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Access Block Experienced by a General Internal Medicine Population: Factors and Outcomes

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Abstract

This retrospective study examines the frequency and intensity of access block experienced by a general internal medicine population within a large tertiary care center. The study demonstrated internal medicine admissions experienced significant emergency department wait times and access block. Factors significantly associated with prolonged emergency department times included age, isolation, admission day, admission in fall, admission year, medicine blocked beds, medicine occupancy, medicine emergency inpatients, hospital blocked beds and hospital full capacity stretchers in use. Admission diagnoses of pneumonia and delirium were associated with emergency department length of stay only, while daily number of internal medicine admissions and admission shift was associated with BWT only. Mortality, intensive care unit transfers and inpatient length of stay were not associated with prolonged wait times. Overall general internal medicine patients experienced significant access block. Isolation exerted the most influence on prolonging wait times. Capacity factors did not exert as much influence as anticipated, possibly due to very high occupancy rates.

Table of Contents

List of Tables

List of Figures

Abbreviations

ACEM	Australian College of Emergency Medicine
AHS	Alberta Health Services
AHW	Alberta Health and Wellness
ALC	Alternate level of care
ARF	Acute renal failure
BWT	Bed wait time
CAEP	Canadian Association of Emergency Physicians
CEHSEU	Clinical Epidemiology and Health Service Evaluation Unit
CIHI	Canadian Institute of Health Information
COPD	Chronic obstructive pulmonary disease
DRG	Diagnostic related group
ED	Emergency department
EDIS	Emergency department information system
EDLOS	Emergency department length of stay
EDT	Emergency department time
EIP	Emergency inpatient
FCP	Full capacity protocol
GIM	General internal medicine
HF	Heart failure
HSMR	Hospital Standardized Mortality Ratio
ICD	International Statistical Classification of Diseases
ICU	Intensive care unit
IPLOS	Inpatient length of stay
IPT	Interprofessional team

M	Mean
MAU	Medical assessment unit
ns	Non significant
PE	Pulmonary embolism
RAH	Royal Alexandra Hospital
RCP	Royal College of Physicians
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
UK	United Kingdom
UTI	Urinary tract infection
WTA	Wait Time Alliance

Chapter 1

Introduction

Access to services in tertiary care hospitals is a vital component of health care. Emergency department (ED) overcrowding has emerged in Canada and other developed nations as a impediment to accessing health services (Alberti, 2004; Forero & Hillman, 2008; General Accountability Office, 2009; Rowe et al., 2006). Multiple causes of ED overcrowding have been identified. Prolonged emergency department length of stay (EDLOS) and bed wait times, referred to as access block, due to a lack of inpatient beds is a significant contributor, with many emergency inpatients (EIPs) awaiting beds in EDs. EDLOS is defined as the length of time from registration in the ED to discharge or transfer out of the ED and bed wait time (BWT) is the length of time from the decision to admit a patient to the patient's departure from the ED. EIPs are admitted patients in the ED awaiting an inpatient bed. The terms BWT and EIPs are synonymous with the terms boarders and boarding time, respectively, commonly used in American literature. The general medicine population appears to experience high rates of access block. Escalating ED overcrowding and associated clinically negative consequences (Bernstein et al., 2009) have stimulated potential solutions such as establishing medical assessment units (MAU). A MAU is a specialized unit providing early assessment and initial treatment of acutely ill medical patients. MAUs optimize bed capacity and impacts access block through contributing to an increased turnover of inpatient beds via a number of strategies including early access to senior physicians, interprofessional teams (IPT), diagnostics and enhanced discharge planning and throughput strategies. There is a lack of empirical data reflecting the efficacy of MAUs and variation among the strategies employed within MAUs to impact access block. In order to develop novel strategies to employ within a MAU, understanding of the factors associated with access block and patient outcomes related to access block must be identified.

ED Overcrowding Definition and Measures

A universally accepted definition of ED overcrowding does not exist (Hwang & Concato, 2004), however, most definitions contain similar elements [Australian College for Emergency Medicine, 2009; American College of Emergency Physicians, 2008; Canadian Association of Emergency Physicians, (CAEP), 2007]. Canadian literature defines ED overcrowding as “a situation in which demand for emergency services exceeds the ability of a department to provide quality care within acceptable time frames” (CAEP, 2007; Rowe et al., 2006). Canadian reports of ED overcrowding surfaced in the 1980s and persisted throughout the 1990s. The CAEP released the first Canadian position statement regarding ED overcrowding in 2001. Subsequent positions statements identify chronic overcrowding as the most significant problem facing Canadian EDs (CAEP 2001, 2003, 2007). In 2006, 62% of Canadian ED medical directors rated overcrowding as major or severe. Overcrowding was most prevalent among EDs with the following characteristics: population base of > 150 000 or annual volumes of > 50 000 visits, being a trauma center, being university affiliated or containing > 30 ED stretchers (Rowe et al., 2006). Canadian ED overcrowding continues to increase, as evidenced by rising wait times; many EDs are unable to provide assessment and care within recommended triage times (Bullard et al., 2009; CAEP, 2007; Canadian Wait Time Alliance, 2009).

Valid, reliable and sustainable ED overcrowding measures have been difficult to establish, despite an extensive international literature base. Multiple measures are reported and many may be considered to be indirect or proxy measures versus actual measures of overcrowding (Bernstein & Asplin, 2006; Schull, Slaughter & Redelmeir, 2002; Solberg, Asplin, Weinick & Magid, 2003). Examples of proxy measures include the number of patients leaving the ED prior to being seen by a physician or ambulance diversion. Ospina et al. (2006) conducted a Delphi study of Canadian ED experts. The percentage of ED stretchers occupied by admitted patients was accepted as the most important measure, followed by total ED patients, total time spent in the ED or EDLOS, percentage of time an ED is at or above capacity and overall hospital bed occupancy. Given the lack of concrete indicators and metrics, Asplin (2006) recommends unadjusted ED throughput, as reflected by EDLOS, as the primary indicator, shifting focus to defining and measuring ideal ED patient flow. The Canadian Emergency Department Working Group has developed a database to collect various time points throughout EDLOS as proposed standardized measures of ED overcrowding and patient flow (CAEP, 2005). A number of scales have been developed to measure overcrowding, but have been demonstrated to require site specific calibrations and are of limited value in EDs experiencing lower rates of overcrowding (Jones, Allen, Flottemesch & Welsch, 2006). Hoot and Leblanc et al. (2009) have developed and validated a tool, ForecastED, designed to predict overcrowding using seven measures. The tool was designed to forecast and warn hospital administrators and clinicians of impeding overcrowding, allowing for mobilization and allocation of resources as an early intervention. There are no reports of ForecastED used as a real time intervention strategy.

ED Overcrowding Conceptual Model

Asplin et al. (2003) developed a conceptual model of ED overcrowding using the components of input, throughput and output. The framework has provided structure for understanding ED patient flow, potential causes of overcrowding and a focus for solutions (Appendix A), within the context of the acute care system, defined broadly as any delivery system component that provides unscheduled care. While multiple causes exist (Derlet & Richards 2000; Hoot & Aronsky, 2008), blocked ED patient output resulting in the ED retaining admitted patients has been recognized as a major contributor of ED overcrowding (Government Accountability Office, 2009; Bullard et al., 2009; McCarthy et al., 2009; Schwartz, 2005). The top two contributors to ED overcrowding, according to Canadian ED directors, were a lack of available inpatient beds and longer EDLOS (Rowe et al., 2006). Prolonged EDLOS, BWT and EIPs are associated with a number of measures of overcrowding (Bullard et al., 2009; Fatovich, Nagree & Sprivulis, 2005; Gilligan et al., 2008; McCarthy et al., 2009; Schull, Lazier, Vermeulen, Mawhinney & Morrison, 2003). McCarthy et al. (2009) demonstrated that bed wait times were most influenced by the number of EIPs and occupancy rates. Bed wait times comprise a significant portion of EDLOS and studies suggest up to 60% of admitted patients' EDLOS is spent awaiting an inpatient bed (Gilligan, Winder, Ramphul & O'Kelly, 2010) and requiring admission has the greatest impact on prolonging EDLOS (Downing, Wilson & Cooke, 2004).

Access Block Definition and Measure

The term access block was first coined and defined by the Australasian College for Emergency Medicine as an EDLOS of >8 hours, reflecting the inability of admitted patients in the ED to access inpatient beds (ACEM, 2009). The United Kingdom (UK) Department of Health defines access block as an EDLOS > 4 hours; whereas Canadian researchers define access block as the inability of admitted patients in the ED to access inpatient beds, in a reasonable time (Alberti, 2004; Ospina et al., 2006). The Canadian Institute of Health Information (CIHI, 2005) reports 76% of Canadians complete their ED visit in less than 4 hours. This is comparable to America, but is significantly lower than the UK, where 96% of patients complete their ED visit in less than four hours (Alberti, 2004). The CIHI (2007) reports 10% and 4% of Canadians wait > 17 and 24 hours, respectively for inpatient beds. The Canadian Wait Time Alliance (2009) reported a median EDLOS of six hours for patients who are discharged from the ED. EDLOS increased to a median of 19 hours when patients are admitted and wait for an inpatient bed, highlighting significant access block. Collectively, the EDLOS, bed wait time and volume of EIPs represent the degree of access block in a facility.

The CAEP (2007) published national benchmark targets of EDLOS of ≤ 6 hours based on triage scores, with all admitted patients being transferred out of the ED within 2 hours after the decision to admit has been made. The Ontario government has leveraged the most political will to develop an action plan (Bell et al., 2006; Hudson, 2009; Schwartz, 2005); completing two major reviews of provincial EDs resulting in government endorsed targets for time spent in EDs, a first in North America. The Ontario government's strategies include financial incentives for improvement, collection of standard time measures, development of new roles for nurses and an ED performance improvement program (Hudson, 2009). Alberta Health Services (AHS) is targeting a total emergency department time (EDT) of < 8 hours for admitted patients (AHS, 2010).

Factors Influencing Access Block

Numerous potential factors contributing to access block have been identified in the literature. Health care funding and delivery models, workforce changes, societal social changes, limited community resources, increased hospital admissions, limited inpatient hospital capacity and bed allocation policies have contributed to access block. Additionally, population aging and chronic disease, advances in diagnostic testing and treatment; demands for telemetry monitoring further compound access block (Asaro, Lewis & Boxerman, 2007; Cameron & Campbell, 2003; Downing et al., 2004; Gardner, Sarkar, Masselli & Gonzales, 2007).

A lack of inpatient beds and high hospital occupancies have been identified as the primary contributors to access block in tertiary hospitals (Fatovich, Hughes & McCarthy, 2009; Government Accountability Organization, 2009; Rowe et al., 2006). In 1999, Bagust, Place and Posnett utilized a stochastic simulation model to replicate the dynamics of a hospital system and risk of bed crisis, based on current volumes and admission rates. Once a tertiary care facility reaches >90% capacity, a critical shortage of inpatient beds routinely occurs. The Institute for Healthcare Improvement (2003) has identified certain characteristics of facilities struggling with patient flow and access block: retaining greater than two percent of total admitted patients at any point during the day at least 50% of the time in the ED due to a lack of inpatient beds or an inpatient midnight census of 90% or more > 50% of the time.

Studies have consistently demonstrated increased hospital occupancy is associated with longer EDLOS and access block (Cooke, Wilson, Halsall & Roalfe, 2004; Ding et al., 2010; Dunn, 2003; Forster, Stiell, Wells, Lee, van Walraven, 2003; Rathlev et al., 2007; Wong, Morra, Caesar, Carter & Abrams, 2010). One study found EDLOS was not associated with the hospital census; however, the hospital occupancy was only 86% on average during the study period (Lucas et al., 2009). Correlations between prolonged EDLOS, BWT and excess inpatient lengths of stay (IPLOS) have been observed, indicating access block may lengthen hospital stays and slow turnover of inpatient beds, exacerbating the inpatient bed shortages (CIHI, 2007; Gilligan et al., 2008; Liew, Liew & Kennedy, 2003; Richardson, 2002).

Overall Canadian health care is now delivered with fewer acute care beds. According to the Organization for Economic Co-operation and Development (2010), Canadian acute care hospital beds have steadily decreased from 5/1000 population in 1976 to 2.7/1000 population in 2007, below the average of 3.6. The Organization for Economic Co-operation and Development defines acute care beds as inpatient beds accommodating patients where the principal clinical intent is to do one or more of the following: manage labor (obstetric), cure illness or provide definitive treatment of injury, perform surgery, relieve symptoms of illness or injury (excluding palliative care), reduce severity of illness or injury, protect against exacerbation and/or complication of an illness and/or injury which could threaten life or normal functions, perform diagnostic or therapeutic procedures.

In addition to absolute decreases in the number of acute care beds, existing beds are used inefficiently. Excessive numbers of non acute patients occupy acute care beds while awaiting a bed at an alternate level of care (ALC), representing another form of access block due to lack of community facilities. Patients requiring an ALC bed have finished the acute phase of treatment but remain in an acute care bed. The majority of patients are awaiting an ALC bed require placement in some form of facility based follow up care such as long term care, complex continuing care or physical rehabilitation. From 2007 to 2008, CIHI (2009) reported 74 000 alternate level of care hospitalizations, representing 14% of acute care hospital days or 5200 beds on any given day. The CAEP (2003) states if all patients awaiting alternate levels of care were removed from acute care beds, most hospitals would not have inpatient bed shortages. Recommendations have been made to provincial governments through advocacy groups and an Ontario government commissioned report for increased funding for acute care beds to achieve average regular hospital occupancy rates < 85%, allowing for flexibility (Bell et al., 2006; CAEP, 2007). There are reports in Alberta (ASH, 2010) and Nova Scotia (Bell et al., 2006) of increased hospital and long term care beds; however the impact on ED overcrowding remains unclear.

Access Block Population

Particular patient characteristics are associated with access block: medical diagnosis related groups (DRGs), older age, high acuity, ED arrival timing, arrival by ambulance, race and social disadvantages (CIHI, 2007; Ding et al, 2010; Downing et al., 2004; Forero & Hillman, 2008; Gilligan et al., 2008, 2010; McCarthy, et al., 2009; PHCC, 2006; Pines, Locallio, Hollander, 2009). A DRG is a system, originating with American Medicare initiatives, which classifies hospital cases into one of approximately 500 groups or DRGs using the International Statistical Classification of Diseases and Related Health Problems (ICD), expected to have similar hospital resource use. Initial classification divides patient presentations into medical or surgical based presentations. Patients with medical DRGs wait longer for initial assessment, referral to the admitting team and subsequent review by the admitting team (Gilligan et al., 2008, 2010), in part due to extensive time required for diagnostic tests and monitoring multiple co-morbidities. Patients awaiting medicine inpatient beds wait longer than other services (CIHI, 2007; Gilligan et al., 2010). Nearly 63% of EDLOS is spent awaiting an inpatient medicine bed (Gilligan et al., 2008, 2010). Wong et al. (2010) analyzed ED admission trends and characterized access block at a large urban teaching hospital. The degree of access block in the ED was primarily driven by patients awaiting medicine beds. The medicine service experienced double the access block and drove higher bed occupancies of 94-96%, as compared with other services. Indeed, the majority of patients admitted to tertiary hospitals via EDs present with problematic medical DRGs requiring admission to medicine beds and studies consistently identify this patient population at particular risk for experiencing access block and long bed wait times (CIHI, 2007; Gilligan et al., 2008). A commissioned Ontario report (Schwartz, 2005) recommended increasing general internal medicine (GIM) bed ratios due to the high volumes of medical patients admitted via EDs, however it is unclear if this has occurred.

Literature Limitations

There are significant limitations in the ED overcrowding and access block literature. While ED overcrowding and access block are reported among developed nations, health care systems and funding models vary greatly. Each hospital serves communities and populations with unique needs. Services and delivery methods may vary considerably; for example, American literature focuses on the impact overcrowding has on hospital financial revenue and profitability. ED overcrowding definitions and measures were identified through consensus surveys and much literature is descriptive and based upon expert opinion. Among the empirical studies, most are single center and retrospective, with data collected from electronic databases. There are numerous inconsistencies among methods and types of data collected. The primary Canadian hospital surveys included hospitals within urban, large population based centers with high visit volumes, potentially skewing results through omitting smaller center experiences. Unfortunately, the CIHI does not routinely collect information from all national EDs and does not collect standardized measures associated with access block such as BWT, leading to significant knowledge gaps. These have contributed to difficulties in standardizing definitions and measures, evaluating interventions and generalizing findings across sites and study populations.

Project Proposal

A local Canadian tertiary care centre is experiencing frequent hospital and ED overcrowding. On average, medicine patients have an EDLOS of 18 to 21 hours, with an average of 18 medicine EIPs daily. Full capacity protocols (FCP) such as placing patients on stretchers on inpatient units due to a lack of available beds are in effect daily. Additionally, medicine IPLOS is in excess of Canadian benchmarks. The senior leadership of the medicine program proposes to reduce access block and enhance patient flow via implementing a MAU. The MAU is a pilot project initiated on August 23, 2010. A three phase implementation was planned with a medical team including an internist, nurse practitioner, medical residents and a pharmacist. Additional phases would include introduction of IPT members and eventual physical relocation from the ED to a separate ward (personal communications, Darda, Johnston, Pawlyshyn & Husband, 2010). My research goals are to: (a) describe access block experienced by cases admitted to the GIM program; (b) explore the relationships between access block and patient, admission and capacity factors; (c) explore the relationship between access block and outcomes and (d)explore the GIM consultation and admission process, access to senior physicians and IPT. Aggregate data from databases spanning January 1, 2006 and August 23, 2010 were analyzed. Twenty cases were randomly selected from this aggregate for chart review focused on GIM consultation and admission in the ED, as well as access to senior physicians and IPT. The results provide insight into factors related to access block among the GIM population; identify negative patient outcomes and weaknesses in the ED GIM consultation and admission processes. Strategies developed with the MAU can potentially target significant factors, improve processes and contribute to improving quality outcomes.

Chapter 2

Literature Review

Given the complexity of ED overcrowding, there are numerous descriptions of interventions or solutions described in the literature. This literature review does not intend to comprehensively address all strategies to manage ED overcrowding. Comprehensive and thorough reviews of strategies and their efficacy have been previously reported (Bond et al., 2006; Cooke, Higgins & Kidd, 2003; Forero & Hillman, 2008; Forero et al., 2010). More specifically, this literature review will focus on a general description of MAU function and the impact of MAUs on access block, patient throughput and associated quality patient outcomes as they relate to reducing access block.

Access Block Interventions

Forero et al. (2010) undertook an analysis of access block intervention studies. The authors noted 28% of interventions aimed to avoid or alter admissions, 51% involved improving management of existing resources and only 6% focused on early discharge or hospital output strategies. Very few studies are random controlled trials and over half are single center interventions. Approximately 65% of interventions had a positive effect on access block, while 22% produced a negative effect and 13% of interventions did not demonstrate any effect on access block. Zun (2009) concluded a lack of consensus on effective techniques exists partly due to demographic, environmental and facility variability. Cameron, Joseph and McCarthy (2009) identified three categories of access block solutions: strategies can decrease demand for tertiary care services through avoiding or minimizing hospital admissions; strategies may improve patient throughput by optimizing inpatient capacity and operational processes and lastly, strategies can increase patient exit from tertiary care facilities.

Strategies decreasing tertiary care demand include enhanced chronic disease prevention and disease management with diversion of patients to other service options such as community resources, hospital outreach programs, hospital in the home and urgent clinics [Haines, Lutes, Blaser & Christopher, 2006; Hudson, 2009; Nash, Nguyen & Tillman, 2009; Royal College of Physicians (RCP), 2007; Victorian

Government Department of Human Resources, 2006]. Emergency operated observation, clinical decision and short stay units offer some reduction in the volume of admissions, with high rates of discharges after a brief period of observation and treatment lasting < 24 hours (Cooke et al., 2003; Daly, Campbell & Cameron, 2003; Henley, Williamson, Bennett & Scott, 2006; Mace, Graff, Mikhail & Ross, 2003). When senior clinical decision makers in the ED and observation areas are readily accessible, further decreases of admissions and increases of direct discharges are noted (Bucheli & Martina, 2004; Miro et al., 2003). Balancing the demands of elective versus non elective admissions can further facilitate a steady manageable influx of patients throughout the week (Allder, Silvester & Walley, 2010; Institute of Health Improvement, 2003; Levin et al., 2008; Rathlev et al., 2007).

Acute care hospitals can focus on streamlining operational processes in all care areas, facilitating efficient throughput of patients and optimizing inpatient bed capacity. While there are numerous recommendations to increase inpatient capacity (CAEP, 2007; Cameron et al., 2009; Department of Health, 2001), there is a lack of literature reporting increased capacities and outcomes. Existing studies have shown absolute increases of hospital capacity has had variable effects on access block, dependent on the specific area in which capacity is increased. Additional ED stretchers has a negative effect on access block (Han et al. 2007; Khare, Powell, Reinhardt & Lucenti, 2009), whereas increased inpatient medical beds has improved access block (Dunn, 2003). An increase of intensive care unit (ICU) capacity demonstrated very little impact on overall EDLOS (McConnell et al., 2005). Capacity can be optimized through improving overall patient throughput processes. Improvement of specific ED processes such as fast track areas, quicker diagnostic and laboratory turnaround time and staffing modifications have had some success (Bond et al., 2006; Considine, Kropman, Kelly & Winter, 2008; Sanchez, Smally, Grant & Jacobs, 2006; Singer, Viccellio, Thode Jr., Bock & Henry, 2008). Fast track areas have the strongest evidence of efficacy, while other strategies such as triage are of unproven benefit (Bond et al., 2006). Full capacity protocols, which distribute EIPs to extra stretchers on inpatient wards, have reports of mixed efficacy (Bond et al., 2006; Innes, Grafstein, Stenstrom, Harris & Hunte, 2007). Rapid admission protocols may expedite the transfer of admitted patients out of the ED to inpatient units; however there must be available inpatient beds, limiting the efficacy of this strategy (Amarasingham, Swanson, Treichler, Amarasingham & Reed, 2010; Quinn, Mahadevan, Eggers, Ouyang & Harris, 2007). Other opportunities for enhancing throughput processes include bed management, increased access to interprofessional teams, frequent physician ward rounds and senior physician involvement in direct clinical care (Alberti, 2004; Allder et al., 2010, Department of Health, 2001; Howell et al., 2008; RCP, 2007).

Lastly, patient exit from acute care hospitals can be expedited. Hospitals can create efficient discharge processes through employing discharge coordinators, scheduling discharge dates on admission, maintaining steady daily discharges, targeting early morning discharges and using discharge lounges staffed to coordinate patient follow up appointments, diagnostics and prescriptions (Alberti, 2004; Allder et al., 2010, Department of Health, 2004). Increasing residential community capacity may further assist by transferring non acute patients out of tertiary care into the community. In Ontario, the government has developed an Alternate Level of Care plan to mobilize patients awaiting alternate levels of care from acute care facilities to the appropriate level of care, thereby optimizing existing hospital inpatient capacity (Hudson, 2009).

Canadian Experience

The Canadian Agency for Drug and Technologies in Health conducted a Canadian wide survey of ED directors in large centres (Bond et al., 2006; Rowe et al., 2006). The survey revealed 68% of Canadian ED directors have tried at least one intervention to manage ED overcrowding. Ontario, Quebec and British Columbia reported the most interventions. Other provinces reporting interventions included Nova Scotia, Alberta, New Brunswick, Saskatchewan, Manitoba and New Foundland. Approximately 71% of interventions were reported as initially effective and 81% of these were still considered effective by the end of the survey. Most interventions were aimed at ED throughput, followed by output and input strategies. A small number of interventions were aimed at system wide process or combinations of input, throughput and output processes. The most common interventions were triage scoring systems (99.3%), fast track areas (62%), ambulance diversion policies (42.4%) and computerized patient tracking systems (37%). Administrative action in the form of hospital policies and response to ED overcrowding were reported by only 36% of ED directors and 75% stated current administrative policy was minimally or not effective in reducing ED overcrowding. A number of strategies were reported in Canada for which no evidence of efficacy exists including: use of float pool nurses, senior physician flow shifts, assignment of home and community care workers in the EDs, full capacity protocols, orphan clinics and coloured codes to decongest ED and EIP units. The reports recommended further exploration of ambulance diversion, staffing modifications, short stay units and system wide complex interventions as possible strategies.

Bell et al. (2006) provided additional information about specific strategies attempted across Canada. Numerous provinces report implementing discharge coordinators, fast track areas, electronic patient tracking systems and electronic diagnostic readers. New Brunswick has increased community long term care capacity; however it is unclear if this has been successful. British Columbia reports some reduction in EDLOS for particular populations due to initiating investigations in the waiting rooms and using asthma treatment protocols in the triage area. British Columbia has also implemented overflow units. Manitoba has focused on improving lab turnaround times, inter facility transport, social work support and follow up contact of patients who left EDs without being seen. It is unclear which initiatives have been introduced and if there has been any impact on EDLOS. Calgary, Alberta has funded 200 additional beds to facilities, implemented a MAU and a code burgundy system, notifying units of severe overcrowding to stimulate discharges. The data about most interventions was provided via media sources and the empirical effectiveness of many of these interventions remains unknown.

Similar to the UK, with strong government and stakeholder support, the Ontario provincial government has completed multiple reports regarding provincial emergency services (Bell et al., 2006; Schwartz, 2005) and has responded with a number of initiatives in response to ED overcrowding (Hudson, 2009). Targeted hospitals with high ED volumes and wait times may receive financial incentives to improve performance through a Pay For Results Program. A provincial wide ED Reporting System is in place for EDs with > 20 000 visits to collect EDLOS, ambulance off load time and time from registration to initial physician assessment, disposition decision and hospital admission. An ED Performance Improvement Program has been created to improve ED flow. Other initiatives include expanded roles for ED nurses to assist with offloading ambulances and nurse led outreach teams for long term care residents, avoiding unnecessary hospital admissions. An Alternate Level of Care plan is underway to minimize the number of non acute patients occupying acute care inpatient bed, placing patients in the appropriate level of care. Community and facility supports are under development to assist managing chronic disease and subsequent ED use.

United Kingdom Success Story

The National Health Service (NHS) in the UK has been internationally acclaimed for significant improvement of ED waiting time, recently reporting approximately 96% of patients presenting to EDs have an EDLOS of < 4 hours (Alberti, 2004). In 2000, the NHS established firm targets aiming to have 90% of patients complete their ED visit in less than four hours. With increasing demand for emergency services and wait times, the NHS initiated radical changes to the UK healthcare system in 2002 (Department of Health, 2001). Subsequent government reports outlined key principles and 10 year strategy to effect significant changes to the healthcare system (Alberti, 2004; Department of Health, 2001, 2004; NHS, 2004). A diagnostic tool found the top four causes of delays in EDs are related to awaiting assessment, specialists, inpatient beds and diagnostics. Improvements in four key areas have been attained: ED performance, ambulance performance, patient and staff satisfaction and expansion of staff workforce and skill mix.

The NHS has implemented a number of strategies to decrease demands of acute care hospitals. These include the use of walk in centers, minor injury units and redirecting emergency calls to alternate service providers. Alternate provider roles are being developed to allow patient assessment and treatment in their home, facility or urgent care outpatient facilities. Hospital capacities are being increased through funding, aiming for an average occupancy goal of 82%. Improved throughput of patients in EDs and the hospital in general have occurred via a number of changes. A 'see and treat' approach, with nurse practitioners or physicians initially assessing, treating and discharging minor injury or illness avoids delays in triage and queues. This has been attributed with providing the largest gains in reduction of EDLOS. A physician model was endorsed whereby patients are reviewed within one hour of referral or consult, by the senior decision maker, to expedite treatment and care plans. ED physicians may even send patients to the wards without waiting for permission by the admitting team. Discharge planning improvement has been a key. Further partnerships were made with community services and primary care to facilitate discharge of patients into the community and an additional 1 000 beds with further increases planned for intermediate, nursing and residential homes, expediting transfer of non acute patients out of acute hospitals. The NHS has increased staff and modified scopes of practice. Nursing scope of practice has been expanded to include prescribing privileges and ordering radiology exams, allowing nurses to lead patient care in chronic disease management, minor injury units and assessment units. Further plans are underway to incorporate primary care providers into the skill mix in EDs. Additionally the use of medical and surgical assessment units have been key, allowing for rapid transfer of patients from the ED to the MAU for further assessment, treatment and care plan development.

Medical Assessment Units

History and Evolution

MAUs were pioneered in the UK, in response to increasing medical emergency admissions, creating increased workloads for EDs and general physicians. MAUs were described as an early strategy in the 1990s to relieve EDs from the pressure of acute referrals from primary care providers, in addition to ED admissions (Wood, 2000). Additionally, changes to medical models including subspecialty evolution and revised junior physician hours (Armitage, 2001) contributed to adoption of MAUs among acute care facilities. The 1998 Scottish publication Acute Medical Admissions and the Future of General Medicine incited further interest in revising management of acute medical admissions through MAUs (Dowdle, 2004) and was subsequently endorsed by the Federation of Medical Royal Colleges (2000). MAUs were rapidly adopted across the UK (Dorward, 2002; Wood, 2000). Pressure to manage ED overcrowding mounted in 2000, with the release of the NHS (2000) directive, mandating reductions in ED waiting times, stimulating further growth of MAUs (Newnham, Thompson, Jenkins & O'Brien, 2009). The Royal College of Physicians (RCP) recognized acute medicine as a subspecialty of GIM in 2003, requiring specialist training and MAUs were central, providing a location to practice. Further recommendations for acute care from the RCP (2004) underscored the importance of MAUs and active participation of senior physicians in receiving, managing and discharging acute medical patients. The NHS and RCP continue to expand the role of MAUs to include ambulatory clinics, rapid response teams for the wards and other NHS specific strategies to manage acute medical patients (Dowdle, 2004; RCP, 2007). Indeed, MAUs have assisted achieving EDLOS of < 4 hours for 96% of patients presenting to UK EDs and approximately 92% of all acute medical patients are admitted to a MAU (Federation of the Royal Colleges, 2008). MAUs were introduced to Australia in 1999 [Clinical Epidemiology and Health Service Evaluation Unit (CEHSEU), 2004] and are becoming commonplace (Henley et al., 2006; Scott, Vaughan & Bell, 2009). With the evolution of MAUs, the United Kingdom Society of Acute Medicine and

Internal Medicine Society of Australia and New Zealand have released guidelines and position statements regarding MAU operations (Henley et al., 2006; RCP, 2007). Other European countries implementing MAUs include Spain and Norway (Guirao, Sempere, Lopez, Sendra & Sanchez, 2008; Rasmussen & Gjorup, 2003).

MAU Definition and Objectives

Scott et al. (2009) conducted a systematic literature review noting a number of synonymous names used to describe MAU's including acute medical units, acute medical assessment unit, acute assessment unit, acute medical ward, acute planning units, rapid assessment medical units and early assessment medical units. Scott et al. (2009) defined these units as: "designated hospital wards specifically staffed and equipped to receive medical inpatients presenting with acute medical illness from emergency departments and/or the community for expedited multidisciplinary and medical specialist assessment care and treatment up to a designated period (typically between 24 and 72h) prior to discharge or transfer to medical wards". This definition is similar to the RCP definition of the acute medical care unit as " a dedicated facility within a hospital that acts as the focus for acute medical care for patients that have presented as medical emergencies to hospitals or who have developed an acute medical illness while in hospital" (RCP, 2007). The Internal Medicine Society of Australian and New Zealand (Henley et al., 2006) define MAUs as "designated hospital wards that are specifically staffed and equipped to receive medical inpatients for assessment, care and treatment for up to a designated period (usually 36-48 hours) prior to transfer to medical wards or home if appropriate". Some MAUs have short stay units embedded within the MAU, allowing a certain population to complete their entire visit within the MAU (RCP, 2007). The RCP (2007) and the Internal Medicine Society of Australian and New Zealand (Henley et al., 2006) recommend facilities admitting acutely ill patients establish a MAU with high dependency capabilities, operated and administered by general medicine programs.

Commonly articulated objectives of MAUs include (a) streamlining of admission processes for acute or complex patients, (b) early review by a senior clinical decision makers and specialty consultants, (c) expedited assessment and treatment initiation by an IPT, (d) daily, rapid access to diagnostics, (e) improved communication with primary care providers and other community resources, (f) improved access to geriatric assessments and other elder community resources, (g) standardization of medical treatment and care through utilization of evidence based protocols and clinical pathways, (h) locus for clinical research of acutely ill medical patients, (i) appropriate triage and streaming of medical patients to subspecialties, wards or home (CEHSEU, 2004; Henley et al., 2006; RCP, 2007). A recent review of MAUs within an Australian region identified the primary MAU objective is" to increase the efficiency of management of General Medical patients by providing a collaborative multidisciplinary approach including intensive nursing, medical and allied health input, within a 48 hour time frame to improve patient outcomes, reduce ambulance bypass, 12 hour stays in the ED and length of stay for patients admitted to Medical Assessment and Planning Unit" (CEHSEU, 2004).

MAUs have been implemented to reduce ED overcrowding (Abenhaim, Kahn, Raffoul & Becker, 2000), manage increasing medical emergency admissions and enhance bed management (Abenhaim et al., 2000; Armitage & Raza, 2002; Hanlon et al, 1997; Huang, 1998). Huang (1998) specifically reported goals of reducing admissions by 15% and IPLOS by one day, with the introduction of a MAU. Early review of patients by a senior clinical decision maker with standardized admission processes, early assessment, planning, treatment and enhanced discharge planning substantially improve patient throughput in acute care hospitals. Access block and ED overcrowding are decreased through admission avoidance, rapid transfer of patients from the ED, shorter IPLOS and optimization of bed management and inpatient capacity. As individual MAUs have demonstrated positive outcomes, units have expanded bed capacity, extended maximum length of stay (Abenhaim et al., 2000; Armitage &

Raza, 2002; Moore et al., 2006) and incorporated additional short stay units or beds (Downing, Scott & Kelly, 2008; RCP, 2007).

MAU Key Components

While MAUs have local variation in processes and practices, there are common key components considered essential for achieving desired MAU outcomes (CEHSEU, 2004; Henley et al., 2006; RCP, 2007). Overall, MAUs provide timely care for acute medical conditions, early access to health care providers and diagnostics, reducing admissions, unnecessary diagnostic investigations and hospital stays.

MAU Facilities

The size or capacity of MAUs are variable and dependent on facility size, inpatient capacity, average number of daily admissions, subspecialty mix, staff availability and community resources (Henley et al., 2006). Huang (1998) used computer modelling of three factors to determine the optimal MAU bed size: the number of emergency admissions daily, distribution of patient arrival times throughout the day and MAU length of stay. MAUs permitting longer stays require more beds for daily admissions (CEHSEU, 2004; Henley et al., 2006) and Australian reports (CEHSEU, 2004; Henley et al., 2006) recommend a minimum of 25 beds with 4 monitored high dependency beds or capacity equivalent to the average daily admission rate, plus at least a 5% increase if the hospital has a regular occupancy rate of > 95%. The RCP (2007) recommends adequate capacity or size allowing 50% of admitted medicine patients to complete care within the MAU, suggesting capacity must accommodate average daily admissions plus 10% capacity. MAUs generally transfer 40% to 80% of patients to an inpatient bed after a defined length of stay and directly discharge 20% to 60% of patients (CEHSEU, 2004; Epstein, Barmania, Robini & Harbord, 2007; Henley et al., 2006; RCP, 2007). The literature reports a wide variation in bed capacity across MAUs, ranging from 4 to 59 beds (Abenhaim et al., 2000;

Armitage & Raza, 2002; Bazarain, Schneider, Newman & Chodosh, 1996; Beckett, Raby, Pal, Jamdar & Selby, 2006; CEHSEU, 2004; Epstein et al., 2007; Henley et al., 2006; St. Noble, Davies & Bell, 2008). An Irish 59 bed MAU reports their MAU bed base allows for 70% of patients to complete their stay in the MAU (Rooney, Moloney, Bennett, O'Riordan & Silke, 2008). Each MAU must tailor capacity to local conditions and irrespective of absolute bed numbers, it is critical to maintain MAU occupancy at <100% or the unit will be immobilized and its' function severely impaired (CEHSEU, 2004; Henley et al., 2006; Downing et al., 2008; Moloney, Bennett, O'Riordan & Silke, 2006).

Other recommendations in the literature include co-location of MAUs with EDs, ICUs and diagnostic facilities (Armitage & Flanagan, 2001; CEHSEU, 2004; Henley et al., 2006; RCP, 2007). The RCP (2007) believes collocation and resource sharing among MAUs, EDs and critical care areas will foster collaboration and appropriate streaming of patients. MAUs should have a separate geographical space from other care areas (Henley et al., 2006; RCP, 2007) and a wide variety of MAU settings reported include standard medical wards, surgical wards, and areas adjacent, but separate from EDs (CEHSEU, 2004; Henley et al., 2006). Virtual MAUs, whereby patients are distributed throughout numerous wards, can hamper MAU objectives by diluting the focus on rapid intensive assessment, planning and treatment. Appendix B outlines other infrastructure and resources recommended for optimal MAU function.

Staffing

The RCP (2007) and Internal Medicine Society of Australian and New Zealand (Henley et al., 2006) have released recommendations specific to physician, nursing and IPT staffing models and complements. The RCP (2007) recommends senior physicians cover consecutive blocks of > 1 but < 7 days, providing consistency in care, while cancelling all other medical commitments or duties to facilitate early medical review of patients. Other facilities have structured a medical on call team in the

ED, which operates separately from medical coverage in the MAU (Armitage & Raza, 2002) and a variety of other medical coverage models have been described (Jenkins, Barton & McNeill, 2010; Rooney et al., 2008; St. Noble et al., 2008; Stewart & Gordon, 2002). The most important factor is the senior physician's involvement in immediate care of patients and conducting frequent regular rounds, ensuring timely decision making. Senior physician presence is a key element to MAU operations and current medical models of practice may not be readily amenable to facilitating cancellation of other clinical duties, such as outpatient clinics or procedures, to meet the expectations of medical clinical coverage. This may require increased flexibility in the working schedules of senior physicians (RCP, 2007). There is evidence that a lack of availability of the senior clinical decision maker contributes to delayed management decisions (McNeill, Brahmbhatt, Prevost & Trepte, 2009). Criticisms of MAU physician models include physician burnout, disconnection from inpatient ward practice and deskilling of physicians who do not routinely participate in the MAU (Moloney, Smith, Bennett, O'Riordan & Silke, 2005).

An IPT must be available for early assessment, proactive planning and intervention, supported by highly skilled, dedicated nursing resources. Recommended IPT resources include social workers, physical therapists, occupational therapists, pharmacists and staff to liase with community resources. The RCP (2007) recommend MAUs create training objectives for all IPT members. A highly skilled nursing staff is required and a nurse to patient ratio of 1:6, as a maximum, has been suggested (Armitage & Flanagan, 2001; Carroll, 2004; CEHSEU, 2004; Henley et al., 2006) and nurses should acquire specialized skills such as performing electrocardiograms, venepuncture, advanced intravenous drug administration and arterial blood gas analysis (Carroll, 2004; RCP, 2007) . The unit also requires adequate clerical, attendant, portering and cleaning staff support. In order to develop a successful MAU, strong clinical leadership is required from physician and nursing leads (RCP, 2007).

MAUs provide care to acutely ill patients within a fast paced, high pressure environment and staff may find the environment stressful; however a number of benefits exist as well. The MAU provides a streamlined, organized work environment with clear goals; cohesion of IPT teams with increased staff morale; an excellent training environment with enhanced education opportunities and skill acquisition for health care professionals; creation of new roles for nurse practitioners and physician assistants (Cameron, 2004; Henley et al., 2006; RCP, 2007). Armitage & Raza (2002) report junior physicians perceive the MAU as an environment with increased teaching opportunities and readily available experienced advice from a senior physician. The function of a MAU is highly reliant on timely access to staff and these benefits may assist with recruitment and retention of MAU staff.

Admission and LOS Operating Policies

MAUs must have a clear role in the patient journey through acute care facilities and streamlining admission processes are a key strength. MAUs receive most admissions via the ED and are often the admitting units for direct admissions from primary care providers or transfers from other facilities. The MAU provides primary care providers a direct link to acute care for patient assessment, treatment and brief admissions as required, allowing patients to bypass busy EDs (Brennan, 2004; RCP, 2007; UdDin & Ramakrishnan, 2004). This association with primary care providers was initially described as the Irish Kilkenny Model and considered essential, given the decrease in primary care providers with hospital admitting privileges (Brennan, 2004). In the NHS, nurses who triage patients at a low acuity level may send patients directly to the MAU for review and possible admission, bypassing the ED altogether (RCP, 2007). Additionally, MAUs may implement rapid admission protocols, allowing the ED physician to write or use a generic order set, expediting patient transfer from the ED to the MAU (RCP, 2007).

MAUs must have clear admission criteria, which are dictated by clinical stability, availability of subspecialty units and predicted length of stay. Generally, acutely ill medical patients with an anticipated IPLOS < 36 to 72 hours or complex patients with multiple active conditions who would benefit from intense comprehensive assessment with a subsequent care plan, prior to transfer to the ward, are the target population for MAU care (Bazarain et al., 1996; CEHSEU, 2004; Henley et al., 2006). MAUs are preferable to inpatient wards for medical conditions with anticipated short stays, as ward based care has resulted in longer waits for senior physician review and IPLOS (Hadden, Dearden & Rocke, 1996; Wanklyn, Hosker, Pearson & Belfield, 1997). Hemodynamically unstable patients requiring intensive or cardiac care units are not appropriate for MAU admission. Additionally, each site may have variable subspecialty wards such as oncology, hemodialysis or gastrointestinal units, more appropriate for management of particular conditions (Armitage & Raza, 2002; Bazarain et al., 1996; Henley et al., 2006; Li et al., 2010). Other possible contraindications for MAU admission may include patients with social presentations, requiring ALC placement or otherwise better served by other services such as geriatrics or psychiatry (Scott et al., 2009).

MAUs generally have a defined maximum length of stay, which is variable across units, from 24 hours to 5 days, dependent on the unit's goals (Armitage & Raza, 2002; Bazarain et al., 1996; CEHSEU, 2004; Epstein et al., 2007; Henley et al., 2006; Li et al., 2010; McLaren, Summerhill, Miller, McMurdo & Robb, 1999; Rooney et al., 2008). Care is focused on the first 24 to 72 hours and length of stay is dependent on patient needs and the facilities' abilities to transfer patients into adequate settings (RCP, 2007). In order to remain consistent with MAU objectives and maximize efficiency, patients who are not MAU candidates should not occupy MAU beds. Some MAUs only admit patients with early predicted lengths of stay < 72 hours (Armitage & Raza, 2002; Abenhaim et al., 2000; Bazarain et al., 1996; Downing et al., 2008), whereas other MAUs were designed to receive all medical admissions, regardless of anticipated IPLOS (Beckett et al., 2006; Epstein et al., 2007; Rooney et al., 2008). Bed management and discharge planning are crucial to expedite ward discharges and subsequent transfers from MAU (Epstein et al., 2007). Acute care hospitals must ensure patient transfers from MAU and management of IPLOS are hospital priorities.

Clinical Management

The first 48 hours of medical care can be crucial to clinical outcomes and rapid access to medical review, specialist care, diagnostics and an IPT are key objectives in the MAU. The RCP (2007) describes three components of patient assessment: (a) immediate assessment and treatment, (b) triage of patients and development of a formal management plan with investigations and (c) regular formal review of patient progress, investigations, management plan and discharge plans. Recommendations for medical management include: a minimum of once daily and ideally twice daily rounds with the senior physician, medical team and IPT; patient review by a member of the medical team within 2 hours of admission to MAU; IPT review within 24 hours of admission to MAU and a formalized management plan, reviewed and available on the chart within 12 hours. The senior physician must be readily available at all times to review patients (Henley et al., 2006; RCP, 2007). Epstein et al. (2007) reports 100% of patients are reviewed by the senior physician within 12 hours of admission; however there is no comparison to traditional models of care. Early senior physician review and access to diagnostics has been shown to reduce admissions by 25.5% and timely medical review can result in decreased IPLOS and costs (Burgess, 1998; Denman-Johnson, Bingham & George, 1997; Watchter, Katz, Showstack, Bindman & Goldman, 1998). MAUs reports senior decision maker led rounds occurring once to four times daily (Abenhaim et al., 2000; Armitage & Raza, 2002; CEHSEU, 2004; Downing et al., 2008; Epstein et al., 2007; Li et al., 2010). MAUs can improve patient access to appropriate speciality care; Moore et al. (2006) reported the proportion of patients cared for by the appropriate subspecialty rose from 27% to 56% across all subspecialties (Moore et al., 2006) and Hanlon et al. (1997) report particular improvement in proportions of patients accessing cardiology and respiratory care.

Additional strategies to enhance quality clinical management within MAUs include standardization of processes for assessment, management and documentation of care (RCP, 2007), use of an early warning score to detect sentinel changes in patient status (Fairclough, Cairns, Hamilton & Kelly, 2009; Palmer, 2000; RCP, 2007), formal guidelines for patient handovers (RCP, 2004) and standardized protocols for management of common medical presentations (Armitage & Flanagan, 2001; RCP, 2007). In a review of Australian MAUs, only a small number of units reviewed have standard clinical pathways, with units reporting one to two pathways currently in use. The most common pathways prescribe treatment for pyelonephritis, pneumonia, asthma and heart failure (CEHSEU, 2004).

Bed Management and Discharge Planning

MAUs are a central hub for acute medicine incorporating short stay, complex care, clinical monitoring, elder care and ambulatory streams (RCP, 2007). This early streaming of patients may increase bed management efficiency (Cameron, 2004). MAUs buffer the predictable disequilibrium between daily admissions and discharges, which can consume approximately 10% of inpatient bed capacity (Allder et al, 2010), negatively impacting EDLOS, especially among medical admissions or weekend admissions (Vermeulen et al., 2009). The MAU buffer provides flexibility to accommodate patients and stream care to specialities, wards, outpatient services and alternate care options, decreasing IPLOS or avoiding admissions altogether. Traditional models of acute medicine admission intake often results in patients placed in non medical beds, spread geographically among a number of units. MAUs decrease the proportion of patients placed in off service ward beds and allows ward medical teams to care for patients admitted to their geographic area or bed base, rather than attending multiple units throughout the hospital. MAUs can provide an impetus for a culture change focusing on active bed management with support from senior administration and participation from senior physicians (Henley et al., 2006).

Discharge planning is incorporated into initial care plans, with an anticipated discharge date documented within 12 hours of admission with regular review of predicted LOS and daily revision as required (Henley et al., 2006; RCP, 2007). MAUs enhance discharge planning through the following strategies: promotion of weekend discharges (Armitage & Raza, 2002; Epstein et al., 2007), use of a discharge manager, patient prioritization by the IPT (Moloney et al., 2005; Rooney et al., 2008), use of predictive discharge dates, early morning discharges and discharge lounges (Epstein et al., 2007; Henley et al., 2006; Moloney et al., 2005). MAU operated ambulatory clinics provide follow up care for patients discharged from the MAU and authors speculate follow up clinics provide physicians increased comfort with discharging short stay or complicated patients and discharging patients during the weekend (Abenhaim et al., 2000; Armitage & Raza, 2002, Epstein et al., 2007). Armitage & Raza (2002) report up to 40% of MAU discharges are reviewed at the ambulatory clinic within two weeks after discharge. Other MAUs allow for the return of patients to MAU for clinical review as required (McNeill et al., 2009). MAUs provide a unique mechanism for enhanced interaction and communication between primary care providers, community services and acute care hospitals (CEHSEU, 2004; RCP, 2007; UdDin & Ramakrishnan, 2004), improving continuity of care. Transfer of care can be made directly back to the primary care provider and community services, proving especially beneficial for patients with chronic disease and complex conditions.

A number of crucial success factors for MAU implementation have been described: inclusion of physicians and senior administrators in planning; a willingness among clinicians to accept change in current medical models; administrative support and provision of additional resources for an IPT; cooperation from subspecialties and diagnostics for prioritization of MAU patients and a unit manager committed to the MAU (Moloney et al., 2005, 2006). The RCP (2007) states the foundation of MAU success is the effective management of the admissions process and patient flow. Primary impediments to MAU function identified in the literature include: inability to transfer patients to inpatient wards or other facilities, delays in medical review by senior clinical decision makers and specialists, inappropriate admissions, delayed access to investigations, inadequate MAU capacity and staff and a lack of adequate monitoring capacity or equipment (CEHSEU, 2004; Epstein et al, 2007). The MAU model is relatively new and there is the possibility staff may misunderstand the objectives, resulting in a lack of resources for key objectives or inappropriate bed use.

MAU Patient Characteristics

MAUs have been implemented to manage medical admissions, however some MAUs report receiving surgical patients as well (Henley et al., 2006). The median age of MAU patients range from 56 to 80 years of age, with a typical median of approximately 65 years of age (Abenhaim et al., 2000; CEHSEU, 2004; Li et al., 2010; Rooney et al., 2008;). The mean age of medicine patients is rising (Li et al., 2010) and > 10% patients were reported to be > 80 years of age (Moloney et al., 2006; Moloney, Bennett & Silke, 2007). The oldest patients have the longest MAU length of stay and IPLOS (CEHSEU, 2004), underscoring the importance of strong links with geriatric programs. Concomitant increases in co morbidity and acuity, measured by the Charleston Index and modified APACHE II scores, have been noted among MAU admissions. Li et al. (2010) noted a 50.1% increase in absolute numbers of patient with a Charleston score of > 0 over 3 years. Rooney et al. (2008) report a rise from 39.7% to 46.4% in the proportion of MAU patients with a Charleston index of > 0 and an increased median modified APACHE II score rising from 6 to 7, over the course of 4 years. Abenhaim et al. (2000) described their MAU population as less acute than the inpatient ward population, as measured by fewer in-hospital complications, fewer subspecialty consultations, lower mortality and readmission rates with a higher proportion of patients discharged home. This particular unit specifically admitted only patients with predicted LOS as < 72 hours. The most common DRG reported among MAU patients are respiratory diseases, especially chronic obstructive pulmonary disease and respiratory infections. Other prevalent

DRGs included cardiac, gastrointestinal and infectious diseases (Abenhaim et al., 2000; Bazarain et al., 1996; CEHSEU, 2004; Downing et al., 2008; Rooney et al., 2008). Rooney et al. (2008) report the case mix of DRGs within the MAU has remained unchanged over 4 years.

MAU Outcomes

The Internal Medicine Society of Australian and New Zealand (Henley et al., 2006) recommends a list of key performance indicators to evaluate MAU performance, as listed in appendix C. There is a small, but growing body of empirical literature regarding MAU outcomes and knowledge gaps. The ability of MAUs to decrease access block and manage increased volumes of complex medical admissions is relatively unknown. Many of the positive outcomes described below were achieved despite stable or increasing medical admissions (Armitage & Raza, 2002; Gallagher, 2004; Li et al., 2010; Moloney et al., 2005, 2006; Rooney et al., 2008), decreasing medical inpatient beds (Armitage & Raza, 2002, Epstein et al., 2007; McLaren et al., 1999), increasing patient acuity (Li et al., 2010; Moloney et al., 2005, 2006; Rooney et al., 2008) and high inpatient hospital occupancy (Downing et al., 2008). Many MAUs were created from existing reconfigured beds (Bazarain et al., 1996; CEHSEU, 2004; Downing et al., 2008; Gomez-Vaquero et al., 2009; Hanlon et al., 1997; Moloney et al., 2005; St. Noble et al., 2008). Some study findings may be confounded due to overall increases in capacity; Bazarain et al. (1996) report a small increase in the number of inpatient beds and Armitage and Raza (2002) report an increasing bed base in MAU during the study period.

EDLOS and EIPs

MAUs appear to have positive impacts on EDLOS and EIP volumes, key indicators of ED overcrowding and access block. Li et al. (2010) report significant reductions in the proportion of patients who have an EDLOS > 8 and 12 hours. Prior to implementing a MAU, 30% and 20% of medicine patients spent more than 8 and 12 hours, respectively, in the ED. After MAU implementation, only 18%

and 10% of medicine patients had an EDLOS > 8 and 12 hours, a finding which was preserved after case matching cohorts. Bazarain et al. (1996) conducted a unique study examining the impact of a MAU on EDLOS for treat and release ED patients. The target population were patients presenting with chest pain, asthma, seizures and sickle cell disease, representing the 4 most common treat and release conditions at the center. EDLOS was reduced by 24% for patients with chest pain and 19% had a mean EDLOS > 8 hours compared to 31%, prior to the MAU. EDLOS was reduced by 15% for patients with asthma; 5% had a mean EDLOS > 8 hours compared to 15%, prior to the MAU. A 14% non significant decrease was noted for sickle cell patients and no change was noted for seizure patients. Bazarain et al. (1996) additionally reported a 42% decrease of patients who left the ED without being seen by a physician, suggesting a MAU may improve throughput for treat and release patients.

Epstein et al. (2007) reported improvements in the proportion of patients with a mean EDLOS > 4 hours, after improving throughput processes within a MAU. Only 14% of patients had a mean EDLOS of > 4 hours compared to 19% prior to MAU improvements. A possible confounder among UK studies is the pressure to meet the 4 hour EDLOS target. Studies have noted peaks of patient transfer activity from EDs to units during the last 20 minutes of the EDLOS target, suggesting 4 hours may be inadequate for appropriate assessment, stabilization and treatment in the ED (Epstein et al., 2007; Locker & Mason, 2005) and misdiagnoses could lead to costly initiation of unnecessary or inappropriate treatment (Beckett et al., 2006). Only one study reported a slight increase of mean EDLOS, despite a significant decrease in EIPs. Gomez-Vaquero et al. (2009) reported a 6.9% increase in mean EDLOS from 3.89 to 4.16 hours. The study reported an increase in ED presentations, decreased cancelled elective admissions and increased elective admissions, which could contribute to the increased EDLOS noted. Downing et al. (2008) report an improvement with a mean of 99% of patients completing their ED visit in 4 hours from a mean of 96%.

Five studies conducted at three separate hospitals reported a significant reduction of EIPs. Bazarian et al. (1996) reported a significant decrease in the mean daily number of EIPs waiting > 8 hours for an inpatient bed, from 9.6 to 2.3 EIPs. Gomez-Vaquero et al. (2009) report a 56% decrease in the mean daily number of EIPs, from 9.1 to 4.0 and an increase from 60 to 176 days per year with a daily mean of < 3 EIPs in the ED. Consecutive studies from an Irish hospital, spanning 2002 to 2006, report incremental improvements in daily median EIPs from 14 to 2, after MAU implementation (Moloney et al., 2005, 2006; Rooney et al., 2008). Peaks in EIPs were prevalent Monday through Thursday and in November and January (Moloney et al., 2005, 2006). The co-morbid status of admitted patients was calculated, using Charleston scores to compute individual indexes, and higher acuity during the prior 24 hour period was predictive of higher numbers of EIPs (Moloney et al., 2006).

MAU Throughput: Admissions, MAU LOS and Discharges

Very few studies report the proportion of medicine admissions admitted via MAUs. Two studies report the MAUs admitting 13%-19% of all ED admissions (Bazarain et al., 1996; CEHSEU, 2004). The Federation of the Royal Colleges (2008) predict 92% of medical admissions flow through MAUs. Australian MAUs admit approximately 60% of all medical admissions with an overall reduction of 15% to 22% of medical admissions to inpatient wards (Henley et al., 2006). McNeill et al. (2009) report a decrease in formal discharges due to significant decreases in the number of patients who are discharged from MAU assessment area without requiring admission. Epstein et al. (2007) admitted 80% of all medicine admission via MAU after making significant improvement to patient throughput within the MAU.

UK facilities report an average MAU length of stay as 24 to 30 hours (RCP, 2007) and Australian MAUs reports length of stay ranging from 24 hours to 5 days, with an approximate average of 48 hours and at least 60% of patients are transferred or discharged in < 48 hours (CEHSEU, 2004). Other individual

MAUs report average length of stay ranging 15 hours to 2.98 days (Abenhaim et al., 2000; Bazarain et al., 1996; Downing et al., 2008; Epstein et al., 2007; Moore et al., 2006). Epstein et al. (2007) reviewed MAU throughput with a two point audit of patient journey through MAU to identify weaknesses. Among patients with prolonged MAU length of stay, 64% experienced avoidable causes of delayed transfer. Primary contributors included long waits for investigations and specialist review; access to physiotherapy and occupational therapy services and a lack of inpatient beds for transfer. An action plan was directed at enhancing access to diagnostics, treadmill tests, endoscopies, pharmaceuticals and specialist consultation. A reduction of avoidable delays was achieved and patient throughput increased from 45% to 90% of patient transfers or discharges occurring in 48 hours. MAU length of stay decreased from 2.9 days to 1.8 days and lost MAU bed days were reduced from 25 to 4 days. After improvements, avoidable delays continued to be due to accessing diagnostics and ward beds. The authors underscored the importance of MAUs operating 7 days per week, with full access to diagnostics, an IPT and discharge planning resources.

Direct discharge rates from MAUs vary and are influenced by individual unit policy on maximum length of stay and availability of inpatient beds for transfer. Most MAUs report direct discharge rates ranging from 20% to 53% (Armitage & Raza, 2002; CEHSEU, 2004; Epstein et al., 2007; Henley et al., 2006; McNeill et al., 2009; St Noble et al., 2008; Stewart & Gordon, 2002), with the remainder of patients transferred to other units or facilities. Discharge rates have been further analyzed by IPLOS. Discharge rates at 24 hours range from 21% to 42% (Armitage & Raza, 2002; Downing et al., 2008; McNeill et al., 2009; St. Noble et al., 2008) and at 48 hours range from 31% to 71% (CEHSEU, 2004; Downing et al., 2008; St. Noble et al., 2008; McLaren et al., 1999). Wanklyn et al. (1997) report an improvement of direct discharges at 24 hours, with an increase from 4% to between 15% and 29% after introducing an MAU. Units accepting primarily patients with predictive short stays report higher proportions of patients discharged home, ranging from approximately 80% to 85% (Abenhaim et al., 2000; Downing et al., 2008), with 42% discharged in 24 hours and 71% discharged in 48 hours (Downing et al., 2008). St Noble et al. (2008) report increases in proportions of patients discharged at 24 and 48 hours after the implementation of a MAU. Discharges after 24 hours rose from 21.5% to 28.5% and discharges after 48 hours rose from 32.3% to 39.5%. Discharge pattern variability decreased and a consistent daily discharge rate was noted. Li et al (2010) increased same day discharges from 13.2% to 17.7%. Epstein et al. (2007) reported delayed discharges were associated with being admitted Thursday to Sunday as compared with Monday to Wednesday. The authors noted a significant decline of discharges on the weekend, which was improved with a change to a physician of the week model, suggesting continuity of care and familiarity with the patients promotes weekend discharges. Other studies have not found an association with the day of admission and likelihood of discharge (McNeill et al., 2009), possibly due to variation in discharge planning practices and physician models between the units and patient populations.

McNeill et al. (2009) investigated the impact of senior physician presence on length of stay in a MAU staffed part time with senior physician. The physician's presence exerted the greatest effect on patients with short stays of < 48 hours. Increases in same day discharges rose from 23% to 32% with 4.1% and 4.8% spending one to two days less in hospital, respectively. Discharges were slower when the senior physician wasn't readily available or when patients were aged > 80. Greater proportions of patients <60 years of age were discharged on the day of admission when a senior physician was present. McNeill et al. (2009) noted a decrease in overall MAU length of stay from 9.06 to 7.72 days and improvement was primarily impacted by physician presence on day of admission, avoiding and shortening admissions. Gallagher (2004) attributed a 10% average daily increase in discharges and improved weekend discharge rates to a daily MAU IPT meeting with the medical team; however limited statistical data was presented.

IPLOS

A number of studies report significant IPLOS reductions after implementing a MAU (Downing et al., 2008; Epstein et al., 2007; Henley et al., 2006; Li et al., 2010; McLaren et al., 1998; McNeill et al., 2009; Moloney et al., 2005, 2007; Rooney et al., 2008; St. Noble et al., 2008). Decreased IPLOS remained significant after adjusting for acuity, co-morbidity and volume of admissions (Li et al., 2010; Moloney et al., 2005). Li et al. (2010) equate the IPLOS reductions to an increase of 4 391 bed days per year, attributing this increased capacity to early senior physician review and IPT care. The authors compared the improvement of IPLOS among internal medicine patients to the IPLOS of medicine subspecialty patients who did not have access to MAU. Similar improvements were not noted among medical subspecialties; however this may not be due to MAU care. Another study has documented a trend for longer IPLOS for patients cared for by a subspecialty compared to the general internal medicine service, within a MAU setting (Moloney et al., 2005). Moore et al. (2006) report a slight decrease of IPLOS; however the decreases did not reach statistical significance. CEHSEU (2004) found the largest reductions of IPLOS were among patients treated for chronic obstructive pulmonary disease, respiratory infections and heart failure. MAUs may decrease the IPLOS for patients who are admitted primarily for the purpose of completing key diagnostic tests. For example, Bazarain et al. (1996) decreased IPLOS for patients requiring a stress test to rule out myocardial infarction from 6.9 days to 2 days. In addition to IPLOS improvements, MAUs have reduced the volume of patients who are placed into off service beds (Downing et al., 2008; Gallagher, 2004; Hanlon et al., 1997). Downing et al. (2008) reduced the mean daily number of patients off service, from 38 to 11 patients and Gallagher (2004) reports a monthly reduction of 33% to 62.5% of medicine patients occupying surgical beds.

There are relatively few reports describing the financial impact of MAUs and most cost savings are secondary to reduced IPLOS and bed days. Armitage and Raza (2002) report a 16% decrease in the number of medical outlier bed days, despite a 6% increase in medical admissions within the first year of MAU operation. It is unclear if this was sustained with a 25% increase in medical admissions at the end of the study period. Moloney et al. (2005) estimated an operational cost savings of 10%, equivalent to € 1 714 152, due to saving 4 039 bed days per year for admissions lasting < 30 days, despite an overall increase of admissions. Australian regions report significant cost savings due to decreased numbers of bed days for the 5 highest volume DRGs including chronic obstructive pulmonary disease (COPD), respiratory infections and heart failure (HF) (CEHSEU, 2004) and by 2006 a 9% decrease or 23 268 bed days over 2 years representing a savings of $900 000 (Henley et al., 2006). Only one study reported a negative financial impact. Bazarain et al. (1996) report MAU operations resulted in higher per day patient costs compared to standard ward care at $490 versus $250 per day per patient due to staff salaries, which were not offset by savings due to decreased IPLOS.

Readmission and Mortality Rates

There are a number of studies examining clinical outcomes, as measured by readmission rates and mortality rates, to ensure increased discharges and shorter IPLOS do not impact patients negatively. The literature review did not reveal any reports of increased readmission or mortality rates among MAU patients. Readmission rates of patients directly discharged from MAUs were primarily unchanged with 7 day rates ranging from 1.5% to 4% (Abenhaim et al., 2000; Armitage & Raza, 2002; CEHSEU, 2004; Li et al., 2010; St. Noble et al., 2008) and 28 to 30 day readmission rates ranging 3% to 13% (Abenhaim et al., 2000; CEHSEU, 2004; Downing et al., 2008; Li et al., 2010; McNeill et al., 2009; Moloney et al., 2005, 2007; Stewart & Gordon, 2002). Wanklyn et al. (1997) reported a slight improvement in readmission rates which decreased 13% to 6%. Henley et al. (2006) reported 7 and 28 day rates of representation to the ED with subsequent discharge as 0.4% to 5.1% and 0.8% to 11.7%, respectively. This is the only authors to report on ED representation rates and data regarding pre MAU representation rates was not provided.

Most centers implementing MAUs report, at the very least, stable mortality rates, while some center report improvements of patient mortality. Rooney et al. (2008) reported the greatest improvements in mortality over 5 years with a 44% decrease of annual all cause mortality from 12.6% to 7% and 36% reduction of 30 day mortality, from 8.8% to 5.6%. Significant independent predictors of death included advanced age, male sex, DRG, month of admission, time of admission, > 2 admissions over a 4 year period, a higher Charleston index and modified APACHE II score. The decrease in mortality was achieved despite increasing admissions and acuity, as measured by Charleston Index and modified Apache scores, over the course of 4 years (Moloney et al., 2007; Rooney et al., 2008) and the odds of death were reduced by 72%. After controlling for expected predictors of mortality, the improvement in mortality rate remained independently associated with the structural changes introduced via the MAU and 30 day all cause mortality did not begin to decline until a year after MAU was introduced. Li et al. (2010) question whether MAU contributed to the mortality reduction, as the baseline mortality rate was considered to be abnormally high. Moore et al. (2006) reported early triage to subspecialty care, facilitated via MAUs, decreased all cause mortality by 51 deaths per year in patients < 65 years of age, representing a 27% reduction of the mortality rate; however the decrease of all cause mortality among all age groups was nonsignificant. McNeill et al. (2009) also report a significant reduction in mortality for patients <65 years of age. Improvement in mortality rates may not be surprising, as prior evidence suggests highly specialized units caring for large volumes of similar patients have been noted to improve patient outcomes including mortality (Chowdhury, Dagash & Pierro, 2007; Foley, Salter & Teasell, 2007; Nallamothu et al., 2006).

Quality of Care

Beckett et al. (2009) are the only authors to examine time to treatment with prospective comparisons between an ED, MAU and standard inpatient ward. Time to treat for 4 conditions were investigated as follows: administration of low molecular weight heparin for acute coronary syndrome, antibiotics for pneumonia, corticosteroids for acute exacerbations of COPD and antibiotics for sepsis. Prior to MAU implementation, standard inpatient wards were significantly slower to treat all 4 conditions as compared to the ED. The MAU was significantly faster to initiate treatment for all 4 conditions compared to inpatient wards; however the ED remained faster than the MAU, with self referrals to ED receiving faster treatment than direct admissions from a primary care provider to the MAU. Only 25% patients on ward received antibiotics for pneumonia within designated target times, compared to 86% of patients in ED and 73% in MAU. Possible contributors to slower treatment time in the MAU compared to EDs included a lack of triage in MAU for sicker patients and the completion of a full admission including medical history and assessment for all patients. The EDs also operate with significant pressure to complete assessment and initiate treatment in 4 hours. The hospital no longer allows direct admissions to the inpatient wards, given significant treatment delays, all direct admission attend the MAU. Ayre and Walters (2009) reviewed medical interventions among UK MAUs and found interventions were appropriately evidence based; however no advancements have been made in care since the last review in 1995, prior to widespread MAU implementation. MAU medication prescriptions have been found to meet acceptable levels compared to literature benchmarks (Alyamani, Hopf, & Williams, 2009); however Gray et al. (2007) found prescription errors in 45% of MAU charts.

Patient and Staff Satisfaction

There are few studies exploring patient or staff satisfaction with MAUs. Hanlon et al. (1997) provided the earliest reports of patient satisfaction. Patients perceived the MAU staff spent more time explaining individual treatment and felt ready for discharge (Hanlon et al., 1997) and 52% of patients perceived the new MAU model of acute care delivery was better than the traditional system (McLaren et al., 1999). The Henley et al. (2006) report high patient satisfaction, with 65% of patients satisfied with care and more than 70% very satisfied with the unit efficiency and information provided; survey methodology details were not provided.

While anecdotal reports of increased staff satisfaction exist (Armitage & Raza, 2002; Cameron, 2004), few studies have empirically examined MAU staff satisfaction. Hanlon et al. (1997) reported survey results with a 57% to 66% response rate indicating physicians were less worried about losing track of patients admitted across multiple wards in the hospital and were satisfied with decreased numbers of patients placed in off service beds. Physicians reported increased concern about blocked beds. Nurses reported the ability to spend more time focusing on health promotion with patients; however experienced increased stress levels due to caring for an acutely ill population. McLaren et al. (1999) reports 91% of nursing staff and 93% of physicians perceived the new model of care in a MAU as better than the traditional model. Relihan, Glynn, Daly, Silke and Ryder (2009) used the validated Safety Attitudes Questionnaire to assess the culture of safety among MAU staff and reported significantly higher scores compared to international benchmarks in four domains: teamwork climate, safety climate, and stress recognition and job satisfaction. Henley et al. (2006) report more than 70% of staff was satisfied with the unit operation and efficiency and 55% indicated quality of care had improved with implementation of MAU; however methodology was not reported.

Literature Critiques

A growing body of evidence suggests MAUs may reduce access block and ED overcrowding through minimizing admissions, expediting patient throughput and decreasing IPLOS, without detrimentally impacting patient outcomes. Indeed, there is some evidence clinical outcomes can be enhanced due to MAU care. All empirical studies reviewed did not specifically report the absence of other initiatives that may have influenced outcome measurements. Other studies report small increases of inpatient capacity (Bazarain et al., 1996) or hospital capacity via MAU beds (Armitage & Raza, 2002).

While it is recommended that each facility implementing MAUs tailor the unit to unique local needs, wide variation among MAU characteristics make comparisons between MAUs challenging. Comparisons are also confounded by differences in healthcare delivery structures across countries and regions. For example, there are some key differences between the UK and Australian health care systems related to ED role in acute admissions, continuity of care and out of hospital follow up (Jenkins, Barton & McNeill, 2010; Scott et al., 2009). The UK has also engaged the entire health care system in significant changes, which may contribute to the efficacy of their MAUs. Much of the data utilized in outcome studies are gathered from electronic databases, with different site specific processes triggering the timestamp of key events, such as patient registration, admission and discharge. A variety of terminology is used in the literature to describe medical staff designations and roles, which may differ markedly between countries, possibly confusing comparisons. MAUs synthesize a number of heterogeneous interventions, aimed at decreasing ED overcrowding and IPLOS and it may be unclear which particular measure contribute most to outcomes.

To date there are no random controlled trials of patient care delivered by traditional models compared to a MAU model, likely due to operational logistics of conducting such a study. While MAU key performance indicators have been identified, publication of results comparing traditional models of acute medical admissions and MAUs are lacking. There are no publications reporting some of the recommended MAU evaluation measures, listed in Appendix C including: the time to senior physician review; consult and time to IPT review, adverse events, pharmacy and diagnostic use and budget and human resource performance. The MAU model requires intense and costly resources, therefore, identification of specific factors associated with access block will contribute to developing MAU models strategically aimed at reducing access block. Planning care delivery via MAUs should consider the target population, focusing on factors placing patients at higher risk of experiencing access block. Various factors may require specific initiatives or interventions delivered within MAU to mitigate access block or negative outcomes associated with access block. Characterizing access block; identifying potential variables associated with access block; reviewing current admission processes and access to senior physician and IPT services may provide focus for resources.

Chapter 3

Methods

Research Purpose

The purpose of this research project was to describe access block experienced by GIM patients and to determine if there were significant relationships between access block and GIM admission volumes, hospital capacity, patient factors and admission factors. The relationship between access block and quality patient outcomes were be examined. This was be accomplished by answering the following research questions: (a) what is the frequency and intensity of access block experienced by the GIM population, (b) what is the relationship between access block and GIM admissions, inpatient capacity, patient characteristics and admission factors, (c) what are the relationships between access block and IPLOS, mortality and ICU transfers (d) what is the wait time to access to IPT and senior medical review.

Definition of Terms

Appendix D provides an outline of the variables measured, definitions and data sources. Access block is defined as the inability for GIM patients to access inpatient beds, preferably within the GIM bed base, as measured by an emergency department time (EDT) of > 8 hours or a BWT > 2 hours. These time frames were selected in accordance with recommendations by the Canadian Wait Time Alliance, AHS and Alberta Health and Wellness (AHW) targets (AHS, 2010; AHW, 2010; WTA, 2009). Patient demographics were extracted from demographic data. Co-morbidities and Charleston indexes were not available for analysis. The demand for GIM consultation within the EDs was measured by the average daily admissions; a complete record of the number of GIM consults for admission from the ED is not maintained. Inpatient capacity is defined as the ability to accommodate an ED admission into an inpatient bed, preferably within the admitting service's bed base. Inpatient capacity was measured by daily hospital occupancy and medicine occupancy. Off service placement of patients and use of full capacity stretchers, reflect inpatient capacity as well. Off service placement of patients refers to assigning patients to inpatient beds within a service's bed base that is different from the admitting service. Off service placement was not captured as a consistent piece of bed management data and unavailable for analysis. Patients' access to IPT resources and senior physicians were examined as they are viewed as important MAU innovations impacting access block. The chart review focused on describing GIM consultation and admission processes (as reliable GIM consultation request data was not available for the large aggregate) as well as access to IPT and senior physicians. IPT members include physiotherapists, occupational therapists, social workers, speech language therapists and respiratory therapists. Quality outcome measures included ICU transfer rates, all cause hospital mortality and IPLOS.

Research Design

The chosen research design was a retrospective design analyzing historical data. The study design provided a description of: (a) all variables measured, (b) relationship between access block and the study variables, (c) relationships between access block and mortality, ICU transfer and IPLOS and (d) GIM consultation and admission processes; access to senior physicians and IPT assessments.

Sample Selection

The total population were general medical patients admitted to general internal medicine programs in large tertiary centers, while the target population was a subset of patients identified as GIM medicine patients at a large urban tertiary care hospital. The variability between hospitals and health care systems can limit the ability to generalize findings to all GIM patients admitted to tertiary care centers. The sample consisted of all adults, aged > 17 who were admitted to the GIM service between January 1, 2006 and August 22, 2010 at the Royal Alexandra Hospital in Edmonton, Alberta. The GIM service admits patients with multiple acute medical conditions, excluding surgical patients or patients requiring higher levels of care within an intensive or coronary care unit. Twenty patient charts were reviewed to obtain data for GIM consultation and admission in ED and access to IPT and senior physicians. These 20 charts were randomly selected by AHS Data Integration and Measurement and Reporting (DIMR) department.

Methods and Instruments

As the study was retrospective without manipulation of variables, the primary method of data collection was aggregate registry data available from the DIMR department within AHS. DIMR compiles data from a variety of sources including EDIS, hospital registration system and from regional bed management reports. Additional data was obtained from databases maintained by infection control services. The medical records for each randomly selected participant was accessed within the medical records department and reviewed using a data gathering tool created to record data (Appendix F). The patient identifier was a numerical code assigned to each patient. No individually identifying data was collected. Data collected is described in appendix D. Additional variables originally planned for inclusion were volume of GIM consults in the ED department, GIM consultation request time, patient co morbidities, acuity and readmission rates; however these were not available for analysis. The use of large aggregate databases allow for collection of large volumes of data in a cost effective and efficient manner. There are acknowledged limitations of a retrospective review with data from large aggregate databases. Data collected may not necessarily meet the definition of terms. Individual hospital staff recording data often develop their own definitions, abbreviations or terms, or timing, leading to inconsistency in the data (Wood & Ross-Kerr, 2011). Additionally data may be missing or illegible. Administrative databases can be unreliable and the standards or rigor for data entry may be variable, leading to error. Structure was introduced through use of a data collection tool for chart review to systematically record identical data on each subject and Davidson's Statistical Data Handling Principles were adhered to.

Reliability and Validity

Reliability refers to the consistency, stability, and repeatability of a data collection instrument (Wood & Ross-Kerr, 2011). The reliability may be threatened through reliance on computerized data systems for information. As the majority of data for this study was provided from existing databases maintained by AHS, I am reliant on the procedures in place for data collection within AHS. Sources of random error are significant threats to the reliability of research data. The use of a data collection tool to guide systematic collection in a quiet well lit environment and reasonably scheduled times for chart reviews were essential. Other threats to data reliability included the lack of key data elements, unclear or contradictory documentation. A final potential source of error affecting reliability is data entry errors from collection tools to digital files or software. Computerized software was used for cleaning and recording data, while reviewing data sets for missing data. Outliers were managed by analyzing the data with and without outliers. Listwise deletion was used as the amount of missing data was small and the sample was large, with relationship strength strong enough to handle missing cases.

Validity refers to the degree to which the data collected measures the concept or phenomenon it intends to measure (Wood & Ross-Kerr, 2011). Face validity is the lowest form of validity and will be achieved through the process of a review by the thesis committee. Content validity is established through comparing the concepts, proposed variables, measures and data measurement tool against the literature. All variables under study have a conceptual basis in the literature pertaining to ED overcrowding, access block and MAUs. Content validity was further enhanced through consulting the thesis committee. External validity will be attained by sampling the entire target population within the study time frame. Bias introduced through chart review was minimized through random sampling and use of a data collection tool to systematically collect data. Key staff involved in quality initiatives, which may impact the outcome will be consulted for possible time specific events or initiatives which may affect the study findings. Internal validity is achieved through control of the design, allowing the researcher to attribute findings to manipulated variables, due to the control of other possible confounding variables. Achieving high levels of internal validity is generally reserved for experimental designs where causal relationships are tested and tight control over variables and conditions are maintained. As this is a descriptive retrospective correlational design, with no manipulation or control exerted by the researcher, internal validity is difficult to achieve. Threats to internal validity relevant to this study include confounders, selection bias and history influences. Incorporation of extraneous variables as study variables will assist in managing the effect of extraneous variables on any correlations noted, as much as possible in the design.

Data Analysis

The data was analyzed using SPSS version 19 (SPSS Inc., Chicago, Illinois) and Davidson's Statistical Data Handling Principles were adhered to (Davidson, 1996). The data set was cleaned and examined for outliers, missing data and potential coding errors. Statistical frequencies were conducted on each variable to identify outliers. 5 cases with outlier wait times were identified and analysis with and without the outliers were similar, therefore the outliers were included. Missing data was noted specifically on the weekends for ALC and hospital FCP data and was taken into consideration. Listwise deletion via SPSS default settings was used and caution noted in interpretation. Cross validation of data occurred through randomly selecting 5% of cases, comparing data in the original digital data file and the data entered in SPSS. Descriptive statistics were performed on all variables collected including (a) means and standard deviations for continuous variables, as well as medians where appropriate, (b) frequencies and percentages for categorical variables. Confidence intervals were set at 95% with an accepted error of 5% for population parameter estimation. Statistical analyses performed included analysis of variance techniques, bivariate correlation using Pearson's product-moment correlation and cross tabulations with Chi Square as appropriate for the level of data. Further analysis was undertaken with multiple regression techniques to examine the effects of multiple variables on access block.

Ethics

This project was approved by the local ethics committee and thesis committee. Operational approval from the Director of Medicine and AHS was obtained. Protection of confidential patient information is an important ethical consideration. The following strategies assisted to maintain the anonymity of the subjects and their health information: collection of non identifying data; chart review data was collected in the secure medical records department; photocopying or removal of patient records from medical records was not permitted; individual data collection tools were physically secured and entry to electronic data files were password secured at all times. All research projects should consider and address the balance of patient benefits and risks related to study participation (Wood & Ross-Kerr, 2011). The data obtained from this research project will contribute to the evaluation of strategies designed to decrease access block, improving access to services and identifying further areas for quality improvement, enhancing the patient experience and quality of care in the medicine program.

Chapter 4

Results

Analysis of 13471 case admissions to the GIM program at the Royal Alexandra Hospital, between January 1, 2006 and August 23, 2010 was conducted with International Business Machines SPSS Statistics 19 software. Medicine and hospital census, funded beds, blocked beds, ALCs, FCPs and EIP data was available from 2007 to 2010. Available data is shown in appendix E. GIM consult data was available for 33% of the aggregate cases; however the data was not utilized for further analysis as the integrity of the data was uncertain.

Patient Characteristics

Of the 13471 cases, 52% were male and 48% were female. The median age of the sample was 67 years; figure 1 displays age ranges of the sample. 6.9% of cases were isolated within the first 24 hours of admission and data was unavailable to determine isolation status of 0.3% of cases. The majority of cases, 89.7%, resided within 50 km of Edmonton; 6.3% resided ≥ 50 km from Edmonton; 2.9% reported no fixed address and 1.1% resided outside of Alberta. Table 1 displays the ten most prevalent admission and discharge diagnoses.

Figure 1

Sample Age Ranges

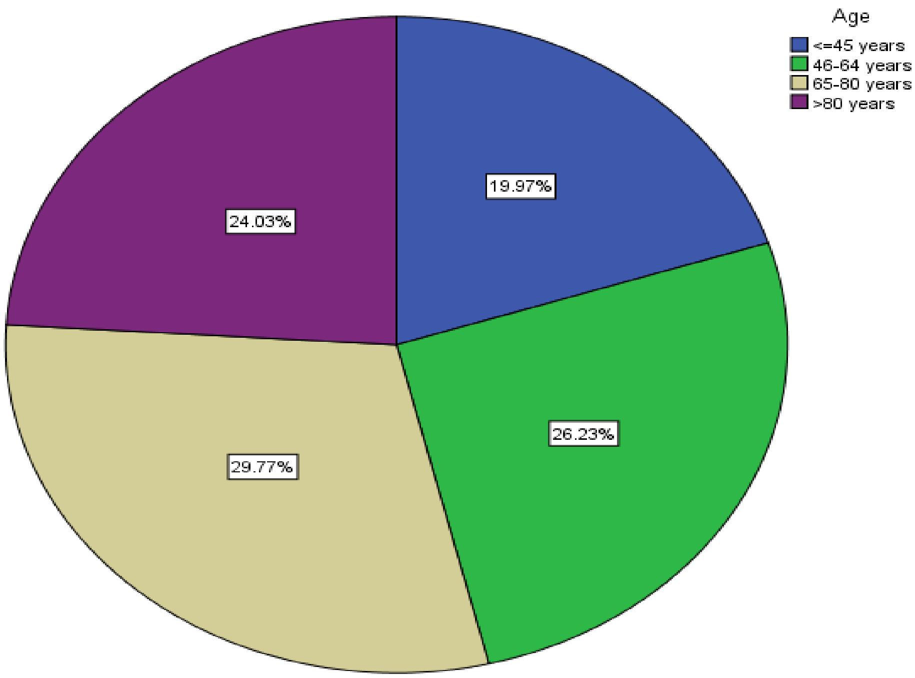


Table 1

Top 10 Prevalent Admission and Discharge Diagnoses

Diagnosis	%	Cumulative %
	Admission	
Pneumonia	7.8	7.8
HF	6.6	14.4
COPD	5.9	20.3
UTI	3.3	23.6
Stroke	3.1	26.7
Cellulitis	2.3	29
ARF	1.9	30.9
PE	1.8	32.7
Delirium	1.8	34.5
Sepsis	1.7	36.2
	Discharge	
COPD	8.6	8.6
HF	6.7	15.3
Pneumonia	5.3	20.6
Cerebral infarct/stroke	3.6	24.2
UTI	3.1	27.3
Alcohol related disturbance	2.5	29.8
Cellulitis	2.2	32.0
Pneumonitis	2.2	34.2
ARF	2.1	36.3
PE	2.0	38.3

HF=heart failure, COPD=chronic obstructive pulmonary disease, UTI=urinary tract infection, ARF=acute renal failure, PE=pulmonary embolism

Hospital and Medicine Capacity

Medicine funded beds remained stable (248 beds) during the study period; there were increases in hospital beds during the study period (648 to 690 beds). Occupancy was calculated using census and available beds (funded beds minus blocked beds). The medicine census captures only medicine cases occupying medicine beds. Medicine cases occupying other services' beds (off-service), EIPs and FCPs are tabulated in the daily medicine census. Off-service cases are accounted within hospital occupancy. Frequencies and analysis of variance with post hoc testing was used to identify significant mean differences among years, seasons and days of the week and shifts. All mean capacity variables by day of week are displayed in table 3.

Medicine Admission Rates

Yearly, seasonal, daily and shift admission rates are displayed in Figures 2 to 5; daily and shift discharge rates are displayed in Figures 6 to 7. The median daily admission rate was 8; 2006 had the most admissions and 2008 had the least admissions. Spring had the most admissions, fall had the least admissions and Friday had the most admissions, Saturday had the least admissions. The majority of GIM admissions occurred between 1500 and 0700 hours.

Figure 2

Admission Rates by Year

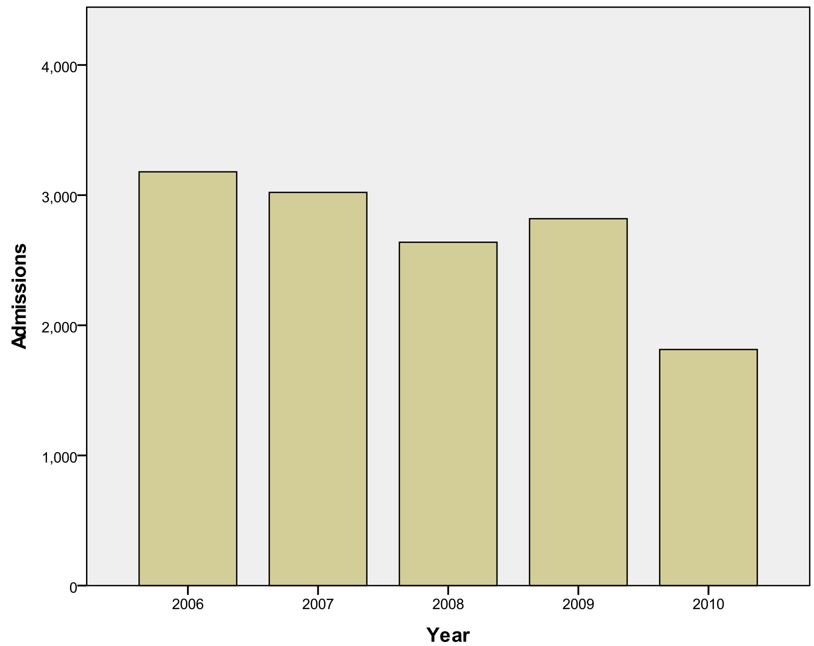


Figure 3

Admissions by Season

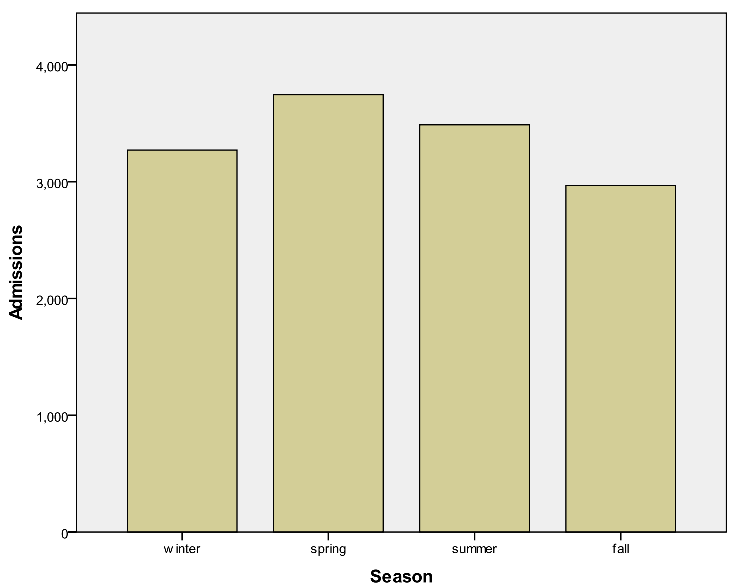


Figure 4

Admissions by Day of the Week

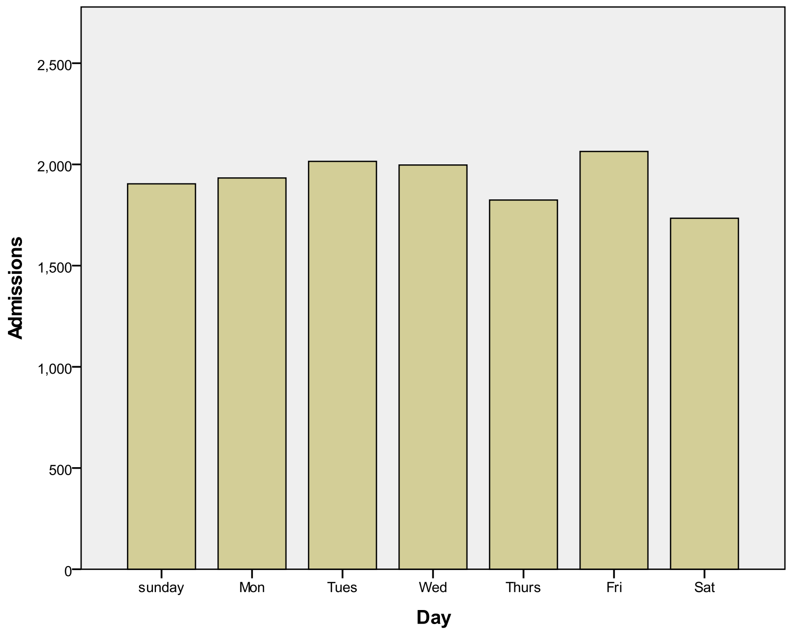


Figure 5

Admissions by Shift

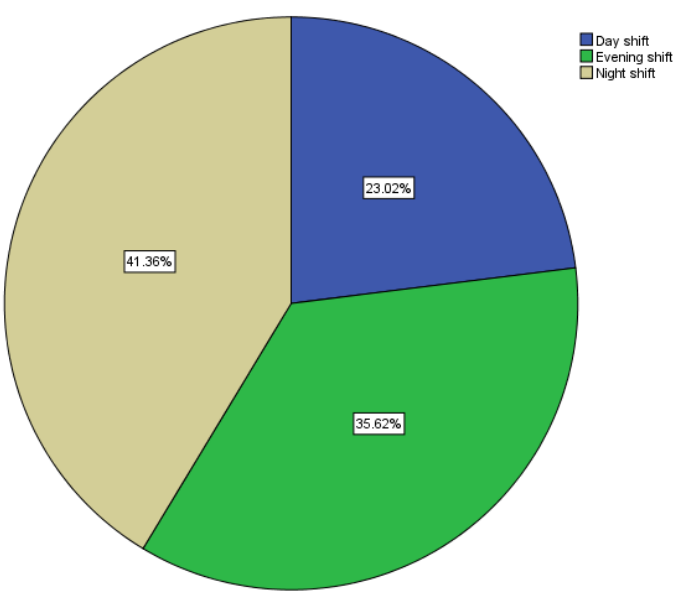


Figure 6

Discharges by Shift

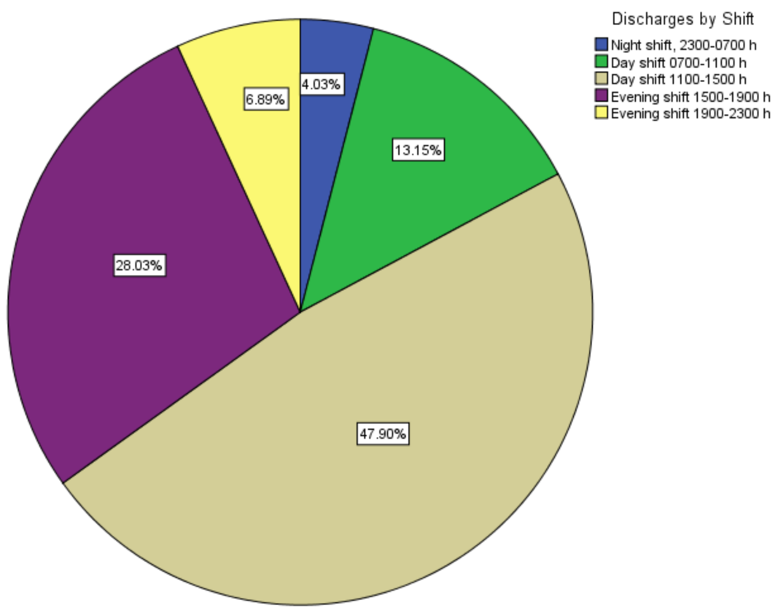
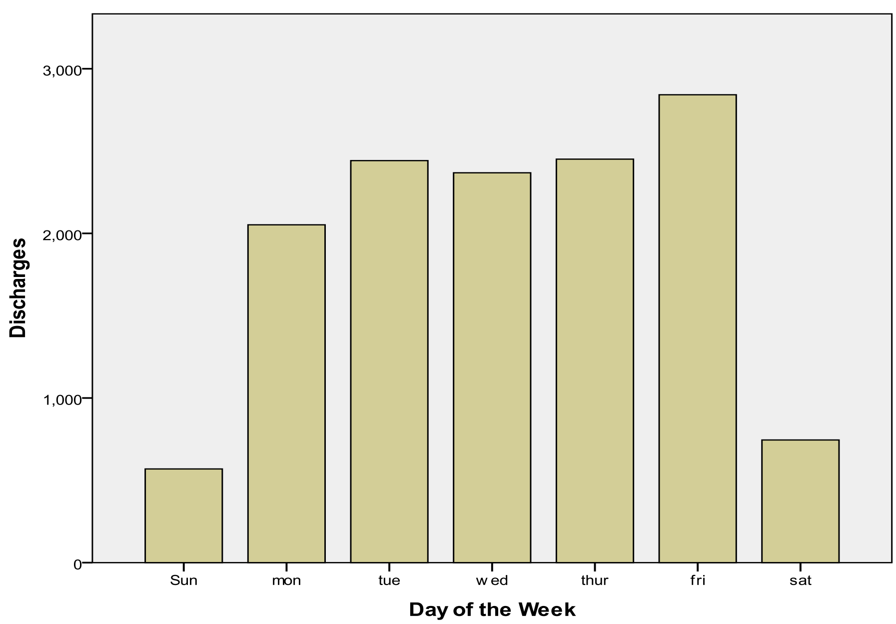


Figure 7

Discharges by Day of the Week



Occupancy

Medicine census accounted for a mean 36.7% of hospital census and is allotted a median of 36% of hospital beds. Mean medicine and hospital occupancy was 98.6% and 99.4%, respectively. There were no significant differences in medicine occupancy rates among years; hospital occupancy increased significantly each year. Medicine occupancy was significantly higher in fall and winter compared to spring and summer; hospital occupancy was highest in fall compared to all seasons and winter was higher compared to spring. Medicine occupancy was higher on Saturday and Sunday as compared to Tuesday through Friday and Monday occupancy was significantly higher than Friday. Hospital occupancy was significantly higher on Wednesday and Thursday as compared to Monday.

Median ALC patients occupying medicine and hospital beds were 68 and 92, respectively. ALC patients occupied a median 10% of site beds and 27.4% of medicine beds. 73.2% of all hospital ALC patients were occupying medicine beds. There was a yearly increasing trend medicine ALC patients; 2009 had significantly more ALC patients than prior years. Hospital ALCs demonstrated a downward trend; 2009 had significantly fewer ALCs compared to 2007. There were significantly more medicine ALC patients in the fall compared to any other season and more in winter compared to spring and summer. Hospital ALCs were significantly higher in fall and winter compared to spring and summer. ALCs were not analyzed by day of the week, as ALC data was consistently lacking for weekends. Occupancy and ALC averages are displayed in Table 2.

Table 2

Mean Occupancy and Alternate Level of Care Patients by Year and Season

	Medicine Occupancy	Hospital Occupancy	Medicine ALCs	Hospital ALCs
		M(SD)		
		Year		
2007	98.37(1.82)	95.40(2.74)***	66.21(7.48)	94.15(11.21)
2008	98.56(1.90)	99.36(5.28)***	65.10(9.59)	92.66(12.72)
2009	98.51(1.81)	101.90(3.64)***	68.59(7.11)***	90.69(9.72)***
		Season		
Winter	98.94(1.79)***	99.88(4.23)***	68.18(7.51)***	95.89(12.43)***
Spring	98.46(1.79)	98.37(4.97)	64.98(8.68)	89.23(9.21)
Summer	98.30(2.03)	98.94(5.25)	66.19(7.12)	89.32(9.18)
Fall	98.83(1.60)***	101.05(3.93)***	71.32(7.57)***	97.75(10.03)***

*** $p<.001$, ALC=alternate level of care

EIP and FCP Volumes

Daily median medicine and hospital EIPs were 13 and 17, respectively. Medicine EIPs represented a median 78.9% of hospital EIPs. Medicine and hospital EIPs varied significantly each year, 2008 had the most EIPs and 2007 had the least EIPs. EIPs were significantly higher in winter compared to all other seasons; spring had significantly more EIPs than summer or fall. Hospital EIPs were significantly lower in the summer compared to all other seasons. There were significantly more medicine EIPs Sunday through Tuesday compared to Saturday; Monday had significantly more EIPs compared to Thursday to Saturday. There were significantly more hospital EIPs on Sunday compared to Thursday through Saturday and Monday compared to Thursday.

Daily median medicine and hospital FCP use was 4 and 5, respectively. Medicine FCPs accounted for 77.9% of hospital FCPs and 50.6% of the study period, all hospital FCPs were medicine FCPs.

Medicine FCPs were significantly low in 2007; hospital FCPs were significantly high in 2008. Medicine FCPs was highest in winter compared to all other seasons; hospital FCPs was significantly higher in the winter than spring and fall. Medicine FCPs are significantly lower on Saturday and Sunday compared to Monday through Friday. Hospital FCPs are significantly lower on Saturdays compared to Monday through Thursdays and lower on Sundays compared to Tuesdays and Wednesdays. Table 3 displays EIP and FCP means by year and season, table 4 displays occupancy, EIP and FCP means by the day of the week.

Table 3

Mean Emergency Inpatients and Full Capacity Protocol Stretchers by Year and Season

	Medicine EIPs	Hospital EIPs	Medicine FCPs	Hospital FCPs
		M(SD)median		
		Year		
2007	10.42(4.82)***	14.27(5.24)***	2.73(3.25)1.00***	4.06(4.38)3.00
2008	14.78(4.65)***	19.09(5.03)***	4.37(3.48)5.00	4.37(3.48)6.00***
2009	13.58(5.20)	17.34(5.57)	4.04(3.37)3.00	4.04(3.37)4.00
		Season		
Winter	15.35(5.46)***	19.01(6.02)***	5.00(3.15)5.00***	5.68(3.68)5.00**
Spring	13.84(5.41)***	17.47(5.69)***	3.61(3.40)3.00	4.48(3.74)4.00
Summer	12.42(4.97)	15.88(5.41)***	4.10(3.78)3.00	5.00(4.71)4.00
Fall	12.47(4.79)	17.05(4.80)	3.91(3.34)4.00	4.41(3.49)4.00

***p<.001;** p=.001; FCP=full capacity protocol stretcher, EIP=emergency inpatient

Table 4

Mean Occupancy, Emergency Inpatients and Full Capacity Protocol Stretchers by Day of the Week

Day	Medicine occupancy	Hospital occupancy	Medicine EIPs	Hospital EIPs	Medicine FCPs	Hospital FCPs
			M(SD)median			
Monday	98.76(1.67)***	98.65(5.08)	14.87(5.05)***	18.19(5.36)***	4.50(3.42)5.00	5.32(4.05)5.00
Tuesday	98.49(1.73)	99.61(4.94)	13.99(5.04)***	17.23(5.31)	4.72(3.36)5.00	5.53(3.73)5.50
Wednesday	98.42(1.92)	100.18(4.74)*	13.47(5.21)	17.32(5.43)	4.66(3.61)5.00	5.56(4.47)5.00
Thursday	98.38(2.00)	100.15(4.63)*	12.71(5.60)	16.44(5.93)	4.57(3.59)5.00	5.40(4.11)6.00
Friday	98.01(2.02)	99.34(4.76)	13.04(5.32)	16.86(6.08)	4.54(3.75)4.50	4.70(3.71)4.50
Saturday	99.16(1.85)***	99.00(4.55)	12.16(5.47)	16.45(5.64)	2.78(2.98)2.00***	3.60(3.65)3.00***
Sunday	99.15(1.24)***	99.13(4.53)	14.28(5.01)***	18.75(5.22)***	2.88(2.84)2.00***	4.05(3.56)4.00***

*p=.015, *** p<.001; EIP=emergency inpatient, FCP=full capacity protocol stretcher

Analysis of variance revealed that as the number of FCPs increased, medicine and hospital EIPs increased significantly (table 5).

Table 5

Average Emergency Inpatients by Full Capacity Protocol Stretchers

FCPs	Medicine EIPs	Hospital EIPs
	M(SD)median	
	Medicine FCPs	
0	11.38(5.47)11.00***	15.15(6.22)14.00***
1-4	12.47(4.89)12.00***	16.31(5.01)16.00***
5-7	14.44(4.55)15.00***	18.28(4.69)18.00***
>7	16.52(4.92)16.00***	20.25(5.26)20.00***
	Hospital FCPs	
1	9.97(5.00)9.00***	13.57(5.60)13.00***
2-5	13.09(5.11)13.00***	16.68(5.36)16.00***
6-8	15.00(4.87)15.00***	18.63(4.91)18.00***
>8	16.40(5.27)16.50***	20.15(5.45)20.00***

*** p<.001; EIP=emergency inpatient, FCP=full capacity protocol stretcher

Multiple regression analysis was used to test if capacity factors significantly predicted medicine EIPs (entered in one block). Hospital and medicine capacity explained 28.8% of medicine EIP volumes, (r^2=.300, F (11, 671) =26.11, p<.001), predictors are displayed in table 6.

Table 6

Significant Predictors of Medicine Emergency Inpatient Volume

Variable	B	SE b	β
Hospital EIPs (not including medicine)	-.211	.073	-.096**
Medicine occupancy	.261	.102	.089*
Hospital occupancy	.062	.051	.050
Medicine ALCs	.165	.041	.225***
Hospital ALCs	-.131	.029	-.258***
Medicine FCPs	.592	.148	.372***
Hospital FCPs	.088	.122	.064
Medicine blocked beds	.114	.033	.170**
Hospital blocked beds	-.065	.015	-.205***
Daily admissions	-.143	.059	-.079*
Admissions day prior	.047	.058	.026

*p<.05, **p<.01, ***p<.001; EIP=emergency inpatient, FCP=full capacity protocol stretcher, ALC=alternate level of care

Wait Times

Admitted cases had a median EDLOS of 27.00 hours, BWT of 16.00 hours and EDT of 43.00 hours. Figure 8 to 10 displays wait times ranges. A Pearson product-moment correlation coefficient revealed strong positive correlations between EDLOS and BWT, r (13471) =.95, p=.000; EDLOS and EDT, r (13471) =.99, p<.001; BWT and EDT, r (13471) =.99, p<.001. EDLOS comprised 62.2% of EDT.

Figure 8

Emergency Department Length of Stay Ranges

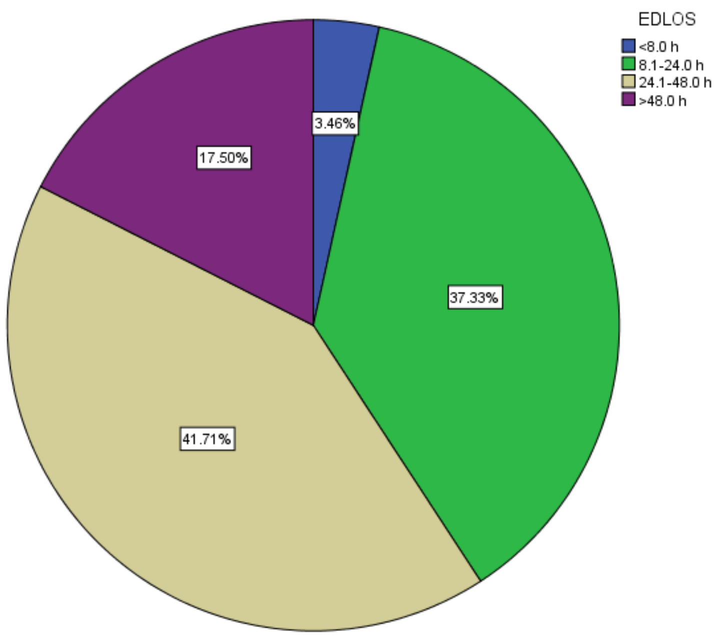


Figure 9

Bed Wait Time Ranges

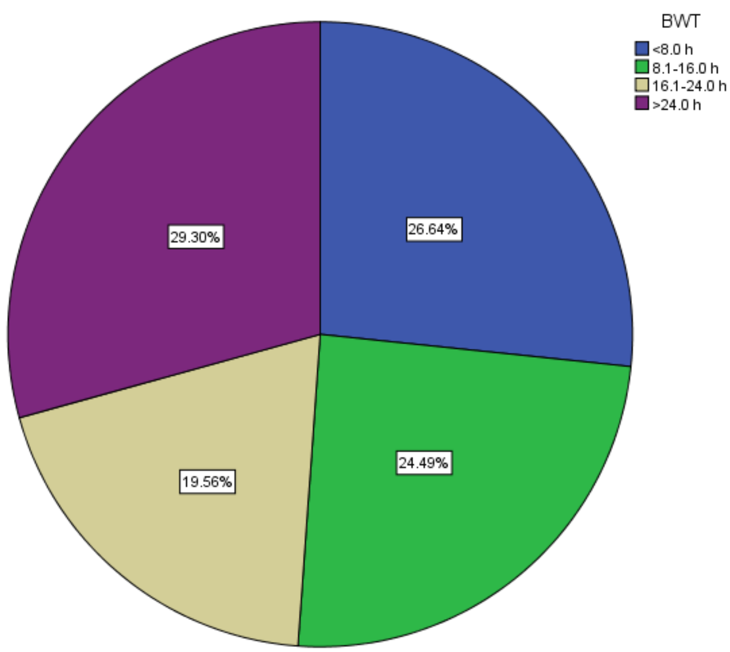
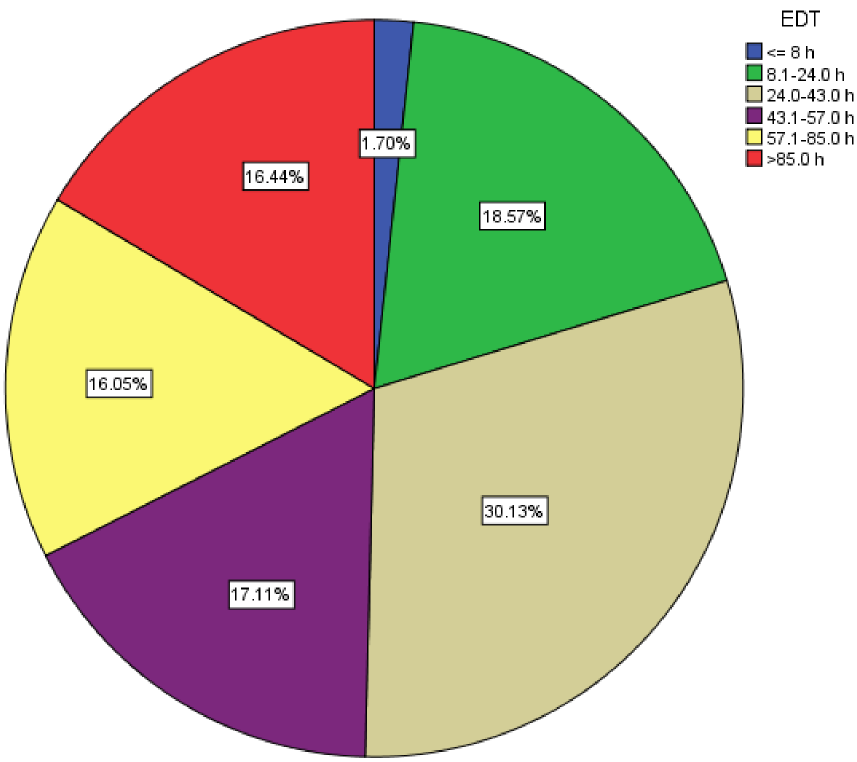


Figure 10

Emergency Department Time Ranges



Patient Factors

Analysis of variance with post hoc tests revealed significant mean differences of wait times among age, residence, sex and isolation status (displayed in table 7). As age increased, all wait times significantly decreased. Cases >80 years of age had the shortest wait times compared to all other age groups, cases 65 to 80 years had a significantly shorter wait times compared to cases <65 years. Cases registered as no fixed address experienced longer wait times compared to all other groups. An independent t test indicates males have longer wait times compared to females and isolated cases have longer wait times compared to non isolated cases. There are significant differences in mean wait times among admission and discharge diagnoses. Table 8 describes significant differences between diagnoses and table 9 and 10 displays mean wait times by diagnoses.

Table 7

Mean Wait Times by Age and Residence

Patient Characteristic	EDLOS	BWT	EDT
	M(SD)median		
		Age	
≤ 45 years	34.88(21.20)29.00	23.84(20.56)18.00	58.72(40.99)48.00
46-64 years	34.02(20.67)29.00	22.53(19.59)17.00	56.55(39.72)45.00
65-80 years	31.41(19.04)27.00***	20.14(17.95)15.00***	51.55(36.51)42.00***
>80 years	29.45(29.45)26.00***	17.99(16.23)14.00***	47.44(32.90)40.00***
		Residence	
No fixed address	38.11(23.15)33.00***	25.67(22.34)20.00***	63.78(45.11)53.00***
≤50 km	32.21(19.43)27.00	20.81(18.45)16.00	53.02(37.39)43.00
>50 km	31.30(19.92)26.00	21.63(18.87)17.00	52.93(38.29)43.00
Out of province	30.89(19.90)26.00	19.66(17.85)15.50	50.55(37.13)42.00
		Sex	
Male	32.80(20.21)28.00*	21.57(19.23)17.00***	54.37(38.98)44.00**
Female	31.79(18.92)27.00	20.36(17.89)16.00	52.14(36.31)43.00
		Isolation	
Isolated	34.74(23.54)28.00**	23.97(22.57)17.00***	58.71(45.82)41.00***
Non isolated	32.13(19.26)27.00	20.76(18.25)16.00	52.88(37.00)43.00

*p=.003, **p=.001, *** p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time

Table 8

Significant Wait Time Differences among Diagnoses

Diagnosis	EDLOS	BWT	EDT
Admission diagnosis stroke	Shorter compared to pneumonia, COPD, cellulitis, other admission diagnoses	Shorter compared to pneumonia and other admission diagnoses	Shorter compared to pneumonia, COPD, cellulitis, other admission diagnoses
Discharge diagnosis of cerebral infarction/stroke	Shorter compared to COPD, pneumonia, cellulitis, PE, alcohol related disturbances and other diagnoses	Shorter compared to pneumonia, cellulitis, alcohol related disturbances and other discharge diagnoses	Shorter compared to COPD, pneumonia, cellulitis, alcohol related disturbances and other discharge diagnoses.
Discharge diagnosis of alcohol related disturbances	Longer compared to HF, COPD, pneumonia, UTI, pneumonitis, ARF, cerebral infarction/stroke, other discharge diagnoses	Longer compared to HF, UTI, cerebral infarction/stroke	Longer compared to HF, UTI, pneumonitis, ARF, cerebral infarction/stroke, other discharge diagnoses

EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time
COPD=chronic obstructive pulmonary disease, PE=pulmonary embolism, HF=heart failure, UTI=urinary tract infection, ARF= acute renal failure

Table 9

Mean Wait Times by Admission Diagnoses

Admission Diagnoses	EDLOS	BWT	EDT
		M(SD)median	
Stroke	27.58(15.97)24.00***	18.10(15.60)15.00**	45.68(31.26)39.00***
Pneumonia	32.04(21.14)27.00	21.87(20.39)16.00	53.92(41.23)42.00
COPD	32.44(20.10)27.00	21.37(18.78)16.00	53.81(38.53)43.00
Cellulitis	33.15(20.16)28.00	21.96(20.02)16.50	55.12(39.82)44.00
Other diagnoses	32.86(19.63)28.00	21.21(18.55)16.00	54.07(37.62)44.00

** $p=.007$, *** $p<.001$; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time

Table 10

Mean Wait Times by Discharge Diagnoses

Discharge Diagnoses	EDLOS	BWT	EDT
		M(SD)median	
Alcohol related disturbances	37.23(19.34)33.00***	23.98(18.65)20.00***	61.21(37.50)52.00***
HF	31.33(18.19)27.00	20.06(17.26)16.00	51.39(35.06)43.00
COPD	32.50(20.62)27.00	21.39(19.54)16.00	53.89(39.76)42.00
Pneumonia	32.48(20.03)27.00	21.88(19.24)16.00	54.36(38.93)41.00
UTI	30.33(16.91)26.00	18.83(15.82)15.00	49.16(32.24)41.00
Pneumonitis	30.27(19.38)25.00	19.83(19.06)14.00	50.10(38.03)39.00
ARF	30.58(18.13)26.00	19.47(17.80)15.00	50.04(35.54)41.00
cerebral infarction/stroke	28.63(16.23)25.00***	18.52(15.45)15.00***	47.15(31.27)39.00***
Cellulitis	34.94(21.83)29.00	23.54(21.05)18.00	58.49(42.48)46.00
PE	33.45(18.38)29.00	21.88(17.48)18.00	55.33(35.30)48.00
Other diagnoses	32.50(19.85)28.00	21.06(18.78)16.00	53.56(38.10)44.00

***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time COPD=chronic obstructive pulmonary disease, PE=pulmonary embolism, HF=heart failure, UTI=urinary tract infection, ARF= acute renal failure

Capacity Factors

Analysis of variance with post hoc testing demonstrated significant mean differences in BWT and EDT among daily admission volumes. Cases admitted on days with >10 admissions had a significantly shorter BWT and EDT than cases admitted when there was ≤8 daily admissions. There were no significant differences in number of daily admissions among EIPs or the number of admissions the day prior. All wait times were shorter for cases admitted when medicine occupancy was <97% or when hospital occupancy is <100%. When medicine ALCs are >71 and hospital ALCs are > 85, all wait times are significantly higher. All wait times significantly increased as the number of EIPs progressively increased. Wait times were significantly longer when medicine and hospital FCPs were > 5. Wait times were significantly lower when hospital FCP was 1 compared to >1. Wait times by daily admissions and occupancy are displayed in table 11; wait times by ALC, FCP and EIPs are displayed in table 12.

Table 11

Mean Wait Times by Admissions and Occupancy

	EDLOS	BWT	EDT
		M(SD)median	
		Daily Admissions	
≤8	ns	21.61(18.69)17.00**	54.29(37.77)44.00*
9-10	ns	20.93(18.57)16.00	53.27(37.69)43.00
>10	ns	20.22(18.51)15.00**	52.03(37.70)42.00*
		Medicine occupancy	
≤97%	29.33(18.13)25.00	18.13(17.30)14.00	47.47(34.96)39.00
98-100%	31.96(18.94)27.00***	20.65(17.84)16.00***	52.61(36.29)43.00***
>100%	33.19(17.38)29.00***	22.32(16.52)18.00***	55.50(33.36)47.00***
		Hospital occupancy	
≤97%	30.18(18.39)26.00	19.09(17.48)15.00	49.27(35.41)40.00
98-100%	29.80(18.03)26.00	18.30(16.90)14.00	48.10(34.43)40.00
>100%	33.00(19.09)28.00***	21.68(18.00)17.00***	54.69(36.59)45.00***

*p=.012, **p=.001, ***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time, ns=non significant

Table 12

Mean Wait Times by Alternate Level of Care, Full Capacity Protocol Stretchers and Emergency Inpatients

	EDLOS	BWT	EDT
		Medicine ALCs	
≤64	30.27(19.01)26.00	18.90(17.92)14.50	49.17(36.43)40.00
65-71	30.05(18.13)26.00	18.52(16.92)14.00	48.57(34.51)40.00
>71	32.06(19.42)27.00**	20.84(18.28)16.00***	52.90(37.26)43.00***
		Hospital ALCs	
≤85	29.21(17.61)25.00*	17.69(16.33)14.00***	46.90(33.38)39.00**
86-92	31.43(19.93)26.00	20.14(18.81)15.00	51.57(38.29)41.00
93-100	30.99(18.62)26.50	19.64(17.46)15.00	50.63(35.56)42.00
>100	31.03(19.30)27.00	19.69(18.26)15.00	50.72(37.12)41.50
		Medicine EIPs	
≤10	26.96(16.60)24.00***	15.81(15.36)12.00***	42.77(31.42)35.00***
11-15	31.57(18.29)27.00***	20.16(17.28)16.00***	51.73(35.05)43.00***
>15	35.77(20.11)30.00***	24.56(19.20)19.00***	60.33(38.87)49.00***
		Hospital EIPs	
≤14	27.10(16.68)24.00***	15.89(15.34)12.00***	42.99(31.45)36.00***
15-19	31.59(18.19)27.00***	20.21(17.19)16.00***	51.80(34.89)43.00***
>19	35.87(20.22)30.00***	24.67(19.35)20.00***	60.54(39.14)50.00***
		Medicine FCPs	
0	29.77(17.93)26.00	18.26(16.73)14.00	48.03(34.12)40.00
1-4	30.28(18.12)26.00	19.26(17.03)15.00	49.54(34.67)41.00
5-7	32.65(18.90)28.00***	21.32(18.00)17.00***	53.97(36.44)44.00***
>7	34.45(20.19)29.00***	23.08(19.25)18.00***	57.54(38.95)47.00***
		Hospital FCPs	
1	27.40(16.59)24.00***	16.06(15.35)12.00***	43.46(31.36)36.00***
2-4	29.36(17.61)25.50	18.56(16.62)15.00	47.93(33.75)40.00
5-8	32.51(19.32)28.00***	21.37(18.46)17.00***	53.88(37.33)44.00***
>8	33.63(19.56)28.00***	22.31(18.68)17.00***	55.95(37.76)46.00***

*p=.002, **p=.001, ***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time; EIP=emergency inpatient, FCP=full capacity protocol stretcher, ALC=alternate level of care

Admission Factors

Analysis of variance revealed statistically significant differences in mean EDLOS, BWT and EDT among admission days of the week, seasons and years. Only BWT varied significantly by admission shift. Post-hoc tests revealed cases admitted on night shift had a significantly longer BWT than cases admitted on day shift. There were no other significant differences among wait times and admission shift. Wait times varied significantly each year from 2006 to 2009. Wait times were longest in 2008 and shortest in 2007. Cases admitted during the winter had the statistically longest wait times and cases admitted during the summer had the shortest wait times compared to all other seasons. Mean EDLOS was longest on Saturdays compared to Sundays through Thursdays; Fridays and Sundays were longer than Monday through Thursdays. BWT and EDT were longest on Saturdays compared to all other days and longer on Fridays and Sundays compared to Monday through Thursdays. Mean wait times by day of the week, season and year are displayed in table 13.

Table 13

Mean Wait times by Day, Season and Year

	EDLOS	BWT	EDT
		M(SD)median	
		Admission Shift	
Day	ns	20.25(18.94)12.00	ns
Evening	ns	20.99(18.43)19.00	ns
Night	ns	21.40(18.57)15.00*	ns
		Day of Week	
Monday	31.49(17.16)28.00	19.72(16.08)16.00	51.21(32.68)43.00
Tuesday	30.96(17.25)27.00	19.30(16.18)16.00	50.25(32.82)43.00
Wednesday	30.09(18.43)26.00	18.97(17.40)15.00	49.05(35.32)41.00
Thursday	29.86(20.39)25.00	18.72(19.33)14.00	48.58(39.25)39.00
Friday	34.15(21.12)26.00***	22.73(22.77)14.00***	56.88(46.50)41.00***
Saturday	36.34(20.36)32.00***	25.34(19.61)21.00***	61.68(39.55)53.00***
Sunday	33.62(17.65)29.50***	22.51(16.96)19.00***	56.13(34.09)48.00***
		Season	
Winter	34.40(20.91)29.00***	22.94(20.03)17.00***	57.34(40.46)46.00***
Spring	32.10(19.59)27.00	20.95(18.65)16.00	53.05(37.78)43.00
Summer	30.57(17.72)27.00***	19.30(16.70)15.00***	49.87(33.88)42.00***
Fall	32.34(20.06)27.00	20.87(18.88)16.00	53.21(38.45)43.00
		Year	
2006	33.84(21.50)28.00***	22.31(20.52)17.00***	56.15(41.52)44.00***
2007	27.64(17.09)24.00***	16.43(16.04)12.00***	44.06(32.59)36.00***
2008	36.10(20.49)31.00***	24.46(19.43)19.00***	60.56(39.46)50.00***
2009	30.80(18.45)27.00***	19.48(17.36)15.00***	50.28(35.29)41.00***

*p=.02, *** p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time

Multiple regression analysis was used to test if patient, admission and capacity factors significantly predicted wait times. Block entry was used; first block included patient factors; second block, admission factors and third block, capacity factors. These factors explained 9.6% of EDLOS, (r^2=.105, F (51, 5404) =12.37, p<.001); 11.4% of BWT, (r^2=.122, F (51, 5404) =14.72, p<.001) and 10.6% of EDT, (r^2=.115, F (51, 5404) =13.75, p<.001). Predictors of EDLOS, BWT and EDT are presented in tables 14 to 16.

Table 14

Predictors of Emergency Department Length of Stay

Variable	B	SE b	β
Sex	.466	.480	.013
Age	-.061	.014	-.064***
Isolated	3.605	.880	.055***
Mortality	1.038	.846	.017
ICU transfer	-4.102	1.357	-.040**
Reside > 50 km	-.801	.970	-.011
No fixed address	2.314	1.603	.019
Out of province	-1.686	2.196	-.010
Admission pneumonia	-2.423	1.112	-.034*
Admission HF	-.939	1.190	-.013
Admission COPD	-2.070	1.361	-.026
Admission UTI	-1.730	1.549	-.016
Admission stroke	-3.150	1.764	-.029
Admission cellulitis	2.190	2.333	.017
Admission ARF	-.431	1.952	-.003
Admission PE	.640	2.563	.005
Admission sepsis	.613	1.955	.004
Admission delirium	3.751	1.888	.026*
Discharge HF	.419	1.501	.006
Discharge pneumonia	-2.126	1.547	-.025
Discharge UTI	.121	1.993	.001
Discharge pneumonitis	-1.538	1.931	-.012

Discharge cellulitis	-3.267	2.603	-.024
Discharge PE	-.470	2.611	-.004
Discharge ARF	-.542	2.105	-.004
Discharge cerebral infarction/stroke	.529	2.059	.005
Discharge alcohol related disturbances	1.475	1.917	.012
Discharge other	-1.233	1.156	-.033
Day shift	-.291	.622	-.007
Evening shift	-.397	.543	-.010
Sunday	1.629	4.324	.005
Monday	-2.936	.788	-.061***
Tuesday	-2.708	.746	-.060***
Wednesday	-2.466	.747	-.054**
Thursday	-3.304	.760	-.071***
Saturday	-7.374	4.496	-.022
Winter	1.143	.732	.026
Summer	-.780	.803	-.019
Fall	-4.138	.819	-.089***
Admission year	1.220	.352	.078**
Medicine blocked beds	.256	.050	.113***
Medicine occupancy	.509	.135	.054***
Medicine EIPs	.409	.111	.123***
Medicine ALCs	.031	.061	.013
Medicine FCPs	-.159	.218	-.030
Daily admissions	-.133	.084	-.021
Hospital blocked beds	-.063	.025	-.060*
Hospital occupancy	-.117	.077	-.028
Hospital EIPs	.123	.099	.040
Hospital ALCs	.047	.045	.028
Hospital FCPs	.419	.172	.091*

*p<.05, **p<.01, ***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time; EIP=emergency inpatient, FCP=full capacity protocol stretcher, ALC=alternate level of care; COPD=chronic obstructive pulmonary disease, PE=pulmonary embolism, HF=heart failure, UTI=urinary tract infection, ARF= acute renal failure

Table 15

Predictors of Bed Wait Time

Variable	B	SE b	β
Sex	.266	.449	.008
Age	-.079	.013	-.088***
Isolated	4.170	.823	.067***
Mortality	.364	.791	.006
ICU transfer	-3.533	1.268	-.036**
Reside > 50 km	.729	.907	.010
No fixed address	1.272	1.499	.011
Out of province	-1.100	2.054	-.007
Admission pneumonia	-1.071	1.040	-.016
Admission HF	-.037	1.113	-.001
Admission COPD	-.803	1.273	-.011
Admission UTI	-1.050	1.448	-.011
Admission stroke	-1.536	1.650	-.015
Admission cellulitis	2.502	2.182	.020
Admission ARF	.355	1.825	.003
Admission PE	1.492	2.396	.012
Admission sepsis	1.281	1.828	.009
Admission delirium	1.819	1.766	.013
Discharge HF	.658	1.404	.010
Discharge pneumonia	-1.594	1.447	-.020
Discharge UTI	.605	1.863	.006
Discharge pneumonitis	-.157	1.806	-.001
Discharge cellulitis	-2.863	2.434	-.023
Discharge PE	-.402	2.442	-.003
Discharge ARF	.058	1.969	.000
Discharge cerebral	.683	1.926	.007

infarction/stroke			
Discharge alcohol related disturbances	.377	1.792	.003
Discharge other	-.968	1.081	-.027
Day shift	-1.783	.582	-.043**
Evening shift	-.206	.508	-.006
Sunday	3.005	4.043	.010
Monday	-3.622	.737	-.080***
Tuesday	-3.261	.698	-.076***
Wednesday	-2.531	.699	-.059***
Thursday	-3.291	.710	-.075***
Saturday	-5.469	4.204	-.017
Winter	.923	.684	.023
Summer	-1.355	.751	-.034
Fall	-3.840	.766	-.087***
Admission year	1.471	.329	.100***
Medicine blocked beds	.308	.047	.144***
Medicine occupancy	.551	.126	.062***
Medicine EIPs	.420	.104	.134***
Medicine ALCs	.042	.057	.019
Medicine FCPs	-.175	.204	-.035
Daily admissions	-.174	.079	-.029*
Hospital blocked beds	-.069	.024	-.068**
Hospital occupancy	-.117	.072	-.030
Hospital EIPs	.100	.092	.034
Hospital ALCs	.025	.042	.016
Hospital FCPs	.421	.160	.096**

*p<.05, **p<.01, ***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time; EIP=emergency inpatient, FCP=full capacity protocol stretcher, ALC=alternate level of care; COPD=chronic obstructive pulmonary disease, PE=pulmonary embolism, HF=heart failure, UTI=urinary tract infection, ARF= acute renal failure

Table 16

Predictors of Emergency Department Time

Variable	B	SE b	β
Sex	.732	.915	.010
Age	-.140	.026	-.077***
Isolated	7.775	1.678	.061***
Mortality	1.402	1.613	.012
ICU transfer	-7.635	2.586	-.039**
Reside > 50 km	-.072	1.849	-.001
No fixed address	3.586	3.055	.016
Out of province	-2.786	4.187	-.009
Admission pneumonia	-3.494	2.120	-.026
Admission HF	-.975	2.268	-.007
Admission COPD	-2.873	2.595	-.019
Admission UTI	-2.780	2.953	-.014
Admission stroke	-4.685	3.363	-.023
Admission cellulitis	4.692	4.448	.019
Admission ARF	-.075	3.721	.000
Admission PE	2.132	4.886	.008
Admission sepsis	1.894	3.727	.007
Admission delirium	5.570	3.600	.020
Discharge HF	1.077	2.862	.008
Discharge pneumonia	-3.720	2.950	-.023
Discharge UTI	.725	3.799	.003
Discharge pneumonitis	-1.695	3.682	-.007
Discharge cellulitis	-6.130	4.964	-.024
Discharge PE	-.873	4.979	-.004
Discharge ARF	-.484	4.013	-.002
Discharge cerebral	1.212	3.926	.006

infarction/stroke			
Discharge alcohol related disturbances	1.852	3.654	.008
Discharge other	-2.201	2.205	-.030
Day shift	-2.074	1.186	-.025
Evening shift	-.603	1.036	-.008
Sunday	4.634	8.244	.007
Monday	-6.558	1.502	-.072***
Tuesday	-5.969	1.422	-.069***
Wednesday	-4.997	1.425	-.057***
Thursday	-6.595	1.448	-.074***
Saturday	-12.843	8.572	-.020
Winter	2.066	1.395	.025
Summer	-2.135	1.532	-.026
Fall	-7.978	1.562	-.089***
Admission year	2.691	.671	.090***
Medicine blocked beds	.565	.096	.130***
Medicine occupancy	1.060	.257	.059***
Medicine EIPs	.829	.212	.131***
Medicine ALCs	.073	.116	.016
Medicine FCPs	-.333	.416	-.033
Daily admissions	-.308	.160	-.025
Hospital blocked beds	-.132	.048	-.065**
Hospital occupancy	-.234	.147	-.030
Hospital EIPs	.223	.188	.038
Hospital ALCs	.072	.086	.023
Hospital FCPs	.840	.327	.095*

*p<.05, **p<.01, ***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time; EIP=emergency inpatient, FCP=full capacity protocol stretcher, ALC=alternate level of care; COPD=chronic obstructive pulmonary disease, PE=pulmonary embolism, HF=heart failure, UTI=urinary tract infection, ARF= acute renal failure

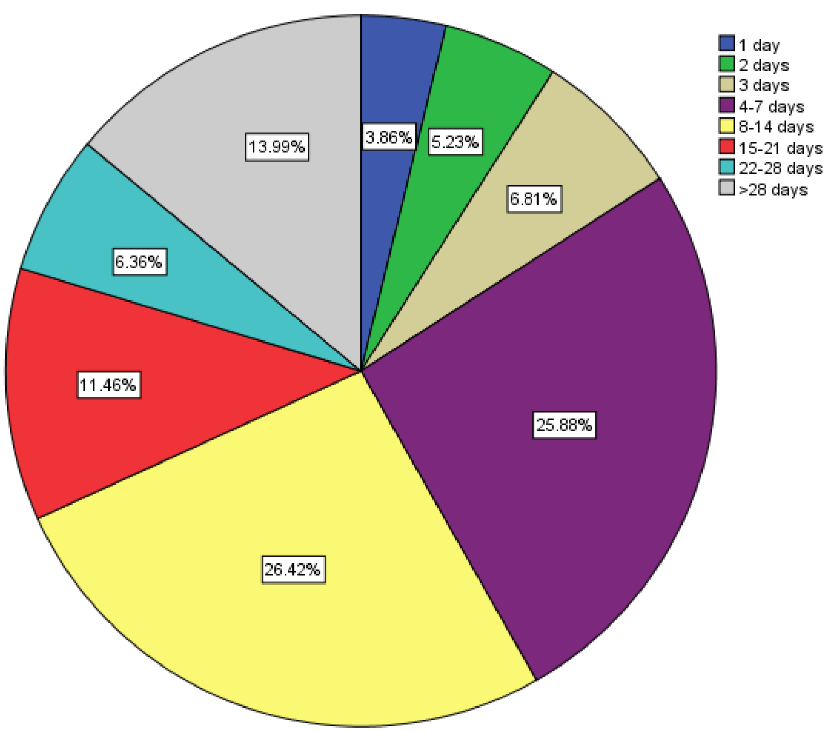
Access Block and Outcomes

IPLOS

Median IPLOS during the study period was 8.61 days. Median IPLOS was 7.3 for cases with IPLOS of < 28 days and 46.9 days for cases with IPLOS >28 days. IPLOS is depicted in figure 11. There were no significant mean differences in IPLOS among wait times or number of EIPs at the time of admission.

Figure 11

Inpatient Length of Stay



ICU Transfers and Mortality

The overall ICU transfer rate was 3.2% and mortality rate was 9.5%. Chi square test of independence was performed to examine the relationship between ICU transfers and mortality by wait times, occupancy and EIPs at admission (displayed in table 17). Cases with EDLOS of <24, BWT ≤ 12 hours or an EDT of < 36 hours had a higher likelihood of a transfer to ICU and higher mortality rates than expected. Cases with EDLOS of >24 hours, BWT > 12 hours and EDT >36 hours had a lower likelihood of transfer to ICU and mortality rates. Chi Square test of independence demonstrated borderline significance between medicine EIPs and mortality. When EIPs were >15, mortality was less than expected, when EIPs were < 15 mortality was higher than expected. There were no associations between ICU transfers or mortality and the number of daily admissions, occupancy rates or hospital EIPs at the time of admission. There was no association between medicine EIPs and ICU transfers.

Table 17

Chi Square Results for Mortality and Intensive Care Unit Transfers

Wait times	Mortality	ICU transfer
EDLOS	114.74***	103.57***
BWT	70.05***	20.16**
EDT	107.85***	45.52***
Medicine EIPs	6.18*	ns

*p=.046, **p=.001, ***p<.001; EDLOS=emergency department length of stay, BWT=bed wait time, EDT=emergency department time; EIP=emergency inpatient, ns=non significant

Chart Review

A chart review of 20 cases was completed, examining key processes for GIM consultation and admission in the ED and access to senior physicians and IPT members. One case was excluded as it was initially admitted under the ICU service in ED prior to transfer to GIM.

Table 18

General Internal Medicine Consultation and Admission Process Timing

	Available Cases %(n)	Median (h)	Limitations
Time ED registration to GIM consult request	42.1(8)	5.9	Lack of GIM consult request time entered in EDIS
Time from GIM consult request to GIM senior resident review	5.3(1)	0.9	Lack of date or time documented on the resident GIM consult, no GIM consult in chart. One case was seen by the GIM resident 9 minutes before formal GIM consult request
GIM consult request to senior physician review	10.5(2)	.85 – 13.25	Lack date or time documented on GIM consult by senior physician, lack of GIM consult on chart.
GIM senior consult to senior physician review	5.3(1)	1.0	Lack of date or time by the resident or senior physician on the GIM consult, lack of GIM consult on chart.
Evidence of senior physician review on date of admission	42.1(8)	-	Lack of documented time, lack of senior physician documentation
GIM consult request to admission order	26.3(5)	4.05	Lack of date or time on admission order
GIM consult to admission order	15.8(3)	2.4	Lack of consult, lack of date or time on GIM resident consult or order
GIM admission order to hospital registration (order processing)	57.9(11)	0.9	Lack of date or time on admission orders

GIM=general internal medicine

Table 19

Patient Access to Interprofessional Team Members

IPT professional	Formal physician order for consult %	Time to initial assessment from order h	Cases Seen %
Physiotherapist	42.1	37.7	31.6
Occupational therapist	36.8	29.0	31.6
Social work	15.8	-	31.6
Speech language pathologist	15.8	-	15.8
Registered dietician	5.3	-	31.6
Pharmacist	5.3	-	26.3
Respiratory therapist	0	-	100.0

IPT=interprofessional team

Patient care orders and IPT documentation were reviewed in manual charts or microfiche. Table 19 displays the number cases with physician orders for IPT assessment, time to initial IPT assessment and number of cases with IPT assessment. A number of cases were seen by IPT professionals without formal orders, primarily registered dieticians, pharmacists and respiratory therapists. There was evidence of initial consults initiated by nursing staff, primarily for social workers. All patients received oxygen therapeutically in the ED and therefore were seen by the respiratory therapists. One case left the hospital against medical advice before the IPT consults could be conducted. Review was limited by a lack of physician orders for IPT consult and a lack of date or time on order or IPT documentation. Other difficulties encountered during the chart review included missing chart pages, incorrect patient information in charts and microfiche out of order of patient admissions.

Chapter 5

Discussion

The research objectives of this study were: (a) to quantify the incidence and intensity of access block within the GIM population (b) identify patient, admission and capacity factors associated with access block and (c) determine if negative outcomes including increased IPLOS, mortality and ICU transfers were associated with access block. A chart review was conducted, exploring GIM consultation and admission processes in the ED and reviewing access to senior physicians and IPT professionals.

Incidence and Intensity of Access Block

GIM admissions at the Royal Alexandra Hospital (RAH) experienced significant access block with reduced access to inpatient beds and prolonged wait times extending beyond those cited in the literature. CIHI (2007) reported a median BWT of 2.1 hours nationally, with 10% of admissions waiting > 17 hours for an inpatient bed in large centers, 5% waiting >24 hours and a 90th percentile BWT of 17.7 hours. Comparatively, this study reports 45.8% and 29.3% of cases with a median BWT of >17 and 24 hours respectively; median BWT was 16.0 hours and 90th percentile BWT was 45.0 hours. A similar median BWT of 15.0 hours was reported by Wong et al. (2010) for the medicine population at a large urban Toronto hospital, with the BWT of medical patients double that of other services admitting patients to hospital.

The AHS (2009) performance report consistently indicates the RAH experiences higher rates of access block in comparison to other large urban hospitals and other high volume EDs in the province. AHS (2009) reports a median EDT of 5.35 hours with a 90th percentile of 18.3 hours for high volume large urban hospitals (includes RAH) and a median EDT of 7.3 with a 90th percentile of 24.6 hours for the RAH. Between 2006 and 2009, 90th percentile EDT for admitted patients through high volume EDs was 13 to

16 hours, 35 to 42% had an EDT of < 8 hours. During this same time period, 26% and 24% of admissions in large urban hospitals and RAH had an EDT of < 8 hours. This study found much higher wait times for GIM admissions with a median EDT of 43.0 hours, 90^{th} percentile of 102 hours and 1.7% with an EDT of < 8 hours. It was surprising the median EDT varies so widely from the RAH reported medians, as medicine admissions constitute a high proportion of ED admissions; however this analysis did not include the other subspecialties within medicine, which may have shorter median wait times. Alternatively, other non medicine services may have extremely shorter wait times compared to the GIM population, as similarly reported in previous studies (Gilligan et al., 2010; Wong et al., 2010). This study has a median EDT similar to Ontario's published wait times of an average EDT of 30 hours for admitted patients; however 45% had an EDT of ≤8 hours (Ontario Health Quality Council, 2010). Wait times in this study exceed previously published target wait times. The CAEP (2009) recommends BWTs of < 2 hours and EDTs of < 6 hours; the WTA (2009, 2011) measures performance with a target EDT of <8 hours. AHS has set a target of 60% of patients admitted through high volume EDs to reach an inpatient bed within 8 hours, increasing to 90% over the next 3 years (AHS, 2010b; Alberta Health and Wellness, 2010). The findings of this study would suggest that the access block experienced by the GIM population may differ from other services or subspecialties within the hospital, consistent with CIHI's previous reports (2005, 2007). Overall the RAH wait times may be primarily driven by GIM admissions.

Factors Influencing Wait Times

Patient Factors

Overall patient factors accounted for a small proportion of predicting wait times. Diagnoses remained predictive for EDLOS only. An admission diagnosis of pneumonia was negatively predictive and an admission diagnosis of delirium was positively predictive, otherwise diagnoses did not exert effects on wait times. This finding may be related to increased time to clinically and diagnostically evaluate the presentation of delirium (Grofton, 2011). Patient factors which remained negatively predictive of all wait times included older age and ICU transfer. Multiple prior studies report increased age was associated with prolonged EDLOS and BWT (Aminzadeh et al., 2002; CIHI, 2005, 2007; Ding et al., 2004; Gilligan et al., 2008, 2010; Liew et al., 2003). This study demonstrated age acted as a protective factor against wait times, with cases aged >80 years with the shortest wait times and cases 65 to 80 years with shorter wait times than cases <65 years of age. Bed management policies were in place, prioritizing older patients to available inpatient beds (Broadhurst, 2012). Older patients are usually sicker on presentation to the ED (CIHI, 2007), this may result in rapid triage and assessment in the ED with a subsequent GIM consultation for admission, explaining shorter EDLOS found in this study. Transfer to ICU led to shorter wait times, similar to Gardner et al. (2007) study and while ICU patients may experience access block (Cowan & Trzeciak, 2005), transfer to an ICU bed decreased EDT by 7.6 hours. Isolation was the only patient factor which remained positively predictive of all wait times. This is the first study to demonstrate isolation status as a significant factor prolonging wait times. There are a limited number of single rooms available in the hospital and this is likely a factor in prolonging wait times for inpatient beds. Cass (2005) described the deadly combination of overcrowded EDs and transmission of severe acute respiratory syndrome in Toronto. The impact of isolation on ED wait times merits serious consideration, as it may potentially add 7.8 hours to EDT and promote transmission of infectious organisms.

Capacity Factors

A lack of available acute care beds and high numbers of EIPs are widely considered as the major determinant of overcrowding in the EDs and hospitals across Canada, leading to prolonged wait times and increased ED occupancy (CAEP, 2005, 2009; Rowe et al., 2006; GAO, 2009). A Stochastic simulation model has previously demonstrated that if hospital occupancy is >85%, access block is discernable and at >90%, regular bed crisis will occur. A significant period of time is required to recover the balance between demand and capacity (Bagust et al., 1999). A number of prior studies have associated high hospital occupancy and EIPs with increased ED wait times (Cooke et al., 2004; Ding et al., 2004; Fatovich et al., 2005; Gilligan et al., 2008; Spirivulis et al., 2006; Wong et al, 2010). Forster et al., 2003 found the majority of prolonged EDT occurs as hospital occupancy reached rates of >90%. Dunn et al. (2003) demonstrated a BWT decrease of 37% due to a 5.9% decrease in hospital occupancy from 94.9 to 89%. The UK found hospital occupancies > 82% was a significant risk for access block (NHS, 2001). This study demonstrated wait times were significantly prolonged as variables reflecting capacity increased; however factors remaining predictive of wait times did not exert as much effect as anticipated a priori. Predictive modeling for wait times found medicine occupancy, blocked beds, EIPs and hospital FCPs persisted as positive predictors and hospital blocked beds persisted as a negative predictor of all wait times. Throughout the study, extremely high occupancy rates were noted, medicine occupancy was above 97% for 81.3% of the time and hospital occupancy was above 100% for 49.2% of the time. Capacity variables may not have exerted a stronger effect due to sustained high levels of occupancy and EIPs throughout the study period. Previous studies reporting the influence of capacity factors, reported lower occupancy rates. The effect of capacity variables on wait times may be more detectable if occupancy rates are not as persistently high, allowing for comparison of wait times among lower and higher occupancy rates. Hospital occupancy may not have persisted as a predictor due to bed managers attempts to maintain GIM admissions within the prescribed medicine bed base, protecting non medicine hospital beds for elective surgical admissions and subspecialty care, while hospital blocked beds may have been a negative predictor, as bed managers place medicine patients off service into these blocked beds.

An interesting association between BWT and volume of admissions was revealed. The volume of GIM admissions were a negative predictor of BWT. One possible explanation is the activation of bed management policies, including FCP and off service placement of patients in the hospital, therefore impacting BWT only. Strategies such as FCP and off service placement of patients are often utilized as strategies to manage large volumes of EIPs (Proudlove, Gordon & Boaden, 2003; Viccellio et al., 2009; Wong et al., 2010) and the effects are unclear. Medicine wait times were longer on the weekend, when FCP use was lowest, however as the number of FCP stretchers increased, wait times and EIP volumes increased. Wong et al. (2010) reported the practice of placing medicine patients in off-service beds did not significantly change EIPs. It is notable that medicine FCPs accounted for 77.9% of all hospital FCPs and approximately half of the study time all hospital FCPs were within medicine; medicine EIPs represented a median 78.9% of all hospital EIPs, a finding similar to Wong et al. (2010) who found the majority of hospital EIPs were GIM EIPs, concluding a lack of beds and hospital occupancy are significant determinants of EIPs and wait times.

ALC occupancy of acute care beds has been a factor identified as potentially impacting wait times via decreasing acute care occupancy (CAEP, 2005; WTA, 2011). CIHI (2007) reports 7.3% of large hospital's beds are occupied by ALC patients with median ALCs of 4 to 11. ED wait times have been previously reported to increase as the median number of ALC patients increase, an effect most evident in large hospitals (CIHI, 2007). Wait times increased with higher medicine and hospital ALCs; however ALC volumes did not remain predictive of wait times. ALC patients at the RAH occupied 10% and 27.4% of available hospital and medicine beds respectively. While hospital ALCs demonstrated a downward trend, medicine ALCs demonstrated an upward trend. The medicine program accepts ALC patient transfers from other hospital services, once the period of specialty care is complete and the patient requires an alternate level of care. Not surprisingly, 73.1% of all hospital ALC patients were occupying medicine beds. These significant numbers of ALC patients reduced the functional capacity of medicine acute care beds by approximately 25%. The effect of ALCs on wait times may be undetectable given the high occupancy rates and the burden of ALCs may directly impact GIM wait times. WTA (2011) states the most important action to improve timely care is addressing ALC volumes. AHS has set a target of reducing ALC patients occupying acute and sub acute beds through opening additional ALC beds in the province (AHS, 2011, AHW, 2010).

Capacity factors were further examined to determine how predictive they were on medicine EIP volumes. Not surprisingly, positive predictors were medicine occupancy, medicine blocked beds, medicine ALCs and medicine FCPs. Interesting negative predictors included hospital EIPs (not including medicine EIPs), hospital ALCs, hospital blocked beds and GIM admissions. It is unclear why these are negative predictors; however this may be due to the activation of bed management policies as medicine EIPs and admissions rise. Medicine admissions may have increased access to hospital 'blocked beds' in surgical or subspecialty areas for off service placement of medicine EIPs and fewer physical transfers of hospital ALC patients to medicine beds may occur. Increases in hospital EIPs that are not medicine EIPs occupy ED stretchers, limiting ED throughput and further GIM admissions.

Admission Factors

Admission factors were examined for association with wait times. Persistent negative predictors of wait times included admission in fall and admission Monday through Thursday. Year was a consistent positive predictor. ED wait times and EIP volumes were longest in 2008 and shortest in 2007. 2008 had the least volume of GIM admissions but the highest blocked medicine beds, EIPs and hospital FCPs. This may reflect the influence of a reduction in functional medicine beds on wait times and hospital patient flow. Decreased admissions may have occurred due to decreased medicine capacity, with diversion of medicine patients to other facilities. Fall demonstrated the least admissions but had high occupancy and ALC volumes. Previously, peak wait times and EIPs have been noted during fall through spring with decreases in summer months (Fatovich et al., 2005; Forster et al., 2003; Wong et al., 2010). Wait times were noted to be longer Friday through Sunday; however only admissions Monday through Thursday remained as predictors of wait times. This may be due to increased GIM discharges during the weekdays compared to weekends, continuously freeing more beds for admissions throughout the week, allowing for shorter wait times. An unexpected finding was the negative prediction of admission on Saturdays (non significant), given the long mean wait times for cases admitted on Saturdays. Saturday was noted for the least admissions and lower FCP rates, but medicine occupancy was highest on Saturday and Sunday compared to the weekdays. These findings are not consistent with CIHI (2007) report that BWT were longer on weekdays compared to weekends and longer during the fall. The majority of cases were admitted during the evening and night shift as opposed to regular daytime hours. Admission during the day shift was a negative predictor for BWT only, whereas CIHI (2007) reported admission during the day shift is associated with longer BWT. This may be due to a decreased volume of admissions during the day shift combined with increased discharges and active bed management during 'regular working hours'. Medicine EIPs were highest Sunday through Tuesday, reflecting a backlog of patient admissions and decreased discharges, compounded by potentially less active bed management on the weekend. With decreased weekend discharges, EIP volumes have been noted to increase with a backlog of patients (CIHI, 2007). Interpretation of daily wait time variation is challenging and is likely multifactorial. Admission volumes, systemic processes in the ED, whole hospital use of available beds, bed management strategies, surgical slate and ED and hospital volumes may all be factors influencing wait times may be extremely influential in explaining variability (CIHI, 2007; Proudlove et al., 2003; Rathlev et al., 2007).

Access Block and Quality Outcomes

Access Block and IPLOS

There were no significant mean differences in IPLOS among admitted cases by wait times, EIPs, FCPs, ALCs or occupancy rates at the time of admission. This is in contrast to prior published studies associating prolonged IPLOS with access block (Berenstein et al., 2009; CIHI, 2007; Krochmal & Riley, 1994). Richardson (2002) reported a longer IPLOS among patients experiencing access block compared to patients that did not experience access block. Liew et al (2003) found a dose dependent relationship between the amount of time spent in the ED, from presentation to transfer to an inpatient bed, and IPLOS. The excess IPLOS, as compared to state average IPLOS, ranged 20-50% dependent on the length of ED time. One study by Bayley et al. (2005) reported no association between EDT and IPLOS among medical patients presenting with chest pain (not requiring urgent intervention or a monitored bed). It is notable that average IPLOS of these studies were 1 to 5.85 days with average EDT of 0.72 to 7.96 hours, significantly lower than this study with a median IPLOS of 8.61 days and median EDT of 43.00. Wait times in this study are so prolonged that significant differences may not be detectable among IPLOS or IPLOS may be prolonged by other factors to the degree that wait times are not a significant contributor.

Access Block, ICU Transfers and Mortality

ICU transfers were more likely for cases with lower wait times. As wait times increased, likelihood of ICU transfer significantly decreased. Early appropriate recognitions of cases requiring a higher level of care appear to occur early in the hospital admission with appropriate transfer to an ICU bed. There was no association between ICU transfers and other surrogates of capacity or access block including occupancy, EIPs and FCPs at the time of admission. There are no previously published data reporting relationships between ICU transfer and access block as a quality outcome measure. Mortality rates demonstrated the same pattern as ICU transfers. Expired cases had a significantly lower wait times and mortality rates significantly decreased as wait times increased. These findings are contrary to other studies linking access block and in-hospital mortality. Sprivulis, Da Silva, Jacobs, Frazer and Jelinek (2006) reported increases in mortality associated with Overcrowding Hazard Scale scores calculated using hospital occupancy and EIPs. Richardson (2006) found 10 day in-hospital mortality was higher among patients admitted during ED overcrowding, as defined by ED occupancy stratified for shift, day, season and year. ED occupancy was not measured in this study and may explain results discrepant with Richardson's (2006) study. One study (Gilligan et al., 2008) did not detect any association between prolonged EDT and mortality rates. Occupancy rates may be exerting a ceiling effect on mortality rates in this study. Sprivulis et al. (2006) reported 26.5% of the admissions occurred when hospital occupancy was <90%, whereas only 2.2% of the study admissions occurred when site occupancy was <90%. In fact site occupancy was >98% for 83.1% of the study period. Similar to detecting differences in IPLOS, consistently high occupancy may not allow for detecting mortality differences. It is also of note that the RAH has had progressive decreases in hospital standardized mortality ratio (HSMR) over the last 5 years, from 93 to 66 (CIHI, 2012). This is the lowest published HSMR in the province, despite having the longest median EDT among large hospitals.

An unexpected finding was the association between mortality rates and medicine EIPs. Mortality rates were borderline higher than expected when medicine EIPs were <10 and were lower than expected when medicine EIPs were >11. No other associations between mortality and occupancy, ALCs, FCPs or hospital EIPs were detected. This finding may be due to medicine admissions proceeding to inpatient beds sooner, when medicine EIPs are lower, leaving the observation of the ED to medical units, FCP stretchers and off service beds where the level or expertise of observation is different. Another possible factor is the pressure on emergency physician workload. As there are more EIPs occupying stretchers in the ED under the care of other hospital physicians, there are smaller volumes of patients in the ED that emergency physicians are actively assessing and treating. When the EIP volume decreases, ED patient throughput increases and the demand on ED physicians increase. A similar phenomenon may occur with ED nursing staffing and observation as well. The association between mortality and EIPs is concerning and requires further review.

Minimal conclusions about GIM consultation and admission processes nor early access to senior physicians and IPT can be drawn from the chart review. There are significant lapses in documentation among staff and physicians. It is difficult to determine if the current processes of GIM consultation and admission processes in the ED are potentially affecting wait times, as suggested by a prior study (Gilligan et al., 2010). A median delay of nearly an hour was noted for the processing of GIM admission into the hospital registration. This may cause confounding data regarding BWT and cause delays in bed requests for admitted EIPs. Additionally, there is inconsistent entry of GIM consult requests into EDIS compounded by inconsistent practice surrounding the timing of entry compromising the reliability of the data.

Limitations

The study was limited as a retrospective design, relying on aggregate databases from a variety of electronic sources, as well as manually tabulated data (isolation and capacity variables), reliant on the rigor of departments collecting and maintaining data. The challenges with GIM consult request data underscore the hazards of data entry by multiple staff into electronic databases. The hospital and medicine volume variables used for analysis were collected at 1500 hours. Findings may vary if analysis examined 8 hour blocks, capturing the fluidity of patient flow throughout a 24 hour cycle or other fixed time points such as midnight censuses. Examination of ALCs was limited by a lack of ALC data on weekends and a complete medicine census was not available. The medicine census only reflected the admitted medicine patients within the medicine bed base and did not account for patients waiting beds in ED, FCPs or occupying beds on other services. It would have been informative to include a number of additional factors including medicine subspecialties, telemetry requirements (available only in the ED) and hospital data, as well as ED volumes. Co-morbidity and acuity have been noted to influence wait times however these variables were not available for analysis. The study was designed to identify associations, not necessarily causation. Additionally, there may be unidentified events impacting wait times or active initiatives to improve wait times, confounding results.

Conclusion and Implications

Overall, it is evident that the GIM population experiences significant access block in large hospitals compared to other services or sub specialties, as well as prolonged wait times in comparison to provincial and national benchmarks of wait times in large hospitals. Access block and wait times continue to be well above proposed targets. Predictive modelling did not account for a significant amount of variability among wait times. This was the first study to demonstrate a consistent impact of isolation prolonging ED wait times. The impact of isolation on wait times has been under-examined to date and the number of isolated EIPs may globally affect wait times for all hospital admissions. Bed management, daily discharges, full capacity protocols, surgical slates and discharge patterns likely influences wait times daily. Capacity factors were not as prominent influences on wait times as anticipated. This may be due to a ceiling effect exerted by extremely high occupancy rates throughout the study period. GIM has large volumes of ALCs, EIPs and FCPs, potentially leading to longer wait times with more inpatient care delivered on FCP stretchers and in the ED compared to other services. It is reassuring that given the excessive wait times, there were no significant associations with increased mortality, increased ICU transfers and prolonged IPLOS; however the influence of prolonged wait times on outcomes may not have been detected due to the consistently high wait times across the sample.

Implications for practice include continuing actions directed at decreasing hospital occupancy. It is alarming that a possible ceiling effect may be occurring within acute care institutions operating with very high occupancies, masking the effect of capacity on wait times and subsequently wait times on patient outcomes. GIM populations appear to be particularly at risk, and patient throughput should be carefully examined for inefficiencies. A review of isolation bed management strategies and infection transmission risks in the ED may be warranted. Identifying barriers to weekend discharges and focus on innovations supporting weekend discharges may be critical to maintaining patient throughput in the medicine program. Bed management does influence wait times and flow of patients however the exact effects are unclear and requires exploration from a hospital wide perspective. Further evaluation into the efficacy of strategies such as overcapacity protocols should be undertaken and the quality outcomes for medicine patients who are cared for on FCP stretchers or in off service beds should be explored to ensure patient safety is not compromised. Further exploration of EIP patterns and patient outcomes are required and ED physicians and nurses may need to examine staffing and support in relation to EIP patterns to maintain patient safety.

This study was limited in some regards due to limited documentation surrounding key time points in admission processes, access to health care professionals and complete data regarding capacity, medicine program demands and bed management decisions. Funded infrastructure may be required to capture the required data to clearly identify possible factors contributing to prolonged wait times. Frontline physicians and staff need to be aware of the importance of accurate and timely documentation or data entry into existing electronic programs, if these are to be relied on to supply data for decision making. The GIM consultation and admission processes require further review for inefficiencies and delays, given that the majority of EDT is EDLOS. Medical staffing should be reviewed to efficiently manage the volume of admissions after hours, possibly minimizing the EDLOS portion of EDT. Whole hospital patient throughput is extremely complicated and interconnected, health care administrators may need to support research examining hospital wide patient throughput, in addition to department specific initiatives. Ultimately, without correcting hospital capacity, initiatives such as MAU may not function optimally. As AHS (2011) reports the opening of more acute care and ALC beds, initiating ‘over capacity protocols and escalation plans’, new discharge processes, and 2 MAUs in the province, it is imperative that initiatives to reduce wait times are underpinned with research, tailored to hospital specific needs to maximize benefits and ensure patient outcomes are not compromised. Innovations and interventions should focus on strategies that will modify factors with high impact and target factors posing high risk to patient safety.

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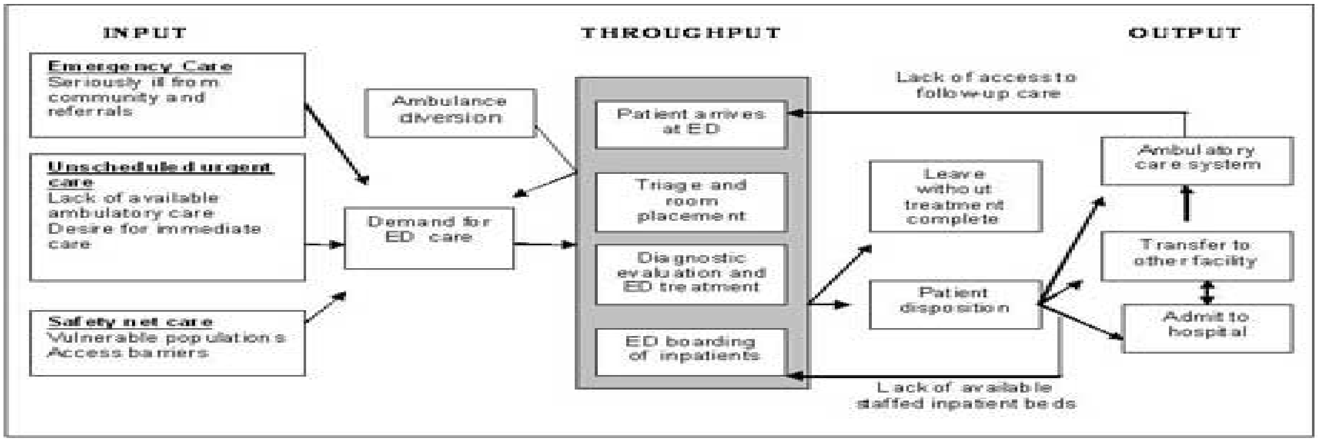
Appendix A

Emergency Department Throughput



Asplin et al., 2003

Appendix B

Recommended Medical Assessment Unit Facility and Equipment Components

1. IT support, preferably wireless
2. Monitored high dependency beds including capacity for non invasive ventilation
3. Short stay beds
4. Isolation rooms
5. Treatment or procedure rooms
6. Adequate equipment storage
7. Adequate work and office space for all staff including members of the IPT
8. Dedicated conference and teaching room
9. Adequate access to pharmacy and medication stores
10. Adequate staff facilities including staff lounge and lockers
11. Visitor lounges
12. Facilities and space for teams providing rapid outreach to ward patients or other acute care services centralized in MAU
13. Safe environment for mental health patients
14. Triage areas for direct admissions and private consultation rooms
15. Monitors to allow full non invasive monitoring
16. Access to arterial blood gas analysis
17. Equipment and support for non invasive ventilation support
18. Bedside ultrasound for central line insertion procedures
19. Treadmill stress tests

Adapted from Henley et al., 2006; RCP, 2007

Appendix C

Recommended Medical Assessment Unit Evaluation Measures

- Number of admitted general medicine patients admitted from ED that attend MAU
- EDLOS prior to MAU consultant assessment
- Bed wait times from ED to MAU
- Ambulance diversion
- Of admitted MAU patients
    - EDLOS
    - Number discharged same day or within 24h of admission
    - Number transferred to other wards within 24h admission
    - Bed wait time from MAU to transfer facility/ward
    - Mean and median MAU LOS
    - Reasons for any prolonged LOS in MAU
    - Top 10 by volume of discharge diagnoses
    - 30 day readmission rate of discharged patients
    - Mean and median time to review by consultant and/or senior physician
    - Mean and median number of allied health assessments/discipline/patient
    - Number of deaths in MAU
    - Number of adverse events in MAU
    - Number of patients receiving formal discharge or transfer summary
    - Nursing and allied health hours per patient hour
    - Indicators for pharmacy and laboratory utilization
    - Accuracy of triage assessment for admission to MAU
    - Patient and staff satisfaction surveys

    - Budget and human resource performance (including overtime, absenteeism and turnover)
- IPLOS (compared to national benchmarks)

Adapted from CEUSEU, 2004; Henley et al., 2006

Appendix D

Study Variables and Data Sources

Variable	Description	Source
EDLOS	Time from ED registration to hospital admission registration	DIMR, AHS, generated from hospital registration system and EDIS
BWT	Time from hospital admission registration to leaving the ED to inpatient bed	DIMR, AHS, generated from hospital registration system and EDIS
EDT	Total time spent in the ED (EDLOS + BWT)	DIMR, AHS, generated from hospital registration system and EDIS
Demographics	Sex, age, admission date, residence, admission and discharge diagnosis, transfer to ICU during inpatient stay, mortality	DIMR, AHS, generated from hospital registration system
Isolation status	Isolation within 24 hours of admission	Hospital Infection Prevention and Control, spreadsheets maintained by infection control nurses
GIM consult request date and time	Formal consult from ED physician to GIM service for possible admission	DIMR, AHS, generated from EDIS
occupancy	percentage of occupied available inpatient beds	DIMR, AHS, generated from regional zone reports of bed management data
ALCs	number of patients occupying available inpatient beds awaiting an alternate level of care	DIMR, AHS, generated from regional zone reports of bed management data
EIPs	admitted cases in the ED awaiting an inpatient bed	DIMR, AHS, generated from regional zone reports of bed management data
FCPs	admitted cases occupying extra stetchers, above funded bed base, on inpatient units	DIMR, AHS, generated from regional zone reports of bed management data
Mortality	in hospital death	DIMR, AHS, generated from hospital registration system
ICU transfer	ICU admission during inpatient stay	DIMR, AHS, generated from hospital registration system
IPLOS	Total time spent in hospital as inpatient admission	DIMR, generated from hospital

	registration system

EDLOS= emergency department length of stay, BWT= bed wait time, EDT= emergency department time, ED= emergency department, DIMR= data integration, measurement and reporting, AHS= Alberta Health Services, EDIS= emergency department information system, ICU= intensive care unit, GIM= general internal medicine, EIP=emergency inpatient, ALC=alternate level of care, FCP= full capacity protocol, IPLOS= inpatient length of stay

Appendix E

Capacity Variables 2007-2010

Capacity Variable	Missing %(days)
Daily admissions	0(0)
Medicine EIPs	5.9 (78)
Hospital EIPS	5.9 (78)
Medicine ALCs	32.4(428)
Hospital ALCs	32.5(433)
Medicine occupancy	6.1(80)
Hospital occupancy	5.5 (73)
Medicine blocked beds	5.4 (71)
Hospital blocked beds	5.0 (66)
Medicine FCPs	5.1 (77)
Hospital FCPs	26.5(350)

EIP=emergency inpatient, ALC=alternate level of care, FCP= full capacity protocol

Appendix E

Data Collection Tool

Random Case Number: __ __ __ __

Date/Time ED registration:

Date/Time GIM Consulted:

Date/Time Senior resident review:

Date/time Senior MD review:

Time to senior MD review (date/time consult to initial senior MD review):

Date/Time of GIM admission order:

Date/Time of Hospital Admission Registration

Date/time order:	Social work consult
	Physiotherapist consult
	Occupational therapist consult
	Speech language pathologist consult
	Pharmacy consult
	Respiratory therapist consult
	Registered dietician consult
Date/time of initial assessment :	Social work consult
	Physiotherapist consult
	Occupational therapist consult
	Speech language pathologist consult
	Pharmacy consult
	Respiratory therapist consult
	Registered dietician consult