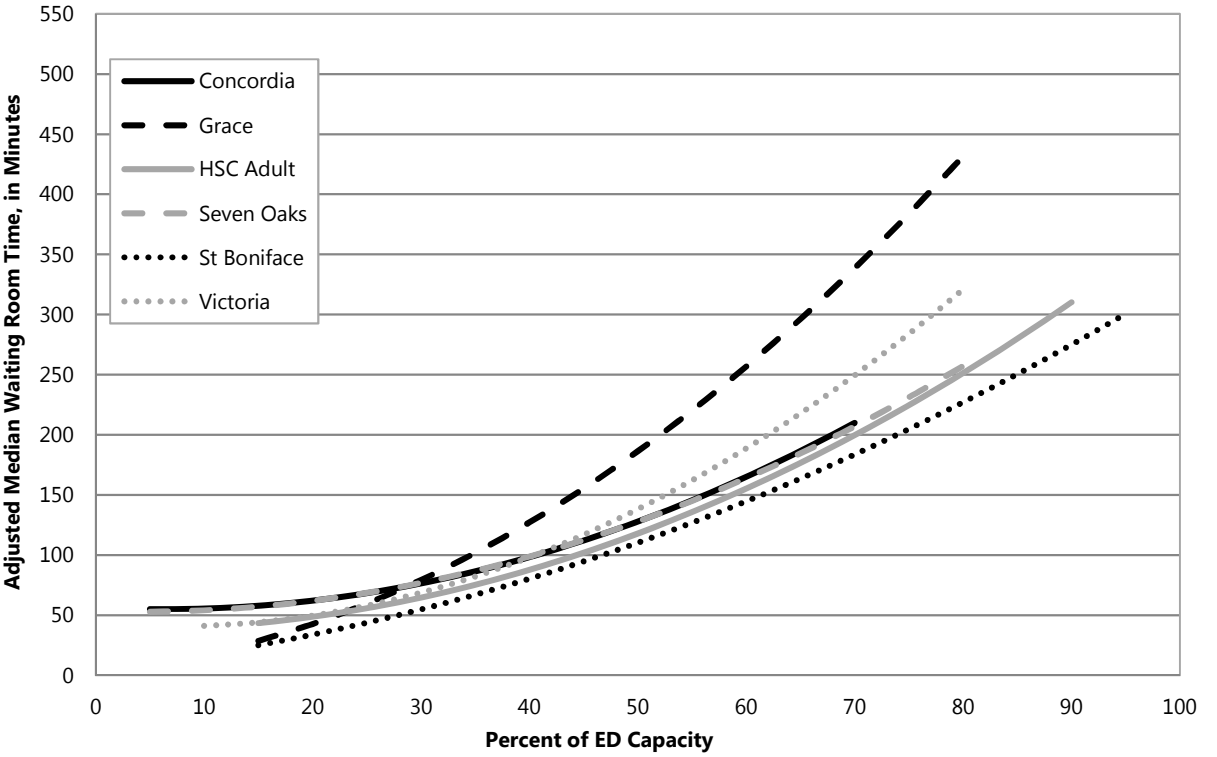
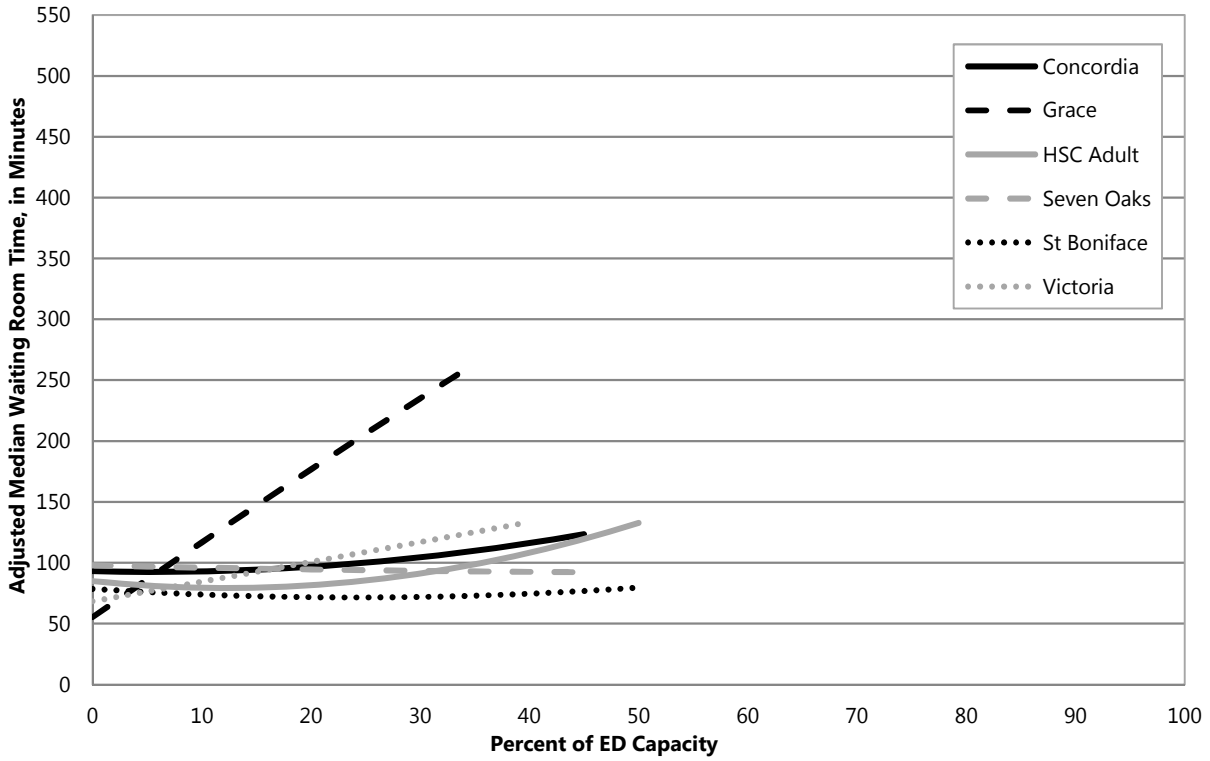


Figure 7.18: Effect of Existing Patients Waiting for Hospital Admission on Adjusted Median CTAS 4&5 Waiting Room Times

Adult ED Site Comparisons, Visits between 8:00 a.m. and 8:00 p.m., Winnipeg, Manitoba, April 1, 2012 to March 31, 2013



CHAPTER 8: MAJOR STUDY CONCLUSIONS, POLICY IMPLICATIONS, AND FUTURE DIRECTIONS

Major Study Conclusions and Policy Implications

The Canadian Association of Emergency Physicians (CAEP) recommends that CTAS 1-3 patients who are not subsequently hospitalized should have a median ED visit duration of at most 4 hours, and a 90th percentile visit duration of 8 hours (Affleck et al., 2013). In the present study, the median duration of *all* CTAS 1-3 visits ranged from 5.0 to 9.0 hours across the six Winnipeg sites. The 90th percentile of these visits exceeded 20 hours at all ED sites, except in one instance (CTAS 3 visits at Seven Oaks, 12.9 hours).[24] CAEP also recommends that the median duration of (non-hospitalized) CTAS 4&5 visits should be at most 2 hours (90th percentile of 4 hours). From the present study, the median duration of CTAS 4&5 visits ranged from 2.9 hours (Seven Oaks) to 6.2 hours (Grace). The 90th percentile of these visits was at least 7 hours at each site.[24] Last, while CAEP recommends that ED boarding times should not exceed 2 hours (Canadian Association of Emergency Physicians, 2006), in the present study this median time was 3.2 hours, with an inter-quartile range (25th-75th percentile) of 1.4 hours to 8.9 hours. Collectively, these data demonstrate the need to improve patient flow in Winnipeg EDs.

What do we know about strategies to reduce ED wait times? The vast majority of scientists state that output factors — and in particular, challenges in getting patients admitted to hospital — are largely to blame (Arkun et al., 2010; Fatovich et al., 2005; Lucas et al., 2009; Rathlev et al., 2007; Rathlev et al., 2012; Vermeulen et al., 2009; White et al., 2013; Wiler et al., 2012; Ye et al., 2012). These authors state that more hospital beds are needed for alternate level of care patients, and that better hospital bed management strategies are required (e.g., to help reduce lengths of hospital stay, to develop more timely hospital discharge protocols) (Affleck et al., 2013; Canadian Association of Emergency Physicians, 2006). However, some authors also report that diagnostic tests are important to consider, citing the many steps associated with preparing for and conducting tests, and interpreting results (Gardner et al., 2007; Kocher et al., 2012; Yoon et al., 2003). To date, no research directly examines which of these factors, and others, are the most important to consider.

The present research was conducted in part to address this knowledge gap. Five major findings are summarized here.

1. About 200,000 ED visits were reported in each year between 2003/04 (N=195,697 visits) and 2007/08 (N=198,798 visits). EDIS was implemented in 2009/10, and at this time, most EDs were renovated, in part to increase their treatment area capacity. Commencing this year, the number of ED visits changed substantially. Total visit counts increased by 12.0% (N=222,526 visits) in 2009/10 and have remained at this level thereafter. Despite this increase, the proportion of visits triaged as lower acuity has remained fairly stable across time (e.g., about 39% of all ED visits were triaged as CTAS 4&5 annually from 2003/04 to 2007/08, versus 42% of all visits in 2012/13). Further, the percent of 'incomplete' ED visits (i.e., where patients leave without seeing a physician) has increased steadily with time, ranging from 5.9% of visits in 2004/05, 7.8% of visits in 2007/08, to 10% of visits in 2012/13. From these and other findings, we conclude that further increasing the number of ED treatment areas in Winnipeg likely has limited value.
2. Like others (Schull et al., 2006), we show in this research that higher volumes of lower acuity patients minimally impact the waiting room times of people more acutely ill. While higher numbers of incoming acutely ill patients lengthen the waiting room times of those less sick, this effect is quite marginal compared to that of throughput and output factors.

24 These values change minimally for ED visits not ending in hospitalization. The median duration of these visits (all sites combined) ranged from 3.8 hours (CTAS 4&5 visits), 5.2 hours (CTAS 1 visits, CTAS 3 visits) to 6.4 hours (CTAS 2 visits). The 90th percentile of these visit durations ranged from 9.6 hours (CTAS 4&5), 16.6 hours (CTAS 3) to 22.8 (CTAS 1) hours (data not shown).

3. Throughput factors, in particular the number and type of diagnostic tests performed, lengthen ED waiting room times at least as strongly as output factors. We found that the effect of having patients waiting for hospital admission was about the same as having patients waiting for urine tests and for troponin blood tests. Other more complex tests (e.g., x-rays, computed tomography scans) more strongly influenced waiting room times, presumably because of the time required to prepare for, perform, and interpret the results of these tests, as well as the shared demands of using this technology with hospital staff. From these results we conclude that reform strategies to reduce ED waiting room times should focus on both the hospital and ED care environments. This conclusion is consistent with CAEP's most recent position statement, asserting that reform strategies to reduce waiting times are likely multifactorial (Affleck et al., 2013).
4. Many researchers state that the solutions to reduce ED waiting times are capacity-based, citing the need to 'free up' hospital beds (Affleck et al., 2013; Canadian Association of Emergency Physicians, 2006). To test this hypothesis, we examined the association between ED boarding times (i.e., from the decision to hospitalize a patient, to the actual admission time) and two metrics of hospital capacity. Our results show that hospitals were less than 90% full when two-thirds of ED patients were waiting for hospital admission. On these occasions, median ED boarding times increased by only 3.4 minutes for every 1% increase in hospital capacity. Similarly, hospitals were between 5% and 15% filled with ALC patients when two-thirds of ED patients were waiting for a hospital bed. On these occasions, median ED boarding time increased by only 2.4 minutes for every 1% increase in the proportion of hospital beds occupied by ALC patients. While these increases were much greater at higher levels of hospital occupancy (e.g., when hospitals increased from 91% to 100% full, median boarding time increased 4.4 hours), overall we conclude from these results that reform strategies focusing on output factors need to involve more than simply creating more hospital space.
5. The factors affecting waiting room times were compared directly across Winnipeg EDs. After accounting for the unique features across sites (e.g., the frequency with which diagnostic tests were performed), in most instances we found that the effect of input, throughput, and output factors on waiting room time was remarkably similar across sites. From these results we conclude that system-wide strategies for reducing ED waiting room times can be developed. Our research highlights one exception: the particular challenges experienced at Grace during the study period. In 2012/13, this ED had an older patient clientele and performed some types of diagnostic tests more frequently than other sites. Patient turnover was also lowest at this site, at a rate close to half of some other sites. Our statistical modeling techniques show that the effect of both throughput and output factors on waiting room times was almost two-fold higher at Grace versus other Winnipeg EDs for lower acuity patients.

Future Directions

While EDIS provides a rich supply of ED data, several key improvements to this data system are recommended. It is especially important to capture 'true' diagnostic test order times, to define with more certainty how long people wait to receive diagnostic tests. Similar data are required for consultations with specialists (i.e., capturing when the request was made, and when the consult actually started and was complete) involving both medical and allied health staff, to better understand the complex nature of waiting and care in EDs.

This research identifies potential areas of healthcare reform but does not dictate how it should take place. Future studies are required to help understand what types of changes should be made, and how these can best and most practically be implemented within the hectic ED and hospital care environments. Administrative data systems are valuable for measuring how well these reform strategies help to improve ED patient flow.

Concluding Remarks

From this research we conclude that reform aimed at reducing ED waiting room times should not simply focus on creating more capacity (ED treatment areas or hospital beds), but rather should also include process changes. Within the ED, this includes ensuring that: i) guidelines clearly demark when diagnostic tests should be ordered; ii) the process for ordering, preparing, conducting, and interpreting diagnostic tests is timely; and iii) an appropriate supply of equipment and personnel is available to provide these services when needed. Similar strategies are required to ensure that patients who need to be admitted to hospital are transitioned in a timely manner.

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