The Physician Trainee Environment and its Associated Effects on Trainees and their Patients

by

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Abstract

Introduction: The physician trainee's work and educational environment impacts patient care and trainee learning and is understudied.

Methods: A cross-sectional survey of trainees at a paediatric hospital evaluated learning, patient care, and adverse trainee events (crashes, needlestick injury, inappropriate personal comments, assaults or threats).

Results: Completed surveys described 132 trainee months and 101 duty periods; 49 (37 %) respondents reported an adverse trainee events. Learning was rated median (IQR) of 6 (5-7) on a 10-point scale. Patient care was rated 4 or more in a 5-point scale by 93%. Multivariable analyses found staff supervision and attendance at education sessions independently associated with increased learning. Trainee adverse events were associated with seniority and working fewer nights.

Conclusion: Preliminary distribution shows questions are understood, a modest distribution of safety responses, and few positive relationships, in this single center pilot. Future iterations in multiple centers can evaluate these questions further.

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List of Abbreviations

ACGME = Accreditation Council on Graduate Medical Education

BMC = BioMed Central

CAHO = Council of Academic Hospitals of Ontario

CIHR = Canadian Institutes of Health Research

CMA = Canadian Medical Association

CPSI = Canadian Patient Safety Institute

CPSO = College of Physicians and Surgeons of Ontario

EEG = Electroencephalogram

EWTD = European Working Time Directive

FRACP = Fellow of the Royal Australasian College of Physicians

FRCPC = Fellow of the Royal College of Physicians of Canada

HIV = Human Immunodeficiency Virus

ICU = Intensive Care Unit

IOM = Institute of Medicine

IQR = Interquartile Range

MD = Doctor of Medicine

MRCP = Membership of the Royal Colleges of Physicians

NSAID = Nonsteroidal anti-inflammatory drug

PARO = Professional Association of Residents of Ontario

PGME = Post Graduate Medical Education

PGY = Post Graduate Year

RCPSO = Royal College of Physicians and Surgeons of Canada

RCT = Randomized Controlled Trial

RDoC = Resident Doctors of Canada

RDH = Resident Duty Hours

UK = United Kingdom

US = United States

Chapter 1

1 Introduction and Background

1.1 Overview

Optimizing the work and educational environments of physician trainees in post-graduate medical education programs is challenging, and requires balancing potentially conflicting stakeholder interests. The relevant stakeholders are the hospitals and healthcare system; the medical education system; and the trainees. Each of these groups has different goals and priorities, which are not always aligned. Competing priorities can create tension and result in trade offs in important areas. Decisions made frequently reflect balances between fatigue and continuity related errors; between the use of inexpensive, available trainees versus relatively expensive fully licenced/registered health human resources; and between political responses to public 'expectation' versus professional autonomy.

The work and educational environment of physician trainees continues to evolve as it changes to match the prevailing dominant ideology. The current system has developed and changed over years. It is complex with inter-related facets and relationships that are incompletely understood. Efforts are made to improve the current system. However these 'improvement strategies' may have unintentional negative consequences.

The purpose of this overall project was to gain a better understanding of the physician-training environment. To meet this objective we aimed to evaluate the physician trainee's work and education framework, and the associated effects for both physician trainees and patients. Given the complexity of the system, an evaluative approach was required that would allow incorporation of the multifaceted environment and interdependent effects. This thesis describes the piloting of a questionnaire developed to meet this purpose.

The main aims of the questionnaire were to obtain (from the perspective of physician trainees) a description of the work and educational environment and to evaluate three effects of that environment: 1) trainee learning in the workplace; 2) patient care in the

workplace; and 3) the number of adverse trainee events experienced by trainees while performing their duties. Finally the questionnaire aimed to generate data to evaluate associations between the work and educational environment and its effects (on trainee learning, patient care and adverse events experienced by trainees). Achieving these aims would provide insight into the global framework in which physician trainees work and learn.

This thesis begins by introducing the concept of medical residency and providing a broad overview of the demographics of trainee physicians in Canada. A description of the work and educational environment of physician trainees precedes a description of the stakeholder groups involved and their associated priorities. The literature on trainee learning, patient care and patient safety and adverse trainee events is explored. The second chapter is a narrative review exploring different perspectives on the role of the medical trainee in the teaching hospital environment. The third chapter describes the justification for using a questionnaire to meet the stated objectives, and the methods used to refine and pilot the questionnaire. The fourth chapter describes the results obtained from the piloting of the questionnaire and the analyses of the a-priori hypotheses. The fifth chapter provides an interpretation of the findings and discussion, a description of future directions for this project and concluding comments.

1.2 Background

1.2.1 Medical Training in Canada

Postgraduate medical education involves initial residency training and the option of subsequent fellowship training. Physician trainees have obtained their medical degree, and are enrolled in a program for a particular area of medicine. Successful completion of (at least) a residency-training program is required as a prerequisite to obtain a licence to practice medicine as an independent practitioner. The term ‘resident’ generally refers to a physician trainee in an initial training program post medical degree. This program may last up to 6 years. The term ‘fellow’ generally refers to a physician trainee performing further subspecialty training after completing a basic residency-training program. The

term ‘physician trainee’ will be used as a universal term to encompass both residents and fellows.

Physician trainees in Canada are granted an educational medical licence by the body regulating the practice of medicine at a provincial level. This licence requires trainees to be supervised by a fully licensed physician while performing their clinical duties. The content of training programs varies depending on the skills identified as important for the chosen specialty. To complete a training program, a physician trainee must meet requirements set out by an accreditation body. They must also pass certain examinations.

The majority of physician trainees in Canada obtain their medical degree in a Canadian university. A medical degree takes 4 years to complete in most universities in Canada. In the 2015-16 year there were 16,200 trainees in postgraduate programs in Canada. The Canadian Ministry of Health funded 12, 841 (79 %) of these trainees (CMA Physician Data Centre, 2017). Foreign governments funded the remaining trainees. These trainees are expected to return to the country that sponsored them once they have completed their Canadian training. The best available data on demographic details of physician trainees in Canada comes from the National Physician Survey, conducted by The College of Family Physicians of Canada, the Canadian Medical Association and the Royal College of Physicians and Surgeons of Canada in 2012. Data obtained from physician trainees across Canada included demographic details, descriptive details of their training program and their future career intentions (Survey, 2012). Responses were obtained from 1,655 (18.9%) of the 8,752 trainees invited. Responses from the family medicine residents were separated from the trainees from other specialties. The survey listed 83 possible training programs that respondents could be affiliated with. This list included sub specialty training programs. Over 66 % of respondents were affiliated with ten programs, namely anaesthesiology, diagnostic radiology, emergency medicine, general internal medicine, general surgery, internal medicine, obstetrics and gynaecology, orthopaedic surgery, paediatrics and psychiatry. The median age of respondents was 29 years. Forty-three per cent of respondents were male. Seventy three percent of respondents did not have children at the time of the survey. Most (84.5%) respondents reported being either satisfied or very satisfied with their training program. See table 1.1.

Physician trainees have dual status as practicing physician who are employed and as students affiliated with a university (Kesselheim & Austad, 2011). Physician trainees in Canada have a professional affiliation with a provincial college such as the College of Physicians and Surgeons of Ontario ((CPSO), 2017). These provincial colleges license and govern physicians. Physicians (including trainees) must obtain medical registration from a provincial college in order to practice medicine in that jurisdiction. These provincial colleges are charged with maintaining standards of practice. As the trainee's licence is granted through these governing bodies, they are subject to the general rules and responsibilities of being a physician, while working in a supervised role.

Trainees are represented at a national level by Resident Doctors of Canada (RDoC) and on a regional level by Professional Housestaff Organizations (PHO). There are seven PHOs throughout Canada. These PHOs are all members of RDoC. For example the Professional Association of Residents of Ontario (PARO) (PARO, 2017a) is the body that represents trainees working throughout Ontario. RDoC reports that it represents over 9,000 trainees working throughout Canada (RDoC, 2017). PHOs represent the personal and practice interests of trainees at the regional level. RDoC facilitates discussions among the provincial groups to achieve consensus on issues of a national interest that pertain to physician trainees.

From an educational perspective, trainees are generally affiliated with a training program that functions through a university. Within the university, the training program is managed by the Post Graduate Medical Education department, for example the office of Post Graduate Medical Education at the University of Toronto (PGME, 2017). Physician trainees maintain student status through the university throughout their training. The university manages the training program at an administrative level. The post-graduate medical education system encompasses both the physician trainers who are directly involved with education and the distinct groups of trainees affiliated with different specialties. These training programs are governed by national organizations that oversee the training of physicians. The Royal College of Physician and Surgeons of Canada oversees the medical education of specialists while the College of Family Physicians of Canada oversees the training of family physicians. These colleges mandate the

requirements of the training programs. Once the trainee has met the necessary requirements of their training program, they are eligible to sit a qualifying examination, which is set by these organizations. Passing this examination is a requirement for independent practice.

The "work" of physician trainees can be broadly described as clinical service provision and acquisition of training in their specialty. Trainees provide supervised frontline care of patients. Such clinical service is primarily for patients but is also a central element of learning for trainees, much like an apprenticeship. The Institute of Medicine report on Resident Duty Hours describes the model as "on-the-job training" as the majority of the work completed or education attained by trainees is closely attached to patient care (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). Patient care provision and education are strongly inter-related in this model. A further feature of this model is the impact of the work environment on the trainee's wellbeing. The training period for physician trainees is widely viewed as an intense period of clinical and educational 'immersion' (Iglehart, 2008). This period of 'immersion' may impact the wellbeing of the trainee. In this way there is an inter-relationship between provision of patient care, educational attainment and trainee wellbeing. A significant change in any one of these areas is likely to impact the other elements.

1.2.2 Duty hours of medical trainees

Historically, physician trainees frequently worked 'long' hours, both in Canada and internationally (Daugherty, Baldwin, & Rowley, 1998; Schwartz et al., 1992). However, for many decades now, such work practices have become increasingly scrutinised by the public and members of the medical profession. As far back as 1971, Friedman et al. studied the effect of fatigue on a clinical task. The study showed that interns that had been awake for 24 hours made almost twice as many errors when reading electrocardiograms. (Friedman, Bigger, & Kornfeld, 1971)

Formal duty hour regulations for medical trainees were put in place in New York State in 1989 when the recommendations of the Bell Commission were implemented. The Bell

Commission was a committee tasked with evaluating the training and supervision of medical trainees following the death of a young woman named Libby Zion while in the care of trainees in an emergency department of a New York hospital. This death led to a state investigation and a civil trial by Libby Zion's parents against the doctors who had cared for her. Following the grand jury's indictment of 2 trainees, the New York State Health Commissioner set up the Bell Commissions to look at systemic problems in medical training. Several recommendations were made regarding various different patient-care issues. Regarding duty hours, trainees were restricted to working no more than 80 hours a week or no more than 24 consecutive hours. The Bell Commission also recommended that an attending physician should be physically present in the hospital at all times to supervise trainees (Holzman & Barnett, 2000).

Similar regulations were implemented at a national level in the US in 2003 with the introduction of the Accreditation Council on Graduate Medical Education (ACGME) duty hour requirements for all accredited residency programs. These regulations were revised in 2011. One of the added rules was the limiting of trainees in their first year of training to a maximum of 16 consecutive hours of duty (Nasca, Day, Amis, & Force, 2010). Attempts have been made to limit physician trainee duty hours in the European Union with the European Working Time Directive (EWTD) regulations in place since 1998. This directive has attempted to limit the working hours of trainees to 48 hours per week. However there is limited official information available on compliance with the EWTD (Pargmae, Martins, Rodriguez, Christopoulos, & Werner, 2011). In Canada there are no federal regulations dictating the limits of trainee duty hours. However there are provincial rules in place (RDH, 2013)**.** The current regulations are based on contracts between trainee associations and their respective provincial jurisdiction (Temple, 2014).

In the US and Europe the emphasis in the discussion on duty hour regulations has been on the potential negative consequences to patients. Conversely in Australia and New Zealand, the justification for duty hour regulations has tended to focus on the potential negative consequences to trainees themselves, from prolonged work hours (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009).

Despite extensive debate in the literature on the consequences of duty hour regulations, no consensus has been reached on the optimal working hours for medical trainees and there continues to be disagreement on the impact of regulations currently in place. A 2007 survey of internal medicine trainees found that trainees felt unprepared to act as leaders of cardiac arrest teams in teaching hospitals (Hayes, Rhee, Detsky, Leblanc, & Wax, 2007). Concern has also been expressed that current teaching, including the limited work hours trainees are exposed to, does not prepare physicians for the 'real world' (Acres, 2004). Current duty hour regulations in Ontario, (i.e., limiting an on-call duty period to 24 hours plus time for handover) have not been shown to protect against significant fatigue or physical symptoms associated with prolonged wakefulness, in a group of ICU fellows (Parshuram, Dhanani, Kirsh, & Cox, 2004). A study comparing 2 different durations of work periods found no difference in the symptoms of physical stress associated with prolonged wakefulness when the length of duty period was decreased to 24 hours (Bismilla et al., 2011). Also it has been suggested that duty hour regulations may have contributed to increased stress in the workplace because an equal volume of work is now compressed into a shorter time period leading to higher workload intensity (Auger et al., 2012).

While there are many common objectives that unify trainees as a group, there are also several distinguishing features that set groups of trainees apart. This is particularly apparent in the debate over reduction of duty hours (Moalem et al., 2009; Zonia, LaBaere, Stommel, & Tomaszewski, 2005) and may contribute to the difficulty establishing a consensus on the issue. Training programs with an emphasis on procedural skills or those with an emphasis on acute care inpatient services have tended to express concern over duty hour regulations, while non-procedural specialties have tended to support these restrictions (RDH, 2013; P. E. Wu, Stroud, McDonald-Blumer, & Wong, 2014). Drolet et al conducted a US survey of residents regarding duty hour compliance and falsification of duty hours. Surgical residents were the most likely specialty to be noncompliant and to falsely report their duty hours. The authors also found a strong association between noncompliance with duty hour restrictions and a negative perception of the regulations. (Drolet, Schwede, Bishop, & Fischer, 2013).

Although duty hour regulations are not an explicit focus of this thesis, they play an important role in the current medical education system and are central to the evolution of the current system. They will continue to be discussed indirectly throughout the thesis and feature prominently in the discussion of patient safety below.

1.2.3 Stakeholders involved in medical training and their respective objectives

There are three major stakeholder groups who are impacted by the practices of physician trainees. These groups are the Hospital/ Healthcare system (including patients), the Postgraduate Medical Education (PGME) system, and the trainees themselves as individuals. Each of these groups has a different perspective, which is reflected in different and potentially conflicting objectives for trainees. There are potential intersections and overlaps in the interests of these different groups. The resulting tensions and associated trade-offs contribute to much of the discourse about physician trainee work and the educational environment. These stakeholders and their objectives are discussed below.

1.2.3.1 The healthcare system and its hospitals

Hospitals are a central component of the healthcare system that supports the training of physician trainees. Both the hospitals and the healthcare system have a shared main objective: providing safe and effective care to patients. However, their perspectives are different.

The main objectives of the healthcare system are to provide *sustainable*, safe and effective care for patients. This involves ensuring there is adequate care for current patients and that the demands of future patients will be met (T. E. Williams, Jr., Satiani, Thomas, & Ellison, 2009). In this way, the long-term perspective of the healthcare system requires high quality physician training. Such training should provide a sustainable supply of inexpensive, capable and competent trainees in the short term, and in the longer-term create well-qualified, independent physicians.

The main objective of hospitals is the *immediate* provision of service to current patients (CAHO, 2017). Hospitals operate within a specified budget. The resulting cost-contained service is operationalized through the efficient provision of care. Physician trainees are an affordable and efficient source of physician care that may prioritize training over salary (Phitayakorn, Macklin, Goldsmith, & Weinstein, 2015). Williams et al. estimated the cost of training a surgical specialist at $80,000 US per year, which is significantly less than employing alternatives (T. E. Williams, Jr. et al., 2009).

Trainees provide the majority of overnight in-house care in high acuity areas (Parshuram et al., 2006). Providing 24/7 in-house patient care helps meet the hospitals service-driven objectives and is predicated on the assumption that training programs ensure a baseline level of competence with supervision from hospital-appointed physicians and sufficient in-built safety systems (Osborne & Parshuram, 2014).

1.2.3.2 The Post-Graduate Medical Education system

The main objective of the post-graduate medical education (PGME) system is to ensure a high quality educational experience that leads to the creation of competent physicians, ready for independent practice in their chosen specialty, within a given timeframe. PGME training programs take pride in producing excellent clinicians to care for future patients. Training programs also encourage their trainees to contribute to research in the field and to take on leadership roles to further the field. A better academic reputation helps both the trainers and the trainees that are already enrolled in the program by attracting better candidates to enrol in that program (Flynn, Gerrity, & Berkowitz, 1993; Love et al., 2012; Parker, Petroze, Schirmer, & Calland, 2013). Furthermore a successful training program is advantageous to the program's current trainees as a good reputation helps the trainees that graduate from that program get a good job upon completion of their training.

The factors that contribute to the success of a program include program level factors and trainee level factors. At a program level, trainees at all levels must receive supervision commensurate with their level of knowledge and experience, thereby ensuring that quality patient care is provided. Furthermore the program must be aware of the strengths and limitations of their trainees both as a group and individually to ensure appropriate

guidance is provided (Kilminster & Jolly, 2000). At a trainee level, trainees should be engaged in the training they are receiving, attend the formal education sessions that are provided and also incorporate self-directed learning into their spare time. These objectives may be at odds with the objectives of the hospital. For example, attending a formal education session may pose a conflict or time delay in providing patient care in the hospital.

The particular approach to training used by a training program may depend on the specialty in question. While there are clear general objectives common to all training programs, programs are not necessarily aligned on all aspects of training. This has become particularly evident in the debate on changes in the work practices for trainees. Programs differ on what is the ideal balance between formal education and clinical experience and the level of supervision provided to trainees. Furthermore the ideal balance between formal education and clinical experience may vary between different medical specialties and even between individuals (RDH, 2013)

Time spent in the clinical setting is an integral part of training; however, among the PGME system, disagreement has emerged about the impact of reducing clinical work hours on training. There is currently a defined length set for each training program. The duration of a residency program varies between specialties but is the same length within each specialty. There is an on going debate about whether work hours (and hence time spent in the clinical setting) can be reduced (in keeping with duty hour regulations), while maintaining adequate experience within the same predefined time period.

Alongside the debate and implementation of duty hour regulations, The Royal College of Physicians and Surgeons of Canada is moving towards a competency-based model (RCoPaSoC, 2017). In such a model, graduation from a training program would depend on an evaluation of a trainee's competence in his or her chosen field of study rather than being based on a defined time period. Progress through training would be defined by the competencies achieved rather than the amount of time served (Leung, 2002).

1.2.3.3 The individual trainee

The main objective of the trainee as an individual is to obtain the required competency in their chosen field of practice to secure certification as an independent practitioner. Trainees have a short-term objective to perform their job well in order to maintain their position and to conform to the formal requirements of their physician licence. In the medium term, there is an expectation that trainees will progress along a continuum within their training program (Carraccio et al., 2016; Frank et al., 2010).

The wellbeing of the trainee may be impacted in meeting the objectives of their training and the requirements of their position. In Papp et al.'s qualitative study, trainees attested to the negative effects of extended duty hours and fatigue on their wellbeing and their ability to perform their clinical duties. (Papp et al., 2004). The impact of long duty periods may depend on the individual's tolerance for fatigue. Furthermore, trainees at different stages of training may have differing tolerance.

There are potential advantages for trainees of tolerating prolonged work hours and potential compromise of wellbeing. A recent survey of general surgery trainees in the US asked why they had exceeded work-hour restrictions. Forty three per cent of respondents reported that it was expected of them while 24.1% of respondents reported external pressure from authority figures (Bennett, Finch, Vuong, McDonald, & Rennie, 2016). In keeping with the concept of an apprenticeship, there is pressure to maintain good standing as a trainee. Creating a good reputation may improve standing within a training program and among supervisors. Trainees must be mindful of their longer-term objective of graduating and transitioning to independent practice, ideally with a strong reference to support them in their entrance to the job market. Certain job markets in medicine are very competitive and the prospect of successful employment following the completion of a training program may be influenced by the reputation created during training.

1.2.4 Three core features of medical training

The areas of trainee education, patient care and the risk of trainee adverse events are three important (and potentially conflicting) areas that are impacted by the structure and

framework of physician training. Inter relationships exist between these areas that can lead to trade offs and tensions between trainee-relevant outcomes. For example patient care may be jeopardised to ensure that trainees gain independence; the risk of adverse trainee events may be increased to maximise trainee learning through prolonged duty periods; patient care and safety may be compromised by fatigued trainees; and fatigued trainees may continue working to meet the expectations of their position despite feeling too tired to do so. The existing literature on these three areas of physician training will be explored below, followed by a discussion of some of the relevant trade offs.

1.2.4.1 Trainee learning

Medical training uses an apprenticeship model (Dornan, 2005). The education of trainees is achieved from the trainees' cumulative clinical exposure and direct participation in patient care, informal and formal interactions with supervising educators, attending formal education sessions and personal study. In this way trainees obtain the necessary knowledge required to transition to independent practice. In an effort to standardise the expectations and objectives of physician trainees, medical educators in Canada have developed a framework to focus on the outcomes of training, namely the CanMEDs framework. This framework outlines the abilities physicians require to effectively care for their patients (Frank & Danoff, 2007; RCPSO, 2017).

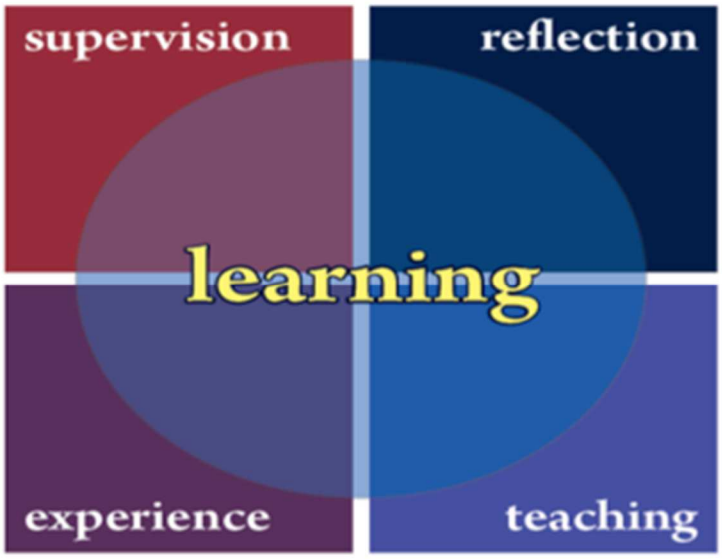

Figure 1.1: **The trainee learning experience**

Three cardinal educational principles underlie quality trainee education: (1) assuming responsibility for patient care with decreasing supervision over time; (2) adequate time allocated for formal learning; and (3) continuity of care with individual patients to understand the natural history of illness (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). The development of professionalism should occur alongside the development of these principles of medical education.

Within this education model both education and clinical experience is obtained by providing direct patient care. However excessive workload can limit the educational value of the patient care provided (Galvin & Buys, 2012) and certain tasks may be considered of more educational value than others. Some training programs have been accused of prioritising the provision of clinical service over clinical education (Quinn & Brunett, 2009) leading to a service versus education debate. Exploitation of trainees as a cheap source of labour has been described since the introduction of training programs in the US in the early twentieth century (Ludmerer & Johns, 2005) and anecdotally continues today in some programs (Reines, Robinson, Nitzchke, & Rizzo, 2007). Haney et al. suggest that either too many or too few patients can result in sub-optimal learning for the trainee. The question of what volume of patients maximises educational value for trainees is dependent on several factors such as the acuity of the patient, the complexity of the case, the seniority of the trainee and the nature of the clinical problem(s). (Haney et al., 2006).

The impact of fatigue and working for long periods of time on education for physician trainees is unclear. Medical learning (both from didactic sessions and training of practical skills) may not be impaired by fatigue or length of shift duration (Jensen et al., 2004; Smith & Parshuram, 2008). One study actually showed an improved performance in sleep-deprived paediatric trainees on a practical skill and no significant effect on a cognitive task (Storer, Floyd, Gill, Giusti, & Ginsberg, 1989). Other studies have shown unchanged performance on simulation tools (DeMaria, McBride, Broderick, & Kaplan, 2005), and cognition, discernment, and rapid eye-hand coordination (Deaconson et al., 1988). However there is consistent laboratory evidence that sleep is important for

memory consolidation (Stickgold, 2005). Medical knowledge test scores have been shown to be negatively impacted by sleep deprivation (Jacques, Lynch, & Samkoff, 1990) and in a simulated surgical training environment, fatigue was shown to have adverse effects on technical ability in simulated procedures (Eastridge et al., 2003). Alhola and PoloKantola showed that both acute total and chronic partial sleep deprivation have negative effects on attention and working memory (Alhola & Polo-Kantola, 2007). However the authors highlight that there are inconsistencies in these findings and difficulty in standardising studies on sleep deprivation. Furthermore there is individual variability and differences based on age and gender that complicate the picture. The authors state that a more thorough evaluation of the impact of partial sleep deprivation (in particular) on higher cognitive functions is needed. These findings highlight the contradictory nature of the research in this area and the need to interpret findings within the specific context studied.

Concern has been raised that reducing trainee duty hours may limit attendance at formal academic sessions, could lead to a more fragmented training experience (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009) and may increase the density of the work carried out by trainees within the restricted time window (Auger et al., 2012). Several studies have attempted to evaluate the impact of duty hour regulations on graduate medical education. A 2011 systematic review looked at the impact of duty hour regulation on postgraduate training and found that reducing working hours to less than 80 hours a week had not adversely affected postgraduate training in the US (Moonesinghe, Lowery, Shahi, Millen, & Beard, 2011). The authors reported that the reduced hours in the UK had been insufficiently evaluated in high quality studies to draw a conclusion on the issue in the UK. Conversely a study of surgical trainees suggested that regulations reducing duty hours have decreased the exposure trainees get to patients and have thus had a negative impact on training (Ahmed et al., 2014). Furthermore a Canadian study of paediatric trainee's on-call duties showed reduced supervision and direct patient care following 2009 duty hour restrictions (Bismilla et al., 2011).

Providing adequate medical training is challenging. The field of medicine is continuously evolving (Alper et al., 2004) and training programs need to adapt to new expectations that arise, such as those outlined in the CanMEDs framework. Such expectations need to be met within the constraints of duty hour regulations and while ensuring adequate patient care. A better understanding of the factors contributing to or detracting from physician trainee learning would be useful to further inform practice.

1.2.4.2 Patient safety

Patient safety is the second core feature of the physician training process to be discussed. Patient safety is a concept that encompasses behaviour intended to minimize harm to patients through the formation and maintenance of an effective care system (Albrecht, 2015). The World Health Organization defines patient safety as "freedom, for a patient, from unnecessary harm or potential harm associated with health care" (Walton et al., 2010). A related concept is that of 'adverse events' which are injuries caused to patients by healthcare, rather than by the patient's underlying condition, leading to disability (prolonged length of stay, morbidity at the time of discharge, or death) (Baker et al., 2004). Notwithstanding the human burden to patients and providers, adverse events also have a significant financial impact (CPSI, 2012).

'To Err is Human' (Institute of Medicine Committee on Quality of Health Care in, 2000) is a landmark Institute of Medicine report that laid out a strategy to reduce preventable harm in the US healthcare system. Prior to and since the publication of this report, there have been several studies published internationally, looking at the rate of adverse events in hospitalised patients, with consideration for the significant implications for patients and the impact on the use of healthcare resources. In 1991 a study looking at adverse events and negligence in hospitalised patients in New York State found that adverse events occurred in 3.7% of the hospitalizations and that 27.6% of the adverse events were due to 'negligence' (Brennan et al., 1991). In 1995 an Australian study found 16.6 % of the admissions studied were associated with an adverse event that resulted in disability or a longer hospital stay for the patient (Wilson et al., 1995). In 2000, a study of adverse events and negligence in hospitalized patients in Utah and Colorado had similar findings

to the aforementioned study of patients in New York State, reaffirming that iatrogenic injury continued to be a significant public health problem (Thomas et al., 2000).

The 2004 Canadian Adverse Events Study found an overall incidence rate of adverse events of 7.5% in the study, suggesting that there could be a preventable adverse event in up to 70,000 annual hospital admissions in Canada (Baker et al., 2004). Furthermore, the Canadian Paediatric Adverse Events Study published in 2012 found a rate of 9.2% (Matlow et al., 2012). In a recently published study looking at patient safety in Canadian ICUs, the rate of adverse events was found to be 78.7 per 1000 patient days (Parshuram et al., 2015). Both the Canadian Adverse Events Study and the Canadian Paediatric Adverse Events Study found higher rates of adverse events in academic centres. There are several factors that may contribute to this finding, including higher complexity of care, a higher number of caregivers including supervised trainees, increased handovers between trainees, and different standards of documentation (Matlow et al., 2012).

1.2.4.2.1 Patient safety and duty hour regulations

Patient safety has featured prominently in the discussion and justification for duty hour regulations, with the expectation that trainees working prolonged duty hours would correlate with compromised patient safety. As previously mentioned, in 1971 Friedman et al. showed the potential negative effect of fatigue on a cognitive task in physician trainees. (Friedman et al., 1971) A further study supporting this suggestion was by Dawson et al. This study equated the impact of 24 hours of sustained wakefulness on cognitive psychomotor performance to the performance deficit observed at a blood alcohol concentration beyond the legal driving limit (Dawson & Reid, 1997). There is also evidence of significant physical symptoms of fatigue in 70% of on-call shifts (Parshuram et al., 2004). However, the general impact of fatigue on performance in the clinical setting remains unknown, and findings from research studies have been inconsistent.

Several studies have looked at the issue of whether duty hour regulations have improved the safety of academic centres. Work hour reforms implemented in 1989 in New York State were not associated with changes in serious outcomes. However these regulations

were associated with delayed test ordering for patients and increased in-hospital complications (Laine, Goldman, Soukup, & Hayes, 1993). In 2004 Landrigan et al failed to show that shorter work schedules produced a significant difference in preventable adverse events (Landrigan et al., 2004). A 2007 retrospective study tracked mortality rates in patients admitted to teaching hospitals between January 2001 and December 2004 and found a 0.25% absolute reduction in mortality among medical patients in teaching hospitals following the implementation of the Accreditation Council on Graduate Medical Education (ACGME) work-hour regulations on July 1, 2003 with no difference observed in the mortality rates of surgical patients (Shetty & Bhattacharya, 2007). Volpp et al., in a study also published in 2007, found that the ACGME duty hour reform was not associated with any change in mortality of Medicare patients in the first 2 years after implementation (Volpp, Rosen, Rosenbaum, Romano, Even-Shoshan, Wang, et al., 2007). A study by the same author found that the ACGME regulations were associated with relative improvement in mortality in 4 common medical conditions in Veterans Administration hospitals. No mortality changes were identified for surgical patients (Volpp, Rosen, Rosenbaum, Romano, Even-Shoshan, Canamucio, et al., 2007). Further studies have assessed the impact of the additional restrictions implemented by the ACGME in 2011. There was no significant change identified in surgical patient outcomes following these reforms (Rajaram et al., 2014; Scally, Ryan, Thumma, Gauger, & Dimick, 2015). Furthermore a recent non-inferiority trial compared the current, standard ACGME duty hour policies with a flexible, less restrictive duty hour policy in surgical training programs in the US and found non-inferior patient outcomes and no significant difference in the trainee's perception of wellbeing or their education quality in the flexible policy group (Bilimoria et al., 2016). These studies appear to support the idea that the changes may have improved outcomes for medical patients but not for surgical cases. Further work will need to be done to confirm whether this trend continues to be supported.

Reasons why the literature has not established the expected relationship between decreased trainee duty hours and increased patient safety are discussed in more detail in the paper 'Delinking patient safety from duty hours' which is published in chapter 2 of this thesis.

1.2.4.2.2 Patient safety and continuity of care

Inadequate handover of patient information from one physician to another has been isolated as one of the most common factors contributing to adverse patient events in hospitals (Sutcliffe, Lewton, & Rosenthal, 2004). It has been well documented that handover of care is imperfectly done (Gandhi, 2005). The changes in work schedules are leading to shorter durations of continuous duty and subsequently more handovers of care are required. Three different trainee schedules in the Intensive Care Unit were evaluated looking at the effects of the schedules on patient safety, trainee wellbeing and continuity of care. The study compared a 24-hour schedule, a 16-hour schedule and a 12-hour schedule. During a weekday, in the 24-hour schedule there was one full and one graduated handover; in the 16-hour schedule there were 2 full handovers; and in the 12-hour schedule there were 2 full handover and one partial handover required. Trainees worked more hours per week in the 24-hour schedule compared with the 16-hour schedule and more in the 16-hour schedule compared with the 12-hour schedule (Parshuram et al., 2015). This highlights the increased need for handovers of care in a schedule incorporating shorter shifts and the increased demand on trainee numbers with shorter shifts. Reducing duty hours places more emphasis on the need for quality handover of care. The quality of handovers was improved with the implementation of a multicentre handoff-improvement program described by Starmer et al. There was a 30% (4.7 vs. 3.3 events per 100 admissions, $P<0.001$) decrease in the rate of preventable adverse events with improvements in communication (Starmer et al., 2014).

1.2.4.2.3 Patient safety and supervision of trainees

The appropriate supervision of trainees is considered an integral aspect of achieving adequate clinical care in a teaching hospital. Close supervision of trainees has been shown to be associated with fewer errors and improved quality of care (Baker et al., 2004; Mitchell et al., 2005). Direct supervision of residents in emergency departments was associated with improved compliance with clinical care guidelines (Sox et al., 1998). In the outpatient setting, it has been shown that direct in-person supervision by faculty affects the management plan of patients (Gennis & Gennis, 1993). Fallon et al have

shown a statistically significant relationship between increased attending physician involvement and decreased complication and mortality rates (Fallon, Wears, & Tepas, 1993). Farnan et al. reviewed published studies looking at the effect of clinical supervision on patient and educational outcomes and found enhanced clinical supervision of trainees was associated with improved patient- and education-related outcomes (Farnan et al., 2012).

Under-supervision has been shown to be a potential threat to patient safety and a cause of adverse patient outcomes. Furthermore, a study of closed malpractice claims found that imperfect supervision and teamwork were the most common contributing factors (Kennedy, Lingard, Baker, Kitchen, & Regehr, 2007; Singh, Thomas, Petersen, & Studdert, 2007). Consequently improvement in supervision levels by the most responsible physician was one of the recommendations made by the Bell commission (Holzman & Barnett, 2000), in the US 2009 IOM report (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009) and was also highlighted within the recommendations of the Canadian Report by the National Steering Committee on Resident Duty Hours: 'Fatigue, risk and excellence: Towards a Pan-Canadian Consensus on Resident Duty Hours (RDH, 2013).

Figure 1.2: **Trainee relevant contributors to patient safety**

1.2.4.3 Trainee wellbeing and adverse trainee events

The third and final core feature of the physician training process to be discussed is the wellbeing of the trainee and the risk of adverse trainee events involved in carrying out their work. As mentioned above, in Australia and New Zealand, the wellbeing and safety of fatigued healthcare professionals has been the primary rationale for duty hour regulations (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). The transition through the physician trainee process is a period of significant personal commitment involving personal opportunity costs. This training period demands many hours dedicated to the acquisition of technical and other professional skills, independent study and group education. This must be done while providing frontline care to patients. A qualitative study used semi-structured interviews to elicit descriptions of wellbeing in residency from residents in Baltimore, Maryland. In these interviews the residents identified their residency as a time of "temporary imbalance", during which they pursued professional development at the expense of family, social contact, and physical activity: this affected mental, spiritual, and financial domains (Ratanawongsa, Wright, & Carrese, 2007). Trainees and early career physicians in the US have been shown to have higher rates of burnout compared to their peers in the general population. This pattern was consistent at all stages (medical student, residency and early career physicians) (Dyrbye et al., 2014).

A potential contributor to burnout is the occurrence of adverse trainee events in or en route to the workplace, which may compromise the safety of the trainee. Studies have shown higher motor vehicle accidents during residency, in particular following an extended shift. In a study of Emergency Medicine residents, 8% of residents reported having 96 motor vehicle accidents and 58% of residents reported being involved in 1,446 near-crashes. The majority of the crashes and near-crashes occurred following the night shift (Steele, Ma, Watson, Thomas, & Muelleman, 1999). A further study by Barger et al. found that residents were 2.3 times more likely to report a motor vehicle accident after an extended work shift and were 5.9 times more likely to describe a near-miss incident after an extended work shift, as compared to a shift of standard length (Barger et al., 2005).

There is an inherent risk of needlestick injuries involved in the work of some trainee physicians. A 2007 review of needlestick injury in surgical trainees found that 99% of trainees had suffered a needlestick injury by the time they reached their final year of training and for 53% the injury had involved a high-risk patient (Makary et al., 2007). A more general survey of trainees from a variety of specialties found that 74% of respondents surveyed had suffered at least one needlestick injury (Heald & Ransohoff, 1990). A survey of Emergency medicine residents reported worrying about their own safety while working in the Emergency Department. The most feared event was a needlestick injury from a HIV-positive patient (Anglin, Kyriacou, & Hutson, 1994).

The issue of interpersonal safety in the workplace is a potential stressor for all physicians (both in training and fully qualified). A 1995 cross-sectional survey of Canadian internists found that 75% of the internists surveyed had experienced psychological and emotional abuse by patients and 38% of the women and 26% of the men had experienced physical assault by patients (Cook, Griffith, Cohen, Guyatt, & O'Brien, 1995). Furthermore a 1996 study of trainees from seven different residency programs at McMaster University found that psychological abuse was reported by 50% of the trainees and other respondents reported physical assault at the hands of patients or their family members (Cook et al., 1996). A 2014 meta-analysis of 51 studies looking at harassment and discrimination in medical training demonstrated high prevalence of perceived harassment or discrimination during training – the most common form of harassment was verbal harassment with a prevalence of 63%. The most common source of harassment was supervising physicians, followed by patients and their families.

The effect of such negative experiences in the workplace is unknown. However there are high rates of depression and burnout among physician trainees, which may be related to such findings. A recent systematic review estimated the prevalence of depression or depressive symptoms among resident physicians at 28.8% and highlighted the need to find effective strategies to prevent and treat depression among trainees (Mata et al., 2015). Furthermore a study of internal medicine residents in the US found that 51.5% of respondents described overall “burnout” (West, Shanafelt, & Kolars, 2011).

Willingness to make a certain amount of personal sacrifice may be considered necessary during physician training. However, the risk of adverse trainee events and their potential negative consequences is poorly understood and a better understanding of these risks would allow protective measure to be put in place to control against them where possible.

1.2.4.4 Potential inter-relationships and tensions

Inter-relationships exist between trainee learning, patient care and trainee wellbeing. These inter-relationships impact the behaviour of the relevant stakeholders involved and are relevant to understanding their actions.

Trainee learning and patient care are linked. As described above, clinical experience obtained through treating patients is an integral aspect of how trainees learn in the profession of medicine. The hospital system relies on trainees to provide a continuous physician presence, which is a necessary element of providing safe care to patients. However there are potential disadvantages to the hospital system associated with the use of providers that are explicitly recognized as trainees. Residents may provide inferior care compared to independent physicians. Baker et al found higher rates of adverse events in teaching hospitals (Baker et al., 2004). The quality of the care that an individual trainee can provide will depend on several factors including the level of seniority of the trainee, the quality of formal education sessions provided to trainees and the trainee's ability to study in their own time. Trainee wellbeing may also impact the quality of care provided (Wallace, Lemaire, & Ghali, 2009).

The system has several protective factors inherent in the functioning of the hospital to preserve patient safety and improve care while allowing for trainees to gain experience and learn. Supervision of residents is a fundamental protective factor. Residents are supervised in a graduated fashion throughout their training to ensure the safety of patients and to provide training to residents. The hospital system includes verifications of orders by nurses and pharmacists, and computer systems that highlight discrepancies or errors where possible (Jena & Prasad, 2013). The organization of the wards and the delegation of patient numbers allows for the adequate supervision of trainees by supervisors. The

hospital system facilitates structured handovers which are crucial to patient care but also provide a teaching opportunity for residents.

The training requirements of residents can create a tension for the hospital system. The hospital needs to provide continuous, affordable physician coverage to inpatients. Trainees are required to attend formal education sessions and attendance at these sessions may interrupt the continuous delivery of care to patients. For the hospital system the provision of resident education and resident wellbeing would be of lower priority than the provision of patient care. Furthermore residents may increase procedural or operative times and induce delays in discharge and interpretation of tests (Hernandez-Irizarry, Zendejas, Ali, Lohse, & Farley, 2012).

A further tension exists between the benefit of continuity in care and the problems related to fatigue for the individual trainee. Trainee wellbeing may be impacted by prolonged work hours. However limiting the duty hours worked by trainees leads to more handovers in care, which may impact patient care and potentially jeopardise patient safety. Extended work shifts improve continuity while shorter shifts have been associated with worsened patient outcomes in some cases (Goitein, Shanafelt, Wipf, Slatore, & Back, 2005).

1.3 Summary

The aim of this work is to gain a better understanding of the experience of physician trainees in Canada to support evidence-based policy. The trainee's role is multifaceted. There are different stakeholders involved, each of whom has different objectives. The trainee aims to meet the needs of their patients, the postgraduate medical education system and their own personal needs. Simultaneously meeting these objectives is challenging, and may involve trade-offs at a clinical and a personal level.

There are relationships between the core areas of trainee learning, patient care and trainee wellbeing. The importance of each area can vary by stage of training, motivation of the trainee and may be impacted upon by personal factors such as fatigue resistance. Despite an extensive body of research and opinion papers on the relevant issues, the current literature tends to separate the concepts and generally focuses on the aforementioned

areas in isolation. This project aims to look at the relevant issues simultaneously to improve our understanding of outcomes in each area and of the potential trade-offs between areas.

Table 1.1: Demographics and levels of stress and satisfaction reported by medical residents from the 2012 National Physicians Survey.

Characteristic	**All residents (n = 1655)**	**Family medicine residents (n = 502)**	**Other specialty residents (1153)**
Level of training - PGY 1 - PGY 2 - PGY 3 - PGY 4 - PGY 5 - PGY 6 or other		 N (46.8%) N 46.4% N 6%	 N (22.1%) N (20.5%) 22.9% 18.5% 10.9% 4.3%
% In final year of residency	23.3%	40.6%	15.8%
Median age	29 years	28 years	29 years
Male	39.9%	32.7%	43.1%
% Born outside Canada	18.4%	17.3%	18.8%
Married or living with partner	54%	54.6%	53.7%
No children	73.4%	74.3%	73.0%
MD not completed in a Canadian university	11%	15.3%	9.1%
% 'Satisfied' or 'Very Satisfied' with residency training program	84.5%	85.5%	83.9%
Level of stress associated with finding employment at the end of residency: - very stressful - somewhat stressful	 19.9% 47.1% 43.4%	 N (8.2%) 41.6% 43.4%	 25.0% 49.5% 19.9%

- not stressful			
% expecting debt of over $100,000 after completion of residency	33.4%	34.4%	33.1%

Chapter 2

The following paper by the present author is a narrative review discussing the issue of resident duty hours and their impact on patient safety. It is published in the BMC medical education supplement 2014, Vol.14 Suppl 1, pp.S2 (Osborne & Parshuram, 2014).

2 Delinking Resident Duty Hours from Patient Safety

2.1 Introduction

The ideal resident duty schedule to maximize patient safety has not yet been identified. In fact, the notion of an ideal schedule may be too simplistic given the diversity of residency programs and training requirements, variations in clinical workload, and differences between individuals with respect to personal preferences and tolerance of fatigue. As such, the creation of a resident duty schedule that maximizes patient safety may be an inappropriate, albeit well-intentioned, aspiration.

In this narrative review we focus on the relationship between resident duty hours and patient safety. We describe the well-recognized relationship between fatigue and error, and the seemingly contradictory evidence that suggests that a reduction in the number of duty hours is not associated with improved patient safety. Next, we explore four possible reasons why the literature has not confirmed the popular expectation that shorter duty hours improve patient safety. First, it is possible that the fatigue arising from resident duty hours is a relatively minor determinant of significant medical error. Second, duty hours may be only a minor factor contributing to resident fatigue. Third, it is possible that the adverse consequences of duty hour reduction will counterbalance any beneficial effects of reduced fatigue. Fourth, the service provided by residents may be of limited consequence to patient safety. While there may be other scientifically or socially valid reasons for duty hour reduction, these are outside the scope of this review.

2.2 The relationship between resident duty hours and patient safety

When evaluating research describing resident duty hours and patient safety, one must carefully consider study design and the patient safety outcome(s) presented. It is important to separate intermediate outcomes such as potential errors, errors without clinical consequence, and perceptions of safety from definitive patient outcomes such as harmful errors, preventable harm, mortality rates, and risk-adjusted mortality rates.

The greatest volume of evidence linking prolonged resident duty hours to compromised patient safety derives from the laboratory-based evaluation of sleep deprivation and performance. This includes the popular work by Dawson and Reid (Dawson & Reid, 1997) and other studies that align the effects of sleep deprivation with that of alcohol ingestion (Arnedt, Owens, Crouch, Stahl, & Carskadon, 2005; Bartel, Offermeier, Smith, & Becker, 2004). Other laboratory work suggests that progressive increases in sleep deprivation are associated with slower reaction times and decreased performance on other tests. A meta-analysis of 60 studies on sleep deprivation (with a total sample of 959 resident physicians and 1,028 non-physicians) evaluated performance in resident physicians and found a 1.5 standard deviation reduction in performance in a wide variety of tests after less than 30 hours of continuous wakefulness. This review found greater effects of sleep deprivation in non-physicians as compared with resident physicians. The authors attributed the differences between resident physicians and non-physicians to chronic sleep deprivation in the resident controls and to differences in the amount of sleep before the study period (Philibert, 2005). Studies using self- reported and objective measures of residents' sleep confirm that acute sleep deprivation is routine, but question the frequency of chronic sleep deprivation and suggest that on-call residents do sleep while they are on duty (Arora et al., 2008; Baldwin, Daugherty, Tsai, & Scotti, 2003; Bismilla et al., 2011; Parshuram et al., 2004; Smith M, 2005), as do physicians in independent practice (Ferguson et al., 2010).

The findings of a single-centre study by Landrigan and colleagues of 20 interns working in an adult intensive care unit (ICU) (Landrigan et al., 2004; Lockley et al., 2004; Smith M, 2005) are often cited as compelling evidence in favour of reducing resident duty hours (Maschmann et al., 2012). This research used a randomized crossover design to compare 16-hour duty periods (intervention schedule) with 30-hour duty periods (traditional schedule). Rates of errors and

adverse event outcomes were obtained by multiple concurrent methods. This study found a higher rate of serious medical errors in the traditional schedule than in the intervention schedule (136.0 versus 100.1 per 1000 patient-days, $p< 0.001$). Importantly, the serious medical errors outcome included errors with the potential to cause harm. The definitive outcomes reported were preventable adverse events (harmful errors) and mortality. There were no differences between the intervention and traditional schedules with respect to harmful errors in the ICU (38.6 and 38.5 per 1000 patient-days, respectively, $p = 0.91$), and mortality was not significantly higher in the intervention schedule (12.7% versus 14.5% $p = 0.55$) (Landrigan et al., 2004). On average, alertness was lower in the 30-hour duty period; however, in four (20%) interns, an indirect electroencephalogram (EEG) measure suggested lower alertness during the 16-hour duty period (Lockley et al., 2004). These sleep and alertness data raise questions about a number of factors, including the generalizability of the conclusion that "less is more" to all first-year residents (or other physician groups), the adequacy of the sample size studied, and the relevance of resident sleep and sleepiness to harmful medical errors.

These randomized controlled trial data, along with other health services data showing time-related improvement in patient outcomes, call into question the notion that reducing resident duty hours improves patient safety (Landrigan et al., 2008). Apparent improvements in outcomes over time in before-and-after studies of duty hours and other "safety interventions"(Fletcher, Reed, & Arora, 2011; Han et al., 2005) may be explained by other factors, including secular trends showing improvement in hospitals with and without residents (Volpp, Rosen, Rosenbaum, Romano, Even-Shoshan, Canamucio, et al., 2007). As well, these studies may, in fact, show only minimal change after the introduction of duty hour regulations (Landrigan et al., 2010).

These data, summarized in the Institute of Medicine (IOM) report, suggest that, overall, resident duty hour reduction does not improve – nor does it worsen – meaningful patient safety and quality outcomes (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). The IOM report states that "patient safety is affected by many factors and the research data available did not make it possible for the committee to assess the current level of all risks to patients or the degree to which fatigued residents contribute to patient harm" (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009) (emphasis added). Four explanations for this apparent contradiction of public expectation are explored below.

2.2.1 Resident fatigue is a minor determinant of harmful errors

In the discourse on harmful medical errors, resident fatigue is frequently "implicated" as a significant causal factor (Fletcher et al., 2008; Williamson, Webb, Sellen, Runciman, & Van der Walt, 1993; A. W. Wu, Folkman, McPhee, & Lo, 1991). Here we suggest that the relative contribution of fatigue to medical errors may be overstated, and that studies reporting harmful and other errors need to account for the duration of clinical exposure.

Evaluating the relative contribution of fatigue to significant medical error is challenging (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). The ubiquitous, ill-defined notion of "fatigue" may be used as a proxy for other more specific individual- and system level factors, including limited experience, limited content or patient-specific knowledge, high workload, and inadequate supervision. Studies focused primarily on these factors report that they are more frequently associated with medical errors than is fatigue (Bartlett, Blais, Tamblyn, Clermont, & MacGibbon, 2008; Brennan et al., 1991; Dean, Schachter, Vincent, & Barber, 2002; Rex, Turnbull, Allen, Vande Voorde, & Luther, 2000; E. S. Williams, Manwell, Konrad, & Linzer, 2007; Zandieh et al., 2008). Notable examples where fatigue has displaced discussion and recognition of other more important factors include the Libby Zion case, in which trainee experience, seniority, and supervision (Holzman & Barnett, 2000) were highlighted but subsequently downplayed, as well as Landrigan and colleagues' landmark study of newly graduated physicians practicing in tertiary-quaternary adult ICUs (Landrigan et al., 2004; Lockley et al., 2004).

A second factor is the exposure effect associated with working longer hours. It is reasonable to expect that individuals who work longer hours will observe or experience a greater number of harmful and other medical errors than those who work shorter hours, simply by virtue of their longer exposure to clinical situations. To date, this "exposure effect" has received limited attention in the literature (Dembe, Delbos, & Erickson, 2009; Jagsi et al., 2005). Studies describing associations between self-reported physician burnout and/or depression and both longer duty hours and medical errors also overlook the effect of clinical exposure on these potentially correlated outcomes (Fahrenkopf et al., 2008; E. S. Williams et al., 2007). Uncritical acceptance of the results of these studies by clinicians and the public further perpetuate the

notion that “long shifts” equate with “bad care.” In turn, this may fuel the demand for reform and shift focus and resources from other, more effective, safety mechanisms.

2.2.2 Resident duty hours are a minor component of resident fatigue

If we accept that the relative contribution of fatigue to harmful and other medical errors is significant, then the contribution of duty hours to resident fatigue warrants closer consideration. The origins of resident fatigue are multi-factorial (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). Attributing fatigue mainly to hours of continuous duty and total duty hours is likely to be an over-simplification that overlooks workload, circadian rhythm disruption, tolerance of sleep loss, and other sleep-related factors (Parshuram, 2006).

Workload during the duty period (both on-call and during regular days) is an important source of resident fatigue. Workload varies significantly between rotations, specialities, and duty periods, and it is associated with reduced opportunities for on-call sleep (Arora et al., 2008; Bismilla et al., 2011; Parshuram et al., 2004). At best, workload is independent of duty hour reduction. However, after duty hour reduction, workload-associated fatigue may be increased if the same work is compressed into fewer hours, and low workload rotations may be transformed into high workload rotations.

The degree of fatigue experienced by residents is influenced by factors such as disruption of the circadian rhythm and their individual tolerance of sleep loss. Working at night disrupts the circadian rhythm in physicians (Kuhn, 2001; Smith M, 2005), nurses (Gold et al., 1992), and other shift workers (Takeyama et al., 2005). Consequently it may be difficult to separate the effects of prolonged wakefulness or prolonged shift duration from those of shorter overnight work periods.

The role of personal preferences and tolerances (Katzenberg et al., 1998) in the genesis of resident fatigue (sleep deprivation) also warrants consideration. An increased number of opportunities to sleep arising from duty hour reduction may not be paralleled by similar increases in the hours of actual sleep. In Landrigan and colleagues’ research, each hour of duty hour reduction was associated with only 20 minutes of increased sleep (Landrigan et al., 2004; Lockley et al., 2004). Other factors, including parenting, other family commitments, financial

pressures, and educational requirements will also contribute to resident fatigue and burnout (Baldwin & Daugherty, 2002; Collier, McCue, Markus, & Smith, 2002; McCann, Knudson, Andrews, Locke, & Davis, 2011).

2.2.3 There are adverse consequences of reducing resident duty hours

If one accepts that the available laboratory and observational data indicate that resident fatigue influences patient safety outcomes, then it is still reasonable to ask whether the reduction of resident hours might nonetheless have harmful effects. The question then arises: "What factors counterbalance the beneficial effects of reduced resident fatigue?" One commonly articulated factor is lack of continuity, mediated through both reduced direct contact with patients and increased frequency of handovers (Antiel et al., 2011; Mann, 2005; Solet, Norvell, Rutan, & Frankel, 2005; Vidyarthi, Arora, Schnipper, Wall, & Wachter, 2006). Others include a shift work mentality (Holzman & Barnett, 2000; Shojania, Fletcher, & Saint, 2006), reduced resident supervision by responsible physicians resulting from reduced supervisor–trainee contact (Bismilla et al., 2011; Shojania et al., 2006), and the cumulative effect of compromised education leading to physicians being inadequately prepared for practice in the real world (Acres, 2004; Coverdill, Bittner, Park, Pipkin, & Mellinger, 2011; Grady, Batjer, & Dacey, 2009; Lang, Mooney, O'Connor, Bordley, & Lurie, 2009).

Hospitalized patients are complex (Manor-Shulman, Beyene, Frndova, & Parshuram, 2008), and economic and other pressures encourage shorter lengths of stay in hospital (Gaba & Howard, 2002). Consequently, the need for health care providers to rapidly know and understand, appropriately investigate, provide optimal treatment, and effectively transfer the care of patients are all fundamental aspects of modern health care. This requires continuity of care. Continuity may originate from individual providers or from health care teams. Continuity operates across three domains:

1. Informational continuity – the use of information on past events and personal circumstances to make current care appropriate for each individual
2. Management continuity – a consistent and coherent approach to the management of a health condition that is responsive to a patient's changing needs

3. Relational continuity – an ongoing therapeutic relationship between a patient and one or more providers (Haggerty and colleagues, 2003) (Haggerty et al., 2003)

Each, and all, domains of continuity may be threatened by duty hour reduction.

There are a number of ways in which duty hour reduction can compromise continuity: increasing the number of handovers; reducing the duration of clinical exposure to patients; increasing the intervals between exposure to patients; and reducing the proportion of available time for residents to interact and become familiar with individual patients and interact with other members of the health care team (Sutcliffe et al., 2004). Physicians who are less familiar with their patients may make less- informed clinical decisions or delay decisions (Laine et al., 1993), or they may compensate for their lack of familiarity by ordering more tests (Griffith et al., 1996). In turn, these actions may undermine the quality and outcomes of care, as has been suggested in studies showing harm associated with care transitions (Petersen, Brennan, O'Neil, Cook, & Lee, 1994) or duty hour reduction (Bollschweiler et al., 2001; Laine et al., 1993).

Despite the ease and frequency with which potential adverse consequences of long resident duty hours for patient safety have previously been articulated, separation of fatigue-related from continuity-related errors is inherently problematic, and this difficulty is compounded by the multidisciplinary and overlapping nature of health care teams. We suggest that the best evidence for the existence of these counterbalancing factors is the lack of improvement in meaningful patient outcomes associated with resident duty hour reduction. Irrespective of duty hours, continued efforts to improve the nature and quality of communication within concurrent multidisciplinary teams and at points of care transition remain an important area for patient safety (Kripalani, Jackson, Schnipper, & Coleman, 2007; Solet et al., 2005; Vidyarthi et al., 2006).

2.2.4 Residents are of limited immediate consequence to patient safety

Residents are recent graduates, are explicitly acknowledged as trainees, require supervision, and are required to attend formal education sessions, complete informal requirements, and pass exit examinations before entering into independent practice. As such, one could argue that residents could pose a potential threat to the provision of optimal care. Conversely, appropriate resident

training is required to sustain the number and quality of physicians in independent practice to ensure the safety of tomorrow's patients.

The value of resident work has been expressed in a variety of ways: as a financial benefit (Nuckols, Bhattacharya, Wolman, Ulmer, & Escarce, 2009), as a way of fulfilling the need to train doctors to care for future patients (Lang et al., 2009), and as the potential for residents to increase patient safety (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). However, it is worth noting that some resident work can be successfully completed by others or can be significantly reduced through the use of health care technology. This suggests that residents may not be "essential" elements of care, something that is consistent with their role as trainees (Bismilla et al., 2011; Chu et al., 2009; Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009; Victores et al., 2011; Wohlauer et al., 2012) and supports the notion that residents have limited ability to either add to or detract from patient safety.

2.3 Other considerations

Several additional factors warrant consideration. The first is the nature of evaluations performed to date. Because these evaluations do not demonstrate clinically significant relationships between resident duty hours and patient safety, one may question the relevance of the studies that have been done. Future studies should evaluate a wider range of duty hours and include both short-term cross-sectional and longer-term system-level outcomes. The use of concurrent assessment of multiple domains (i.e., workload, fatigue, educational opportunity and outcome, and patient safety) will enable consideration of the relative impact of resident duty hours on each of these important domains. Second, duty hour regulations usually describe maximum duty hours either for continuous duty, or for a certain period, or both (Gaba & Howard, 2002). The distinction between regulation and real-world practice is fundamental. If practice does not reflect regulatory change, then inferences linking changes in patient safety to changes in resident duty hours are moot (Landrigan et al., 2008; Landrigan et al., 2010). Third, the impact of the local safety culture and professionalism warrants more rigorous evaluation as a potential factor mitigating patient safety following duty hour reduction (Pronovost, Berenholtz, et al., 2006; Pronovost, Needham, et al., 2006). Finally, the impact of fatigue tolerance, personal motivations, and evolving expectations and standards of care (Pronovost et al., 2002) will change the landscape against

which the relationship between resident duty hours and patient safety is evaluated. Ongoing assessment is therefore needed.

2.4 Conclusion

An increasing body of evidence undermines the assumption that long duty hours for residents compromise patient safety and quality of care. Conversely, the evidence that shorter duty hours compromise patient safety is weak. Delinking the association of duty hours, fatigue, and compromised patient safety is important beyond providing clarification of the basis for a socially desired change. The possible and probable reasons that resident schedule changes have not influenced important patient safety outcomes are many, and include the limited relevance of fatigue to the creation of harmful errors, the modest contribution of duty hours to the overall burden of fatigue, the fact that any beneficial effects of duty hour reduction are counterbalanced by adverse effects, and the fact that, as trainees in a complex system, residents are of limited relevance to patient safety. While disentanglement of these issues is desirable, the current literature is limited. Greater understanding will enable pre-emptive mitigation and optimization of a complex system that all seek to improve.

Chapter 3

3 Methods

3.1 Objectives

The overall objective of the research project was to gain a better understanding of the physician-training environment.

The objectives of the thesis were as follows:

[1] Describe the characteristics of the physician trainee's work and education environment.

We aimed to obtain a detailed description of the trainee and their educational environment, including their demographic details, their workday, and general aspects of their work life that may impact their wellbeing.

[2] Describe three mains domains associated with this work and educational environment.

We aimed to describe three domains of the work and educational environment: trainee learning in the workplace, patient care in the workplace and the number of adverse trainee events that occurred.

[3] Evaluate associations between the work and educational environment, and its effects on trainee learning, patient care and adverse trainee events.

3.2 Rationale for choice of research method

As described in the background chapters, there is significant diversity among physician trainees and their environment. A broad research tool was required to describe the different features of interest. Furthermore we aimed to evaluate the inter-relationships that may exist between features of interest.

The randomized controlled trial (RCT) previously performed by Parshuram et al. was very context specific (Parshuram et al., 2015). It used both objective and subjective clinical outcomes in addition to resident self-report as the basis of its survey. The response rate in that study for resident participation was 96%, suggesting that residents are interested in participating in this sort of study.

A broader population study using a mixed methods approach could provide the required insights. However such an approach is complex, resource intense, expensive and logistically very challenging. This is especially true given the extent of variability that exists between trainees. It would also be very challenging to gather adequate concurrent direct and objective measurement of the overlapping domains using this method. To meet aforementioned objectives, the research tool needed to identify differences between individual trainees, distinct groups of trainees affiliated with different specialties, trainees rotating through different specialties, the effects of different supervisors, and training environments.

It was felt that a repeated cross-sectional questionnaire design would facilitate collection of data from a wide cohort of the relevant population at any one time and could provide concurrent descriptions of variations in the trainee population. Such a questionnaire has the potential to generate new knowledge about the inter-relationships between trainee learning, patient care, and exposure to adverse trainee events among a diverse population. In the future such a questionnaire could be distributed to trainees working across Canada. Trainees are accessible via their representation bodies, at a provincial level and our also linked to specific universities which facilitates access to them as a group, for distribution of a questionnaire. A questionnaire-based approach seemed a feasible and potentially fruitful option for gathering this multi-facetted data.

3.3 Hypotheses

We articulated the following three main hypotheses a-priori, to be assessed using data from the questionnaire distribution and analysis of results.

The first set of hypotheses relates to trainee learning and the expectation that learning will be improved with increased supervision and formal teaching during a duty period and that trainees will be better equipped to learn if they are not overworked, burnt out or experiencing unpleasant experiences either en route to work or in the workplace. Shorter duty periods may limit the exposure trainees have to clinical encounters the cumulative experience obtained. As learning is affected by fatigue, we hypothesised that learning would be worse in overnight duty periods.

> [1] Trainee learning would be greater with more supervision, more formal teaching, and improved trainee wellbeing, and would be worse in shorter duty periods, with low or high patient volume and in duty periods that included the overnight period.

The second set of hypotheses relates to patient care. Supervision and adequate sleep during the duty period were expected to improve patient care, with the expectation that well rested and supervised trainees are more likely to be able to provide the care required by the patient. The adequacy of handover was hypothesised to be an important factor in the perception of excellent patient care. Furthermore patient care was hypothesised to be worse at both low and high patient volumes (Haney et al., 2006) and in both longer and shorter than average duty period durations and overnight duty periods.

> [2] Residents would perceive patient care to be improved by more supervision by staff, more trainee sleep during a duty period, higher quality of handover during the duty period and would be worse at extreme low or high patient volumes, at longer and shorter duty period durations and during overnight duty periods.

The third set of hypotheses relates to adverse trainee events. We hypothesised that the incidence of adverse trainee events may be impacted by personal characteristics of the resident such as age or level of seniority within the training program – factors which will impact their home life and the nature of the work performed by the trainee. The number of duty periods worked and overnight duty periods over the previous 30 days reflects the nature of the work expectations of the resident (including the 'exposure effect') as does the volume of patients cared for during the last duty period.

> [3] The incidence of adverse trainee events would be affected by characteristics of the trainee such as level of seniority, program and age, the number of duty periods worked over the previous 30 days, the number of overnight duty periods worked over the previous 30 days, and the number of patients cared for during the last duty period worked.

The complex interaction of the variables measured and their hypothesized relationships to the outcome measures are illustrated in the following causal pathway diagram. See figure 3.1.

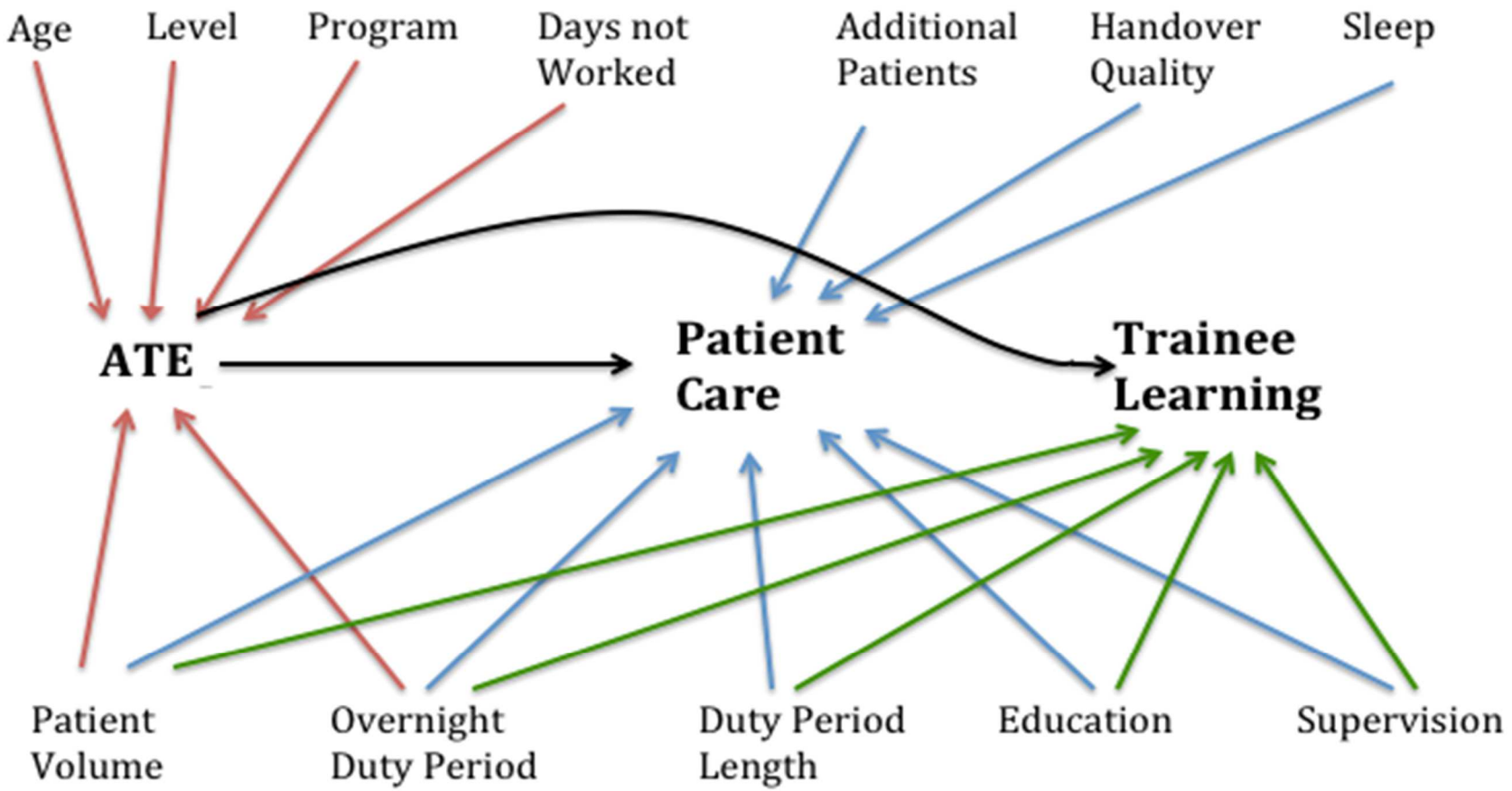

Figure 3.1: **Causal pathway** diagram outlining hypothesized relationship. (ATE = Adverse Trainee Events)

3.4 Method

The author was provided with a questionnaire (previously developed by Parshuram et al.) aimed at meeting the objectives of the study. The questionnaire was refined and piloted among physician trainees to assess the feasibility of using this tool to meet the stated objectives. The data and results from this pilot process are described below.

3.4.1 Initial questionnaire

Item generation for the initial content was derived by review of the literature, from expert opinion, and was related to questionnaires used in the CIHR funded study "Safety, Fatigue and Continuity in the ICU: a pragmatic mixed methods study" (PI Parshuram). The design was a cross-sectional questionnaire, designed for repeated administration.

Item reduction refers to the process of restricting the number of potentially relevant questions within a domain to ensure the number of questions is practicable. This process is important to ensure a balance is maintained between obtaining adequate information versus making a questionnaire too long and causing respondent burden, as lengthy questionnaires are less likely to be completed (Burns et al., 2008). In relation to this questionnaire, item reduction occurred initially following consultation with a group of physicians who were involved in resident education. Certain questions were removed based on group consensus.

3.4.2 Iterative piloting process

This questionnaire was distributed on seven different occasions during the overall piloting process. The initial questionnaire was paper-based for convenience of administration and to allow easy modification during the piloting process.

The initial distribution of the questionnaire facilitated an assessment of face validity, ease of use and feasibility. The questionnaire was then distributed to a group of respondents who provided written and verbal feedback on the structure and content of the questionnaire. This qualitative feedback highlighted certain questions that were unclear to these respondents or that they felt were difficult to provide responses to.

These initial distributions of the questionnaire and basic analyses of the responses highlighted minor errors in the structure of the questionnaire and in wording of the questions. The questions that were highlighted as problematic were modified where possible. Some of these suggestions led to modifications while others were felt to be too important to change. For example, some respondents reported that they did not have a 'scheduled' end time to their duty period and therefore had difficulty answering this question. After consideration it was felt that we would leave this question as it was despite the difficulty some respondents reported. The value of the 'perceived' scheduled work hours versus the actual hours worked was deemed sufficiently important to leave in place.

Two stand-alone questions were removed. These questions were felt to be prolonging the questionnaire without providing useful additional information. Three stand-alone questions and 1 follow up question were added. These questions related to near-miss car accidents, in order to capture 'missed' adverse trainee events and a question relating to professionalism. The added follow-up question related to how much uninterrupted sleep was obtained. Some inconsistencies in question responses were highlighted and attempts were made to make some questions more clear. General changes were made to font size and formatting details throughout the questionnaire to improve ease of use. Page numbers were inserted and the four sections were separated to facilitate navigation through the questionnaire. There were minor changes to wording of questions that will not be discussed individually. These changes were accepted for the questionnaire version date 05 March 2012. The new version of the questionnaire was distributed on the subsequent dates of distribution.

3.4.3 Final questionnaire design

The final questionnaire had 44 main questions and 21 branching follow up questions that depended on the initial responses to the main question.

The questionnaire was separated into 4 sections: [A] attributes of the participant; [B] educational exposure and perception of patient care over the last 7 days (prior to the date of the questionnaire); [C] significant personal and work related events over the last 30 days (prior to the date of the questionnaire); and [D] a detailed description of the duty period worked on the date specified on the questionnaire. All respondents were asked to complete sections A-C. Only those

who worked a duty period on the date specified on the questionnaire were asked to complete section D.

The timeframe used in the questionnaire design aims to strike a balance between achieving high quality recall and potentially capturing what may be a relatively infrequent event. Thus for the purposes of patient care and attendance at educational sessions, a 7 day timeframe was chosen. Experience and the literature suggests that the occurrence of crashes and other significant personal events would be less frequent and would be able to be remembered reliability for 30 days following the event. This seemed a sensible duration for recollection of a prominent event. A longer period was not chosen for the following reasons: [1] to avoid the potential for forgotten events; [2] the burden of reporting more than one crash or near crash may deter responses; [3] feedback from potential respondents suggested that this timeframe was reasonable; and [4] future consideration of the interval between survey administrations of one month.

In the questionnaire a duty period was defined as follows: [1] duty periods are periods of continuous duty; [2] duty periods are worked either in hospital, from home, in a clinic, or in combinations of these; [3] duty periods include time allocated for academic half-days; [4] duty periods include regular work days, nights shifts, and 'on-call'; [5] duty periods describe your time associated with scheduled academic and clinical activities. This description was included on both the cover sheet and in the body of the questionnaire.

The questionnaire included questions relating to 4 main domains. One domain described the respondent. This corresponded with section A. The three other domains were trainee learning; perception of patient care; and exposure to adverse trainee events. Questions relating to these domains were embedded within sections B, C and D. The domains of trainee learning and perception of patient care both had a main outcome question and further secondary questions relating to that domain. The secondary questions served to further describe the resident's experience and to ask about potential predictors related to the main domains. Exposure to adverse trainee events was mainly centered on a description of events over the 30-day period prior to the date of the questionnaire.

Question responses were either specific quantifications (i.e. number of patients, number of minutes), yes/no questions or statements of agreement using a Likert ranging from 0 to 10. For consistency, lower numbers indicated less of the attribute described. A branching style was used

when required that allowed the respondent different follow up questions depending on the response to the initial question.

A copy of the questionnaire (version date March 5 2012) is included in Appendix A.

3.5 Main objectives of the questionnaire

3.5.1 Describe the characteristics of the work and education environments

The description of the trainee's work and educational environment began with demographic details relating to the respondents. Section A of the questionnaire obtained demographic information on all respondents and also asked about their specific program of training. All trainees were asked about their exposure to formal education over the 7 days prior to the questionnaire date, and were asked how many days they had not worked over the 30-day period prior to the questionnaire. They were also asked about their exposure to adverse events in the workplace. Those respondents that had worked a duty period on the date of the questionnaire provided a detailed description of this duty period. This included the length of that duty period, their workload during the duty period, a detailed description of their experience with handover and their supervision during the duty period.

3.5.2 Describe the consequences of the work and educational environment

The main consequences of the environment are encompassed in the three domains of interest: trainee learning, patient care and trainee wellbeing. All three had both primary and secondary outcome questions. Table 3.1 outlines the primary outcome questions relating to these domains.

3.5.2.1 Trainee learning

The main trainee learning outcome was a question asking respondents to rate how much they had learned that was useful for their practice as a physician in the duty period worked. Only respondents who worked a duty period were asked this question. The respondents' self-reported assessment of learning during the duty period was deemed an appropriate proxy for general trainee learning. The responses were on a Likert scale ranging from 0 (nothing useful) to 10 (I learned a lot of useful things).

The secondary outcome questions asked respondents to report how many patients they had learned from during their duty period and to rate their learning during formal education sessions attended during a duty period.

3.5.2.2 Patient care

The main patient care outcome was a question asking the respondents that had worked a duty period to indicate their agreement/ disagreement with the following statement: "My patients received the care they needed when they needed it". Agreement was rated on a 5-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'.

The secondary patient care outcome asked respondents how many patients they had cared for in the 7 days prior to the date of the questionnaire who they perceived had been harmed by medical error.

3.5.2.3 Trainee wellbeing

The primary trainee wellbeing outcome related to adverse trainee events. It was operationalized as a dichotomous variable reflective of whether respondents had been exposed to one or more adverse trainee events during the 30-day period prior to the date of the questionnaire. The occurrence of one or more of the following was deemed an adverse trainee event: [1] involvement in a motor vehicle accident; [2] having a needlestick injury or other unintended bodily fluid exposure at work; [3] being the subject of an inappropriate personal comment; or [4] being physically assaulted or threatened by a patient or family member. Exposure to one or more of these four adverse trainee events indicated a negative outcome.

There were 5 further trainee wellbeing questions, all relating to the 30-day period prior to the date of the questionnaire, which are secondary outcome questions for trainee wellbeing. These were the number of days respondents did not work over the last 30 days, the number of overnight duty periods worked over that period, the number of sick days taken (over last 7 days) and 2 questions added to later versions of the questionnaire (both in relations to 'the last 30 days') asking if respondents had fallen asleep while driving after a duty period and if they had done something they were not proud of during a duty period.

3.5.3 Evaluate associations between the work and educational environment, and its consequences.

We identified certain factors encompassed in the questionnaire that could be potentially associated with the domains of interest. These were certain characteristics of the resident, supervision from staff physician, volume of workload, length of duty period worked, whether the duty period included the overnight period, sleep during the duty period, attendance at formal teaching during the duty period, quality of handover received, trainee wellbeing, number of days worked over the 30-day period prior to the date of the questionnaire and the number of overnight duty periods worked over that same 30-day period.

The characteristics of the residents used were program affiliation (categorical), their level within the training program (ordinal) and their age (ordinal). The assessment of supervision asked how long the resident had interacted with their staff physician during their duty period. This was measured in minutes and was treated as a continuous variable. Workload was assessed by asking how many patients the resident had assumed care for at the start of their duty period. This was a continuous variable. A further question relating to workload was the dichotomous question asking residents whether additional patients had been handed over to them during their duty period. Asking residents what time they had started and finished their duty period assessed the length of the duty period. This variable was measured in hours and was treated as a continuous variable. This question was also used to analyse whether the duty period included the overnight period (23:00 – 05:00 hours). Respondents were asked how many hours (if any) they had slept during their duty period. The outcome was continuous. Residents were asked if they had attended a formal education session during their duty period, which was a dichotomous variable. The quality of handover was measured by asking respondents how well the handover had prepared them to care for their patients. Responses were on a Likert scale ranging from 0 (not at all) - 10 (completely). The trainee wellbeing outcome (above) was a dichotomous variable. The number of days worked over the 30-day period prior to the questionnaire was a continuous variable as was the number of overnight duty periods worked over that same period.

3.6 Participants and administration

The Research Ethics Board at The Hospital for Sick Children Toronto approved the questionnaire and the study design. Eligible participants were medical trainees currently enrolled

in a training program. Participation in the study was voluntary. Completion of the questionnaire indicated implied consent.

The questionnaire was distributed in The Hospital for Sick Children on 7 specific dates between August 2010 and August 2012 to a convenience sample that was easily accessible. The dates of distribution were within 2 days before and 2 days after the date specified on the questionnaire. The questionnaire was generally distributed at various academic sessions where trainees would be gathered together for teaching. Two specific groups of trainees included the General Paediatric trainees, which encompass residents from 1st to 4th year of training (approximately 65 residents if all were in attendance) and the Paediatric Critical Care trainees, who are generally more senior in their training (approximately 24 trainees if all were in attendance). The questionnaire was also distributed to smaller groups of trainees (generally groups of 5 trainees) affiliated with Paediatric Sub-specialty training programs. These trainees would also be more senior in their training.

A short description of the questionnaire was provided with designated collection points outlined. The proposed plan was to estimate response rate for initial distributions of the questionnaire and to express them as a proportion of the number of distributed questionnaires. Following the seven dates of distribution, the accumulated data was analysed.

3.7 Statistical analysis

Statistical analyses were performed using SAS 9.3. Responses from each variable were presented in tabular form. The median and interquartile ranges were presented for continuous variables. Categorical variables were presented as proportions. Responses for each question were presented as the number of useable and anticipated responses.

The data was analysed on face value to obtain a description of the trainee and their experience. Univariate analyses were used initially to summarize questionnaire responses using nominal (proportions) and ordinal (median and interquartile range) measures.

The results of the three main outcome questions were analysed. Then bivariate analyses were performed to assess the relationship between the 3 main outcome questions and the potentially

predictive factors. Variables that were significant at a p value of 0.2 or less were included in multivariable regression analyses.

Regression models were created for each outcome and its predictors. Logistic regression was used for trainee wellbeing, and linear regression models were created for each of the trainee learning and patient care outcomes. For each model a stepwise backwards variable elimination process was used whereby the least significant variable with $p>0.05$ was removed and the model re-run. The final model was selected when only variables were significant at $p\leq0.05$ remained.

Table 3.1: Primary outcome questions relating to the consequences of the work and educational environment

Trainee learning outcome
Section D: Describing my duty period… Overall in this duty period, how much did you learn that was useful for your practice as a physician?
Patient care outcome
Section D: Describing my duty period… During the duty period described by this survey please indicate your agreement/ disagreement with the statement… "My patients received the care they needed when they needed it"
Trainee wellbeing outcome (composite outcome)
Section C: In the last 30 days…. - Were you involved in any crashes? - Did you have a needlestick injury or other unintended bodily fluid exposure while at work? - Were you the subject of inappropriate personal comments during a duty period? - Were you physically assaulted or threatened by a patient or family member?

Chapter 4

4 Results

The results of the distribution were used to assess whether the questionnaire could meet the three main objectives of [1] providing a description of the trainee and their experience; [2] exploring 3 important domains relating to physician trainees – trainee learning, patient care and adverse trainee events; and [3] identify factors associated with these domains of interest. Analysis of the results also allowed us to critically assess the quality of the questions asked, how the respondents answered the questions, the quality of the data provided and to assess the adequacy of the main domain questions. In summary it allowed us to pilot the questionnaire as a tool to meet the stated objectives.

4.1 Responses

4.1.1 Completed questionnaires

The overall piloting process resulted in a total of 132 completed questionnaires. Paper-based questionnaires facilitated easy modifications as needed and an inexpensive pilot process. However the pilot distribution method did not allow an accurate response rate to be measured, as there was limited traceability of questionnaires. It was impossible to know whether respondents had started a separate questionnaire more than once. Therefore assessing how many of printed total were returned completed was not an accurate method of assessing response rate. We felt that the data would be of value independent of a response rate and that the priority was to pilot the questionnaire among a group of varied trainees at a single centre. As described in the methods section, the distinct groups of trainees that were targeted were from a range of specialties and varied widely in their seniority and the years of training they had completed.

A total of 101/132 (77%) respondents worked a duty period on the date of the questionnaire and completed all 4 sections of the questionnaire. Twenty-three per cent answered section A describing their individual characteristics and C describing their last month but did not work a duty period on the date in question and therefore did not complete section D. Section B describing events in the last 7 days was completed by 75% of respondents (see below).

4.1.2 Specific question response rate

Most of the questions were well answered with few omissions or excessive responses. Section A had an average question response rate of 99%. The average response rate to section B was 75%. These questions were less well answered because in early versions of the questionnaire, they were erroneously positioned such that respondents who had not worked a duty period were not asked these questions. However the response rate to section B increased to 95% once these questions were positioned appropriately in the questionnaire (March 2012 version). The average question response rate in Section C was 98%. The stand-alone questions in section D were well answered with an average response rate of 96%. The follow-on questions were answered less consistently. Response rate to follow-on questions ranged from 77% to 102% (excess responses). The average response rate to follow-on questions in section D was 88%.

A full summary of the questionnaire questions, individual question response rates and a summary of individual responses are listed in Appendix B.

4.1.3 Responses and data management

Of the 132 completed questionnaires collected, 124 (94%) respondents provided a response to the question “Did you work a duty period on the date of the questionnaire”. All 92 respondents indicating ‘yes’ provided descriptions of their duty period (section D of the questionnaire). A description of the duty period was provided in 9 (22.5%) of the 40 responses where the question response was ‘no’ (n = 32) or left blank (n = 8). We decided that if respondents described a duty period then this indicated that a duty period was worked, and superseded any response to the direct question ‘Did you work a duty period on the date of the questionnaire”.

With regard to handover, 2 respondents did not provide a response to the initial question asking if they had received a handover but proceeded to describe a handover. Similarly, we decided that if a description of a handover were provided, we would assume that this indicated that they had received a handover.

4.2 Main objectives of questionnaire

4.2.1 Objective 1: Describe the characteristics of the trainee work and education environments

4.2.1.1 Personal characteristics

The personal characteristics of the respondents are summarized in Table 4.1. The cross section of respondents extended from PGY 1 to fellow, encompassing the full spectrum of seniority. Fifty per cent of respondents were aged between 25 and 30 with a further 34% aged between 31 and 35. The respondents were primarily affiliated with paediatric medicine (54.2%), paediatric critical care medicine (25.19%) and paediatric medicine sub-specialty (20.61%). There is a relatively high representation of trainees from the sub-specialty of paediatric critical care medicine in particular as the project supervisor is affiliated with this department.

4.2.1.2 Formal educational exposure

Respondents were asked to report their scheduled and actual attendance at formal education sessions over the 7 days prior to the questionnaire. The results are in table 4.2. The median (IQR) hours scheduled was 6 (4 - 7.5) and median (IQR) hours attended was 5 (3 – 6).

Respondents who worked a duty period were also asked to report their experience with formal education during the duty period. See table 4.3.

4.2.1.3 Trainees' clinical experience

One hundred and one respondents described the duty period they worked on the date of the questionnaire. Seventy-one respondents (72%) were working on a paediatric medicine sub-specialty service during the duty period in question. Ninety (90%) were doing a 'core' rotation and 96 (95%) worked their duty period in a hospital. The remaining 5% worked in a clinic, from home or from 'hospital and home'.

The median (IQR) number of hours scheduled was 10 (9.5 – 24.5) and the actual number of hours worked was 11 (9.5 – 25). Respondents reported 6.5 (6-7) hours of sleep prior to their duty period. The median (IQR) number of patients that respondents assumed responsibility for was 5 (3-11).

Table 4.4 outlines the results relating to handover of care. A handover was received by 74 (76%) of respondents. Sixty-two (79%) of handovers were done verbally in person while 10 (12%) were done on paper and verbally in person. The median number of patients handed over was 8.5 (4-17). Respondents rated the handover received on a Likert scale (0-10) for the following factors – median (IQR): structure 7 (5-8), staff involvement 6 (0-9), informal teaching 1 (0-3), accuracy 8 (7-9), and ability of handover to prepare you to care for patients 7 (6-8). The median (IQR) length of handover in minutes was 30 (15-60). Thirty-one (32%) of respondents were handed over additional patients during the duty period. Respondents also rated the adequacy of the handover that they gave upon completion of their handover on a Likert scale at a median (IQR) of 8 (7-9).

Sixty (61%) of respondents did not admit additional patients during their duty period. Respondents reported a median (IQR) of 60 (30 – 180) minutes of staff contact during the duty period. Twenty-five (27%) reported being supervised by other trainees during their duty period and 20 (22%) reported supervising other trainees during their duty period.

There was a large range of responses to the supervision question. The number of minutes spent with the staff during a duty period ranged from 0 to 600. The median (IQR) was 60 (30-180) minutes. Supervision was consistently longer in the paediatric critical care respondents. Ten per cent of residents across all groups had no interaction with staff in the duty period.

4.2.2 Objective 2: Describe the effects of the work and educational environment

The three main domains of interest each had both primary and secondary outcome questions. Table 4.5 outlines the results of the primary outcomes questions relating to the three main domains.

4.2.2.1 Trainee learning

Response to the primary trainee learning outcome (*Overall in this duty period, how much did you learn that was useful for your practice as a physician?*) was a median (IQR) of 6 (5-7) on a scale 0-10.

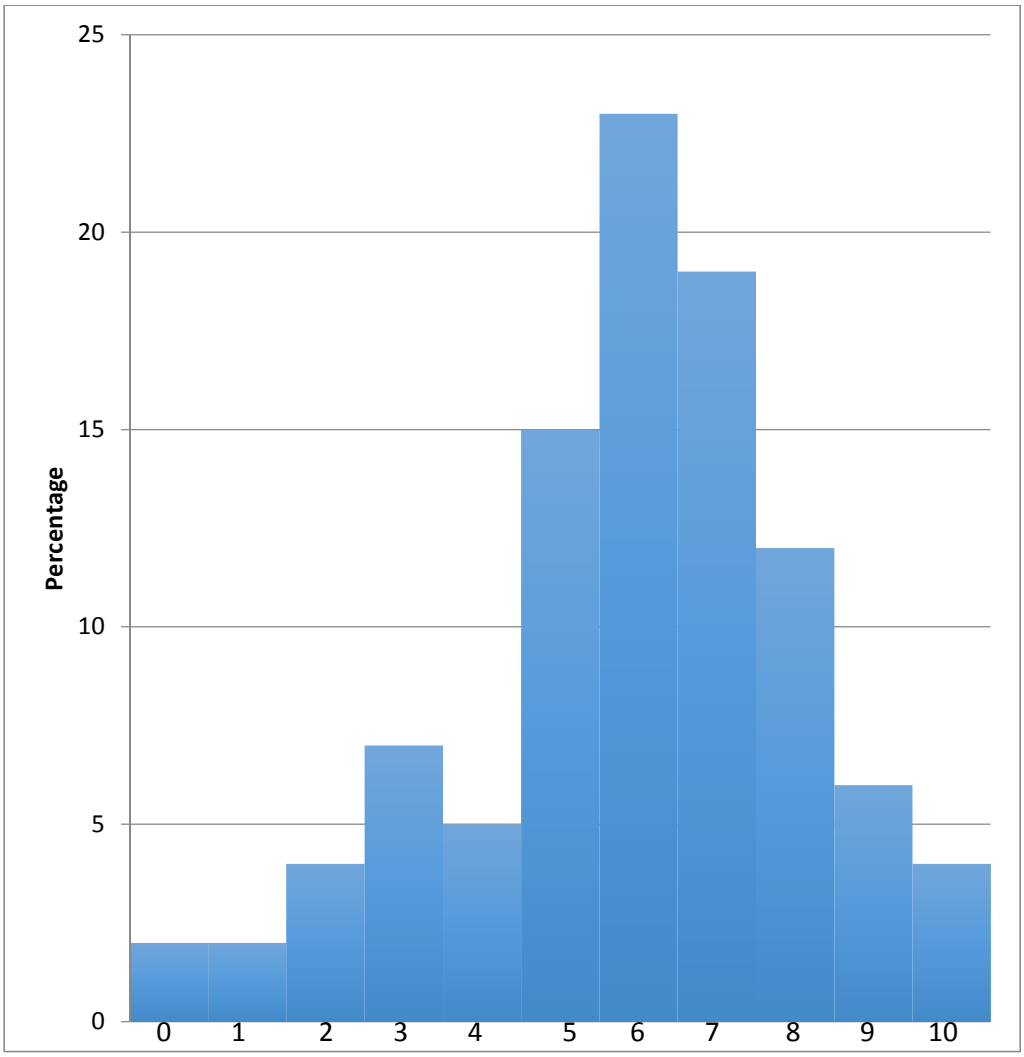

Figure 4.1: **Trainee learning outcome** Overall in this duty period, how much did you learn that was useful for your practice as a physician? *Nothing Useful [0] – [10] I learned a lot of Useful things.* Median (IQR) = **6 (5-7)**

With regard to the secondary outcome questions respondents were asked how many patients they had learned from during their duty period. Ninety-eight respondents provided a response to this question. Twenty-five respondents (26%) reported learning from 1-2 patients, while 42 respondents (43%) reported learning from 3-6 patients and a further 21 respondents (21%) reported learning from 7-10 patients. Of the respondents who attended a formal education session during the duty period, the median (IQR) rating of how much they learned during the education session(s) was 7 (6-8).

4.2.2.2 Patient care

Regarding the primary outcome question in relation to patient care respondents were largely in agreement with the statement, *"My patients received the care they needed when they needed it"*. Thirty-one percent of respondents strongly agreed with this statement and a further 62% agreed.

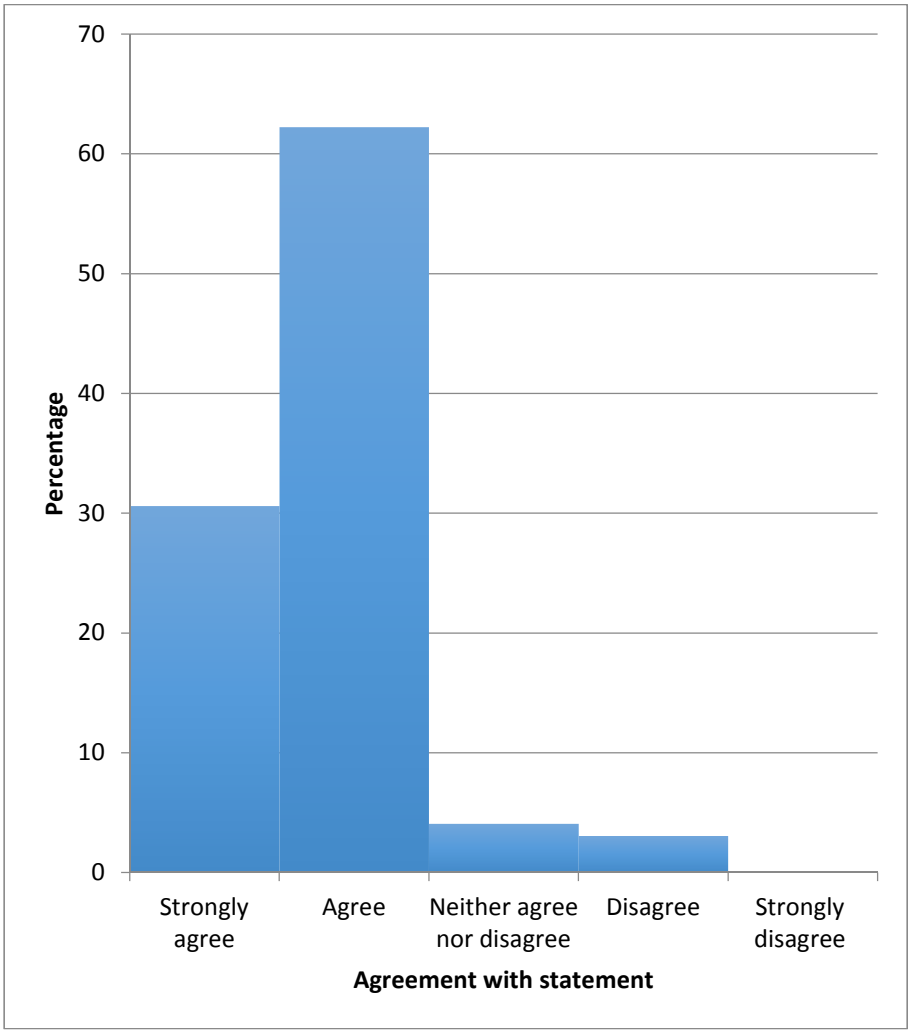

Figure 4.2: **Patient care outcome** Agreement rating with the statement: *"My patients received the care they needed when they needed it"* (during the duty period)

Ninety-nine respondents (75%) provided a response to the secondary outcome question regarding patient care. The majority – seventy-one respondents (72%) did not feel they had cared for any patients that they considered had been harmed by medical error (in the 7 days prior the date of questionnaire). Twenty-one respondents (21%) felt they had cared for 1 such patient in

the relevant time period, while 6 respondents (6%) felt they had cared for two such patients. There was one outlying respondent who reported caring for 10 patients such patients.

4.2.2.3 Adverse Trainee Events

Regarding the primary outcome for adverse trainee events, 49 (37 %) respondents reported at least one adverse trainee event (motor vehicle accident, needlestick injury, inappropriate personal comment or physical assault or threat) during the 30-day period prior to the date of the questionnaire. Eight respondents (6 %) reported being physically assaulted or threated by a patient or a family member during that period. Twenty-seven per cent of respondents were subject to an inappropriate personal comment on at least one occasion over the study period. Nine per cent of respondents in this sample experienced a needlestick injury or other unintended bodily fluid exposure while at work. Respondents reported making a total of 3648 journeys to or from work and there were 2 motor vehicle crashes reported. This equates to a rate of 0.55 per 1000 commutes. A smaller number of respondents were asked about falling asleep after working a duty period in our sample. There were 2 incidences reported which equates to a rate of 1.99 per 1000 commutes.

See table 4.6.

Regarding the secondary outcome questions, respondents reported a median (IQR) of 6 (4-9) days not worked over the 30 days preceding the questionnaire. The median number of overnight duty periods worked was 5 (4-7). Fifteen per cent of respondents took at least 1 sick day in the 30-day period.

A proportion of respondents (n = 44) were asked 2 additional questions (in later versions of the questionnaire following the modification process). Firstly they were asked if they had fallen asleep while driving after a duty period. Two respondents (5%) reported falling asleep while driving after a duty period. The rate per 1000 commutes was 1.99. Secondly they were asked if they had done something they were not proud of on a professional level over the 30-day period. Twelve (27%) respondents reported doing something they were not proud of on at least one occasion.

Twenty-seven per cent of respondents reported being the subject of (at least one) inappropriate personal comments during a duty period. Six per cent of respondents reported being physically assaulted or threatened by a patient or family member.

4.2.3 Objective 3: Evaluate associations between the work and educational environment and its effects.

4.2.3.1 Relevant results relating to work and educational environment

The results described in this section were used in the regression analyses outlined below. See table 4.7 for results in tabular form.

Forty-two per cent of respondents attended a formal education session during their duty period.

The median (IQR) number of minutes of supervision during a duty period was 60 (30-180) minutes. Ten per cent of residents across all groups had no interaction with staff in the duty period.

In this sample actual length of duty period was very close to scheduled length. The mean scheduled length of duty period was 15.51 hours with a range between 3 and 27 hours. The mean length of duty period worked was 15.43 hours with a range between 3 and 28 hours. Looking at overnight duty periods (defined as greater than 15 hours), the mean scheduled length was 24.89 hours. The mean actual length was 25.25 hours.

The median (IQR) number of patients that respondents assumed responsibility for was 5 (3-11). Thirty-two per cent of respondents were handed over additional patients during the duty period.

Respondents reported a median (IQR) of 6 (4-9) days not worked in the last month. The median (IQR) number of overnight duty periods worked was 5 (4-7).

Seventy-three respondents (76%) received a handover from the previous physician when starting the relevant duty period.

4.2.3.2 Regression analyses

Regression was used to assess the relationship between the main outcomes and the potentially associated factors (according to the hypotheses).

4.2.3.2.1 Trainee learning

The trainee learning hypothesis was that trainee learning is perceived to be better when there is more staff supervision, more teaching and less exposure to adverse trainee events (improved trainee well being) and is perceived to be worse when patient volumes are too low or too high, during shorter duty periods, and in duty periods that include the overnight period.

Three predictive factors had a p-value of less than 0.2 and were therefore eligible for inclusion in the multivariable analysis. These were staff supervision, teaching and patient volume.

A multiple linear regression was calculated to predict trainee learning based on patient volume, staff supervision and attendance at a teaching session. The two predictive factors associated with trainee learning that reached the statistical significance of $p < 0.05$ were staff supervision and attendance at a teaching session. A significant regression equation was found ($F(2,90) = 10.71$, $p< 0.0001$), with an r^2 of 0.1922.

See table 4.8.

4.2.3.2.2 Patient care

The patient care hypothesis was that the perception of patient care is improved by more staff supervision, more trainee sleep, additional patients handed over, better quality of handover during the duty period and is perceived to be worse when patient volumes are lower or higher, and is impacted by length of the duty period.

The number of patients cared for during a duty period was the only predictive factor with a p-value less than 0.2. This was not predictive at a $p<0.05$ level. Therefore there were no significant predictive factors found in multivariable regression.

4.2.3.2.3 Adverse trainee events

The adverse trainee events hypothesis was that trainee well being (as measured by presence of absence of adverse trainee event) is adversely affected by the number of duty periods worked in the 30 day period prior to the date of the questionnaire, the number of duty periods including overnight duty in the 30 days prior to the date of the questionnaire, patient volume, and characteristics of the trainee (age, program affiliation and years as a physician).

There were three predictive factors that were significant at a p-value of 0.2 in bivariate analyses and were therefore included in multivariable regression analyses. These were the number of duty periods including overnight duty in the 30 days period prior to the date of the questionnaire, the age of the respondent and the level of training of the respondent.

A logistic regression was calculated to predict trainee wellbeing based on night duty periods worked over the last, the age of the respondent and the level within their training program.

The final model found the level of training and the number of night duty periods worked over the 30-day period prior to the distribution date significant at the 0.05 p-value. Thus more trainee adverse events were associated with working less nights and being more senior.

See table 4.9.

Table 4.1: **Personal characteristics of respondents**

Characteristic No. (%)	**All respondents (n = 132)**	**Paediatric medicine (n = 71)**	**Critical care medicine (n = 33)**	**Paediatric medicine sub-specialty (n = 27)**
Which Canadian training program are you primarily affiliated with?	n = 131	71 (54.20 %)	33 (25.19 %)	27 (20.61 %)
Postgraduate year of training	n = 129	n = 70	n = 32	n = 27
- PGY 1	29 (22.48 %)	17 (24.29 %)	6 (18.75 %)	6 (22.22 %)
- PGY 2	38 (29.46 %)	33 (47.14 %)	1 (3.13 %)	4 (14.81 %)
- PGY 3	15 (11.63 %)	15 (21.43 %)		
- PGY 4	4 (3.10 %)	4 (5.71 %)		
- PGY 5 or more	14 (10.85 %)		4 (12.50 %)	10 (37.04 %)
- International medical graduate working as Clinical fellow	29 (22.48 %)	1 (1.43 %)	21 (65.63 %)	7 (25.93 %)
Since you graduated from medical school, how many years have you worked as a physician/trainee physician?	n = 131	n = 71	n = 33	n = 27
- One year or less	30 (22.9 %)	25 (35.21 %)		5 (18.52 %)
- Two years	31 (23.66 %)	29 (40.85 %)		2 (7.41 %)
- Three years	10 (7.63 %)	10 (14.08 %)		
- Four years	8 (6.11 %)	3 (4.23 %)	4 (12.12 %)	1 (3.70 %)
- Five years	13 (9.92 %)	1 (1.41 %)	4 (12.12 %)	8 (29.63 %)
- Six or more years	39 (29.77 %)	3 (4.23 %)	25 (75.76 %)	11 (40.74 %)
Core exam completed	n = 130	n = 71	n = 33	n = 26
- Number (%) who have completed a core specialty exam	78 (60 %)	6 (8.45 %)	28 (84.85 %)	18 (69.23 %)

Children - 0 children - 1 child - 2 children - 3 or more children	n = 131 101 (77.1 %) 15 (11.45 %) 8 (6.11 %) 7 (5.34 %)	n = 71 0 (63 %) 4 (5.63 %) 1 (1.41 %) 3 (4.23 %)	n = 33 22 (66.67 %) 7 (21.21 %) 3 (9.09 %) 1 (3.03 %)	n = 27 16 (59.26 %) 4 (14.81 %) 4 (14.81 %) 3 (11.11 %)
Age group - <25 years - 25-30 years - >30-35 years - >35-40 years - >40 years	n = 130 4 (3.08 %) 65 (50 %) 44 (33.85 %) 11 (8.46 %) 6 (4.62 %)	n = 70 4 (5.71 %) 54 (77.14 %) 9 (12.86 %) 3 (4.29 %)	n = 33 3 (9.09 %) 22 (66.67 %) 7 (21.21 %) 1 (3.03 %)	n = 27 8 (29.63 %) 13 (48.15 %) 4 (14.81 %) 2 (7.41 %)

Table 4.2: **Scheduled versus attended formal education sessions**

Survey question	**All respondents asked the question (n = 132)**	**Paediatric medicine (n = 71)**	**Critical care medicine (n = 33)**	**Paediatric medicine sub-specialty (n = 27)**
Hours of formal teaching you were scheduled in the last 7 days? **Median** (IQR)	n = 116 6 (4 – 7.5)	n = 65 6 (4 – 8)	n = 28 6 (3 – 8)	n = 25 5 (4 – 6)
Hours of formal teaching you attended in the last 7 days? Median (IQR)	n = 115 5 (3 - 6)	n = 64 5 (3 – 7)	n = 26 5 (3 – 6)	n = 22 4 (4 – 5)

Table 4.3: **Formal education experience**

Question (numbers who worked a Duty Period)	**All respondents (n = 92)**	**Paediatric medicine**	**Critical care medicine**	**Paediatric medicine sub-specialty**
Did you attend formal education sessions during your duty period?	n = 97 No = 56 (57.73 %)	n = 61 No = 38 (63.33 %)	n = 20 No = 8 (40 %)	n = 16 No = 10 (62.50%)
If not why?	(n = 44)	(n = 31)	(n = 7)	(n = 6)
- None scheduled	34 (77.27%)	26 (83.87%)	4 (57.14%)	4 (66.67%)
- I had better education opportunities staying with a patient	1 (2.27%)	1 (3.23%)	3 (42.86%)	2 (33.33%)
- My clinical responsibilities prevented me	7 (15.91%)	2 (6.45%)		
- I chose not to attend for some other reason	2 (4.55%)	2 (6.45%)		
If yes how long were the sessions? (Minutes) **Median (IQR)**	Yes = 41 (42.27%) 60 (60 – 120)	Yes = 22 (36.67%) 60 (60 – 120)	Yes = 12 (60%) 60 (60 – 60)	Yes = 6 (37.50%) 60 (60 – 120)
For how long did you attend these sessions?	n = 36	n = 20	n = 10	n = 5

(minutes) **Median (IQR)**	60 (60 – 120)	60 (60 – 140)	60 (60 – 60)	60 (60 – 120)
How much did you learn in sessions? Likert scale 0 (Nothing) – 10 (I learned a lot) **Median (IQR)**	n = 41 7 (6 – 8)	n = 22 7 (6 – 9)	n = 12 5.5 (3.5 – 6.5)	n = 6 8 (7 - 8)

Table 4.4: **Responses to handover questions**

Survey question (numbers who worked a Duty Period)	**All respondents (n = 92)**	**Paediatric medicine (n = 57)**	**Critical care medicine (n = 18)**	**Paediatric medicine sub-specialty (n = 16)**
Did you receive handover from the previous physician when starting the duty period? - Yes	n = 87 73 (76.04%)	 41 (70.69%)	 18 (100%)	 14 (82.35%)
How did you receive the handover? N (%) telephone verbally in person on paper by phone and verbally in person on paper and verbally in person by email and verbally in person telephone, verbally in person and on paper	 1 (1.27 %) 62 (78.48 %) 2 (2.53 %) 1 (1.27 %) 19 (12.66 %) 1 (1.27 %) 2 (2.53 %)	 34 (73.91 %) 1 (2.17 %) 1 (2.17 %) 8 (17.39 %) 2 (4.35 %)	 19 (95 %) 1 (5 %)	 1 (7.69 %) 9 (69.23 %) 1 (7.69 %) 1 (7.69 %) 1 (7.69 %)

How many patients were handed over to you? **Median (IQR)**	9 (4-17)	10.5 (4-22)	8.5 (3.5-13.5)	7 (5-10)
How structured was the handover? **Median (IQR)**	7 (5-8)	7 (5-8)	8 (7-9)	7 (5-9)
How involved were staff physicians in the handover? **Median (IQR)**	5.5 (0-9)	2.5 (0-8)	8.5 (5.5-10)	5 (0-10)
How many minutes did the initial handover take? **Median (IQR)**	30 (15-60)	20 (15-40)	57.5 (17.5-90)	30 (10-90)
How do you rate the accuracy of the information about the patients handed over to you? **Median (IQR)**	8 (7-9)	8 (6-8)	7 (7-9)	8 (7-9)
How well did the handover prepare you to care for your patients? **Median (IQR)**	7 (6-8)	7 (6-8)	7 (6-8)	8 (7-9)
How would you rate the accuracy of the information in the handover you gave to others? **Median (IQR)**	8 (7-9)	8 (7-9)	7.5 (6.5-8.0)	9

Table 4.5: **Response to primary outcome questions**

Question **(numbers who worked a duty period)**	**Respondents**
Trainee learning How much did you learn during your duty period that was useful for your practice as a physician? Likert scale from 0 (nothing useful) to 10 (I learned a lot of useful things) **Median (IQR)**	n = 98 6 (5 – 7)
Patient care *'My patients received the care they needed when they needed it'* - Strongly agree - Agree - Neither agree or disagree - Disagree - Strongly disagree	n = 97 30 (30.93 %) 61 (62.89 %) 4 (4.12 %) 2 (2.06 %)
Trainee wellbeing Exposure to adverse trainee event - No. (%)	n = 132 49 (37 %)

Table 4.6: **Exposure to adverse trainee events**

	N	Percentage
Physical assault or threat by a patient or family member	8	6%
Inappropriate personal comment	35	27%
Needlestick injury	11	9%
Motor vehicle accident	2	1.5%

Table 4.7: **Factors potentially associated with trainee learning, patient care and adverse trainee events**

Question	**N (%) responses**	Response value
Did you attend formal education sessions during your duty period?	n = 97 (96 %)	Yes = 41 (42.27 %)
Approximately how long (in minutes) did you interact with your staff physician(s) for over the duty period? **Median (IQR)**	n = 94 (93 %)	60 (30-180)
At the start of the duty period, how many patients did you assume responsibility for? **Median (IQR)**	n = 94 (93 %)	5 (3 – 11)
Were additional patients handed over to you during your duty period?	n = 97 (96 %)	Yes = 31 (32 %)

In the last 30 days, how many days have you not worked? **Median (IQR)**	n = 132 (100 %)	6 (4-9)
How many duty periods that you worked included the hours between 23:00-5:00? **Median (IQR)**	n = 132 (100 %)	5 (4-7)
How well did the handover prepare you to care for your patients? Likert scale from 0 (not at all) to 10 (Completely) **Median (IQR)**	n = 92 (91 %)	7 (6-8)
Which level of training are you within this program?	n = 129 (98 %)	PGY 1 = 29 (22.5 %) PGY 2 = 38 (29.5 %) PGY 3 = 15 (11.6 %) PGY 4 = 4 (3.1 %) PGY 5 or more = 14 (10.9 %) International medical graduate fellow = 29 (22.5 %)
Age group	n = 130 (98%)	<25 years = 4 (3.08 %) 25-30 years = 65 (50 %) >30-35 years = 44 (33.85 %) >35-40 years = 11 (8.46 %) >40 years = 6 (4.62 %)
Which Canadian training program are you primarily affiliated with?	n = 131 (99%)	Paediatric medicine = 71 (54.2 %) Critical care medicine = 33 (25.2 %) Paediatric medicine sub-specialty = 27 (20.6 %)
Duty period length **Median (IQR)**	n = 86 (85 %)	11 (9.5-25) hours

Adverse trainee event exposure	n = 132 (100 %)	49 (37%)
How much sleep did you get during the duty period? (hours)	n = 101 (100 %)	0 (0-2.5)

Table 4.8: **Regression analysis - predictors for trainee learning**

Predictive factor	**Estimate**	**Standard error**	**P-value**	**Estimate**	**Standard error**	**Exit p-value**
Staff supervision	0.0067	0.0018	0.0004	0.0062	0.0018	0.0008
Education session	1.3207	0.433	0.0030	1.1287	0.4220	0.0089
No adverse trainee events	0.5686	0.4505	0.2099			
Duty period length	-0.0340	0.3022	0.2633			
Patient volume	-0.0472	0.0234	0.0464			
Overnight duty period	0.5340	0.4422	0.2303			

Table 4.9: **Regression analysis – predictors for trainee wellbeing = 0 (no adverse trainee event)**

Predictive factor	**Estimate**	**Standard error**	**P-value**	**Estimate**	**Standard error**	**Exit p-value**
Night duty periods worked over last 30 days	-0.1546	0.0712	0.0298	-0.1594	0.0701	0.0229
Level within training program	0.1908	0.1384	0.1682	0.2108	0.1039	0.0425
Age	0.0594	0.3340	0.8587			

Chapter 5

5 Discussion

The discussion chapter will begin with an interpretation of the results followed by a discussion of the implications for the relevant stakeholders involved.

5.1 Interpretation of results

The questionnaire was distributed to physician trainees in an Ontario teaching hospital on seven separate occasions to test the feasibility and utility of the questionnaire. The aim was to assess whether the questionnaire could meet the stated objectives to 1) describe the characteristics of the work and educational environment; 2) describe three effects of interest associated with this environment; and 3) evaluate associations between the environment and its effects. The distribution resulted in 132 responses from a range of trainees all working at a paediatric institution, of which 101 worked a duty period on the date specified on the questionnaire.

The data obtained describes the respondents' work and educational environment well. The research method was effective at obtaining a description of the variability that exists in clinically relevant outcomes such as handover occurrence and supervision. Exposure to both informal and formal education was well documented using this approach. Furthermore adverse trainee events that are an important feature of the environment (and a potential effect of it) were well described. The results revealed some interesting findings including a significant number of adverse trainee events including 2 motor vehicle accidents. The high number of adverse trainee events highlights the need to follow such occurrences more closely and suggests that this warrants further study. The section on adverse trainee events was very well answered implying that trainees are able to recall such events up to 30 days later.

Regarding the second objective of providing a description of the effects of trainee learning, patient care and adverse trainee events, the responses described a positive learning experience, a strong perception of patient care and, as previously mentioned, a surprising incidence of adverse trainee events. The results of the primary outcome questions relating to trainee learning and patient care revealed limited variability. This may be because the pilot distribution was limited to one centre and only paediatric trainees. Therefore the results of this pilot cannot confidently

assert that the questionnaire (and these primary outcome questions) is an effective tool at describing the domains of trainee learning and patient care.

The limited variability in the responses to the main outcomes questions relating to trainee learning and patient care meant that there was limited ability to evaluate associations between the work and educational environment and these effects. However despite these limitations, the results of the multivariable regression found that staff supervision and attendance at a formal education session were positively associated with overall trainee learning during a duty period. Furthermore in relation to adverse trainee events, more senior residents and those that had worked fewer overnight duty periods over the last 30 days were more likely to have experienced an adverse trainee event during the studied period. These findings may relate to the nature of the work performed by more senior residents – potentially more challenging patient and family interactions for example. The findings may also be related to an exposure effect whereby those that work fewer overnight duty periods may be more likely to interact for longer with patients and family members, may perform more procedures and may even commute to and from work more often. Future study could attempt to establish reasons for such a finding.

In piloting this questionnaire, we have obtained a description of several important aspects of the trainee experience such as scheduled versus actual duty hours, days free of duty, the handover provided to the next caregiver and the amount of supervision provided. While the pilot data has not shown sufficient variability to fully meet the stated objectives, it seems that the questionnaire is an effective tool at describing the work and education environment of trainee physicians and could reveal further associations between the environment and the relevant effects if the respondents were more varied and if more responses were available.

5.2 Stakeholder groups

The data obtained from the pilot of this questionnaire has implications for the different stakeholder groups involved in medical education. These will be discussed below individually, although obvious overlaps exist.

5.2.1 Implications for the hospital system

The data obtained in this pilot would be reassuring to this hospital as the perception of patient care and the ability to provide adequate care was generally very positive. In a hospital system

where trainees provide a significant proportion of the frontline care, it is important to track the perception of patient care, both from the point of view of patients and providers. Most trainees reported supervision during their clinical work, the importance of which has been emphasized for patient safety (Institute of Medicine Committee on Optimizing Graduate Medical Trainee & Work Schedule to Improve Patient, 2009). There were no factors found to be associated with improved patient care in the regression analysis performed. This may have been secondary to the lack of variability in perception of patient care in this population. It might also reflect the strong culture of patient safety at the one institution studied.

The secondary patient care outcome asked if respondents had cared for patients whom they perceived had been harmed by medical error in the last 7 days. Twenty-eight respondents (28%) reported caring for 1 or more patients harmed by medical error in the week prior to the questionnaire. It is concerning that a relatively high proportion of respondents reported patient harm. Future studies should explore this finding in more depth, perhaps with qualitative methods, to gain a better understanding of these incidents.

The occurrence of 2 motor vehicle accidents in this sample was surprising given the relatively small sample all from one institution and the anecdotal information that we obtained that a significant proportion of trainees live within walking distance of the hospital. The number of accidents is less than a previous study of motor vehicle accidents among medical trainees (Barger et al., 2005). The incidence in this sample equated to an incidence of 0.55 motor vehicle accidents per 1000 commutes in this sample which was less than the rate of 1.07 per 1000 commutes found in the study by Barger et al. Nonetheless this result is both interesting and encourages extension of the questionnaire to a wider sample working at different centres. Furthermore there was also a concerning proportion of trainees who reported falling asleep while driving after a duty period. These are trends that also warrant further investigation. Motor vehicle accidents in fatigued trainees have potential implications for the hospital system as appeals courts in two states in the United States have ruled that the employer can remain responsible for fatigue-related accidents even after the employee has left work (Barger et al., 2005).

The high rate (9% of respondents) reporting an unintentional bodily fluid exposure is of relevance to the hospital, PGME and to trainees. Nine per cent of respondents in a given month experiencing such an exposure implies there may be room for improvement in this area.

Furthermore this sample included few surgical trainees. A sample including surgical trainees would likely result in a higher rate of unintentional bodily fluid exposure given the nature of their work.

The extent of supervision described by the respondents could be of interest to the hospital system. Supervision varied significantly between respondents, as did the extent of handover. Continuity of care is increasingly highlighted as an important aspect of patient care. In our sample 75% of respondents reported receiving a full handover of care at the beginning of their duty period. The handover described varied significantly in length. Such information is important for the hospital system to appreciate, to recognise potential areas of improvement.

5.2.2 Implications for PGME

The results of this pilot survey have implications for PGME, including some areas that overlap with the hospital system. Specifically relevant to the office of PGME are the results of the questions pertaining to attendance at education sessions. Formal education sessions were relatively well attended in this sample. However there was a consistent difference between the median number of hours of formal teaching scheduled (6 hours) over the 7 days prior to the questionnaire and the median number of hours attended (5 hours). Furthermore during the duty period there were 10 respondents who chose not to attend a scheduled education session. Therefore there was a pattern of missed formal education sessions among this sample. However the questionnaire did not ask whether these sessions were mandatory. Furthermore we do not know if respondents were post call or on vacation when they missed these hours of education. Program directors would nonetheless likely be interested in maximizing attendance at, and learning from, formal education sessions.

The results of the multivariable regression found staff supervision and attendance at a formal education session to be positively associated with overall trainee learning during a duty period. This has implications for PGME in providing areas to focus on when attempting to improve trainee learning during clinical periods. More generally, this questionnaire can provide clarification on the ‘service versus education’ component of the medical trainee experience in the hospital surveyed. Trainees can document their learning from education sessions and can openly disclose that clinical learning opportunities may be superior to the formal education sessions with implications both for trainees and PGME.

PGME needs to maintain a good understanding of the clinical and personal features that improve learning for trainees. Some trainees rated the informal learning during handover very highly. Conversely others reported minimal learning during handover. This is likely reflective of differences between specialties, but also differences between supervisors. Handover is an increasingly important aspect of the clinical day and should be well understood by PGME. The results allow a comparison of the different styles of handover and could inform a debate on the optimal approach to handover in the institution and a possible attempt to standardize the approach to handover across the institution.

It is important for the PGME system to be aware of the risks to trainees associated with the current system of training, including the rate of motor vehicle accidents or near miss events and bodily fluid exposures. A further question of relevance related to potential abuse or threatened abuse at work. There were 8 respondents who reported at least one episode meeting this description. However, due to the nature of the questionnaire, we lack details on any specific incidents. Furthermore we have no information on whether the event(s) occurred outside of regular work hours or whether the respondent was sleep deprived at the time of the event. In retrospect such information would have been very informative. A 1996 study from McMaster previously reported high levels of abuse, harassment and discrimination among medical trainees and was able to elaborate further on the nature of the offence (Cook et al., 1996). More detail would be useful to better understand this problem and to consider the impact of it and ways to respond.

5.2.3 Implications for physician trainees

This questionnaire allowed anonymous reporting of significant aspects of the training experience that may contribute to burnout. The surprising numbers of adverse trainee events have already been discussed and will not be repeated here. However it is worth noting that some medical trainees are disinclined to report aspects of their training that may not be positive. It is well documented that trainees in the United States do not necessarily disclose the hours they work or report needlestick injuries (Ayas et al., 2006; Cohen, Czeisler, & Landrigan, 2013). This may be because it could reflect negatively on their program or on themselves. Furthermore trainees would be disinclined to disclose to their program that they had done something they were not proud of. The added question, asked of 42 respondents asking if they had done something they

were not proud of over the last 30 days, has the potential to uncover events that have occurred that trainees may not otherwise report. Such information is potentially very valuable, both for the trainees themselves and for the training program.

The questionnaire also provided a mechanism for trainees to describe their perception of care, without drawing potentially unwanted attention to themselves. The respondents in this pilot perceived patient care positively. Ninety-four per cent of respondents either agreed or strongly agreed that their patients had received the care they needed when they needed it. This implied a reassuring positive perception of patient care among this sample.

Residents had an overall positive perception of their learning during the duty periods described. Schedules were generally adhered to amongst this sample. Most scheduled education was attended. Scheduled duty hours generally matched worked hours. However an analysis of the documented start and finish times of the duty periods revealed one hour difference between the scheduled work hours and the actual hours spent at the hospital. Furthermore the number of days not worked and overnight duty periods worked over the 30 day period prior to the date of the questionnaire generally met the relevant provincial guidelines (PARO, 2017b) . This is important because one criticism of duty hour restrictions has been the possible impact on attendance at formal education sessions. In this sample of trainees there was no evidence of compromise of education because of duty hour restrictions. Secondarily, compliance with duty hours has been widely discussed both in Europe and the US with concern that duty hour restrictions are not adhered to. In this sample, trainees worked within the limitations of provincial guidelines. This highlights that the hospital system and training program are interested in complying with these rules and may be informative for future applicants to this training program.

5.3 Limitations

5.3.1 Limitations associated with the research tool

Questionnaires are a practical method of collecting a broad range of information from a large and varied group of subjects (Baldwin & Daugherty, 2004). However there are limitations inherent in using questionnaires for collection of data. Specifically, the following limitations are apparent in relation to this project.

First, the questionnaire relied on self-report data, which may have led to inaccuracies. Social desirability bias may have influenced the responses provided to some of the questions. This does not mean the respondent is intentionally lying when giving a socially desirable answer. This contrasts with the concept of 'faking good' when the respondent is intentionally attempting to create a false positive impression (Streiner, 2003). This may have also influenced some of the responses. The responses provided to questions concerning scheduling could have been affected by such a phenomenon. The medical trainees surveyed may have felt pressure to report adherence to provincial rules on duty hours for example and may have been concerned about whether the questionnaires were truly anonymous. The responses provided generally adhered to provincial rules. This may have been a true reflection of the situation or may have been influenced by bias. Furthermore the questions relating to patient care and supervision could have been affected by such a bias. Trainees may want to give a socially desirable response to the question concerning adequate care provision.

Another bias that may have featured in the responses provided is the central tendency or end-aversion bias, which refers to the reluctance of people to use the extreme categories of a scale (Streiner, 2003). Several questions on the questionnaire were based on scales. One example where responses were clustered centrally was the question asking 'How many patients did you learn from?'. The 'central' response was 3-6 patients. The spectrum ranged from 0 to >15. Forty-three percent of respondents reported learning from 3-6 patients. This may be reflective of a common number of patients trainees are exposed to in an average day or may be reflective of a central tendency bias. A larger and more varied sample would provide more robust information on whether these biases are influencing our findings.

Second, the distribution method did not allow us to accurately measure a response rate. Future distributions of this questionnaire would prioritise obtaining measures of the eligible population, the number of eligible individuals with opportunity to participate and the number of returned questionnaires in order to calculate response rates. Low response rate to a questionnaire limits the generalizability and validity of the responses. In this pilot evaluation the priority was to test the utility of the questionnaires, and its individual questions.

Third, respondents filled out certain sections incorrectly or illegibly, which could have influenced the quality of the data. As outlined in the results section, there were a number of

respondents who either reported not working a duty period or did not respond to this question, but then proceeded to respond to the questions about a duty period. We decided that if information were provided, we would assume a duty period was worked. However this may have created a bias in the data, towards respondents providing information that they felt was relevant, rather than strictly following the questionnaire format.

Fourth, the questionnaire method was anonymous and did not allow us to follow up on particular questions or clarify issues. A mixed method approach would have enabled us to obtain more information on certain areas, which could have been informative. However respondents may have been reluctant to provide further information on certain sensitive issues.

Fifth, respondents at different levels of training may perceive patient safety very differently. The analytic approach used assumed perceptions of safety and patient harm did not change over years of residency training. Greater understanding of how respondents perceived the concept of 'patient harm' will require further study and may lead to modification of the questions and, or the analytic approach used.

Finally, there may have been a recall bias associated with asking respondents to describe information from the last 30 days, the last week and detailed information from the duty period recently worked. For this reason the questions asked focused on features of the work and clinical experience that should be easily remembered over the timeframe within question.

5.3.2 Limitations of this project

The distribution to trainees all based in one paediatric centre was an efficient way to pilot the questionnaire. It facilitated surveying a group of trainees at different levels of seniority and with different demographic characteristics, all working in the same institution. A number of trainees completed the questionnaire more than once and therefore had a familiarity with the questionnaire, which should have facilitated ease of completion. However isolating the distribution to one centre limits the generalizability of the results to other centers and populations. The questionnaire will need to be validated in other settings.

All respondents were trainees working with paediatric patients. Trainees working with adult patients may have different attitudes towards patient care or very different clinical and on-call

experiences. Furthermore the scope of practice of our participants was relatively narrow and included few surgical trainees who may have very different experiences and perceptions. Future studies should include trainees from several different centres, ideally both rural and urban settings and should include trainees affiliated with different specialties to understand the differences that may be a feature of their training.

The questionnaire design is such that the majority of the questions in the questionnaire are related to a specified duty period. If respondents did not work a duty period on the specified date, a large section of the questionnaire was not answered. In the responses obtained from this pilot, 25% of respondents did not work a duty period on the specified date. There was a reduced response burden for these respondents but the associated cost was a reduced volume of data available for analysis.

There was limited variability in some of the question responses. This may be a limitation of the questions themselves or may be because the respondents were all working in the same institution. One example is the main outcome question relating to patient care. There was limited variability in the response to this question. This may be because all respondents were working in the same centre, with a collective attitude towards provision of patient care. It may also suggest that the question is unable to adequately distinguish variability in provision of patient care. The lack of variability in responses limited the ability of this question to function as a main outcome question to assess potential predictive factors associated with improved patient care. More variability in this outcome would support conduct of more informative regression analyses.

Finally, there is no data available on non-responders or trainees who chose not to respond on a given date of distribution. Trainees on busier clinical days may have chosen not to respond, or conversely non-responders may be less busy trainees who opted not to complete the questionnaire. Dominance of either situation may have caused results to be less representative of extremes.

5.4 Future Directions

Distribution of this questionnaire to a wider variety of medical trainees working in different training environments would allow comparison of responses between different teaching hospitals

and diverse medical specialties. A larger number and more diverse range of responses may provide more variability in responses and would allow further analysis of the inter relationship between different predictive factors in the training hospital environment. Trainees should be accessible through the universities they are affiliated with or through provincial organisations that represent them.

Distribution of the questionnaire to groups of trainees in specified training programs only or, on a larger scale, to all trainees working at a particular hospital (via their hospital email) or trainees affiliated with a particular university (via their university email), would allow knowledge of a denominator and would contribute towards calculating a response rate. An electronic version of the questionnaire would lend itself to distribution via email as opposed to paper-based distribution. In future paper distributions of the questionnaire a unique identifier on each physical questionnaire would allow an accurate calculation of the number of returned questionnaires, thus facilitating calculation of a response rate –facilitated by robust knowledge of the denominator.

Future iterations of the questionnaire could avoid missing the duty period details by asking respondents to provide data on the most recent duty period they had worked rather than a specified date. Increasing the window for duty period description would allow many more respondents to describe their most recent duty period yielding more results from respondents. Furthermore future iterations of the questionnaire could be distributed in an electronic format, which would allow better management of expandable questions and would ensure internal consistency in responses. A possible strategy combining electronic format and maximizing the quality and quantity of data could be to ask trainees to fill in the questionnaire as soon as they have completed a duty period. This could be done in person, by text or by email – to provide different options to the respondents.

Analysis of the responses obtained from the pilot distribution revealed intermittent inconsistencies in the data, as described above. Such inconsistencies would be avoided by use of an electronic format. Follow-on questions would only be present when indicated by the previous question's response. An electronic version of the questionnaire would need preliminary testing in a similar fashion to this pilot to evaluate the applicability of the questionnaire in this format.

Future studies should explore the finding of report of medical error in the last seven days in more detail, perhaps with a qualitative component (if anonymity could be retained). Furthermore it

would be interesting to consider the impact of seniority on perception of patient care. Anecdotal evidence would suggest that more senior residents perceive patient care differently than their junior colleagues. It would also be informative to include an analysis of the different factors that motivate residents. This is particularly relevant given the diverging preferences that appear to be emerging, in particular with regards to duty hours, between residents training in different specialties (Drolet et al., 2013).

5.5 Conclusion

This thesis has described the motivation behind development of this questionnaire, modifications made to the design of the questionnaire, and the methods and results of its pilot distribution. The objectives of this questionnaire were to describe the physician trainee and their work and education framework, describe three effects of this environment relating to both physician trainees and their patients, and to evaluate associations between the environment and these three effects. The questionnaire was piloted on seven separate occasions among trainees working at a paediatric centre. The overarching aim of this research was to inform policy regarding physician training, for the hospital system, post-graduate medical education programs and trainees themselves.

The original motivation for this questionnaire was to look at the inter-relationships between the areas of trainee learning, patient care and adverse trainee events. The data obtained provides a preliminary exploration of this topic. The evaluations were underpowered to evaluate the relative importance of and inter-relationships between the factors of relevance to the physician trainee environment, due to the modest sample size, limited variability in the primary patient care outcome and some potentially predictive factors, and evaluation in a single centre. However in analysing the data we discovered valuable descriptive results that inform us about the trainee physician framework and adverse trainee events experienced by the trainees in this sample.

This pilot project serves as a proof of concept to inform future iterations and distribution of this type of questionnaire. The preliminary analyses have provided insight into ways in which this questionnaire can be improved upon to further meet the overarching objective in the future. One future goal is to extend the distribution of this questionnaire to obtain sufficient data to more fully meet the research objectives. A broader population would allow a comparison between

trainees working in different centres and a larger population could provide the data required to effectively evaluate potential inter-relationships between the trainee environment and its effects on trainee learning, patient care and adverse trainee events.

The medical trainee environment is dynamic and continues to evolve in line with the expectations of the PGME, the public and the trainees themselves. The results of 132 completed questionnaires have provided insight into the physician trainee experience and the variability that exists even between trainees working in the same institution. As medical training moves towards a competency-based model, this questionnaire may be used to capture the current experience and to identify strengths and weaknesses of the current system and to monitor the impact of ongoing changes.

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Appendices

Appendix A: Questionnaire – version date 5 March 2012

Physician wellbeing, medical education & patient safety: *a survey of trainee physicians in Ontario*

Trainees in Ontario Teaching Hospitals provide the majority of frontline care to patients.

The purpose of this research study is to understand physician trainee well-being, formal and informal education, patient-care responsibilties, supervision, workload, worked hours and scheduled hours (for both clinical and education 'duty') and to evaluate the relationships of these with learning and patient safety.

Participation in this study is completely voluntary.
Completion of the survey will indicate implied consent.

We have defined Duty periods are follows:

- Duty periods are periods of continuous duty
- Duty periods are worked either in hospital, from home, in a clinic, or in combinations of these.
- Duty Periods include the time allocated for academic half-days.
- Duty periods include regular work days, night shifts, and 'on-call'.
- They describe your time associated with scheduled academic and clinical activities.

Home Call & Duty Periods:

- Duty periods that start in the morning may include home call for the overnight or other portion of a CONTINUOUS period of duty. These composite 'days' should be counted as ONE duty period.
- The end of a home call duty period: duty periods where you are doing home call that merges into a new day (eg. 8am) should be regarded as ending at the time of morning handover, or when you start clinical work.

Investigators: CS Parshuram, H Kirpalani, R Osborne
A Atkinson, G Bandiera, P Bragg, S Edwards, L Flynn, S Ginsburg, A Kotsakis,
G Norman, R Schneider, K Shojania, S Spadifora, R Reznick, K Taylor, M Topps, M Walton, H Yang

Data Entry
Date ____/____/____

Verified
Date ____/____/____

1

centre | Physician Trainee Record | Daily Diary Study | participant number

Please describe yourself

date 30 APR 12 (day month year)

Section A: The following questions refer to you as you complete this survey

1. Which Canadian training program are you primarily affiliated with?

[ ] Anaesthesia	[ ] General Surgery	[ ] Surgery Sub-speciality
[ ] Emergency Medicine	[ ] Paediatric Medicine	[ ] Paediatric Med. Sub-specialty
[ ] Family Medicine	[ ] Internal Medicine	[ ] Internal Med. Sub-speciality
[ ] Obstetrics- Gynecology	[ ] Opthalmology	[ ] Critical Care Medicine
[ ] Other	[ ] Psychiatry	

2. In which level of training are you within this program? (expressed as postgraduate year of training)

[ ] PGY1	[ ] PGY2	[ ] PGY3
[ ] PGY4	[ ] PGY5 or more	[ ] International Graduate as clinical fellow

3. Since you graduated from medical school, how many years have you worked as a physician/trainee physician?

[ ] One year or less	[ ] Two years	[ ] Three years
[ ] Four years	[ ] Five years	[ ] Six or more years

4. Do you have your Core Specialty examinations/certification either in Canada or another Country?

(for example your FRACP, FRCPC, MRCP)	[ ] No	[ ] Yes

5. How many times have you completed this survey previously? (before this time)

[ ] Never before	[ ] Once before	[ ] Twice before	[ ] 3 times before	[ ] 4 or more times

6. Do you live with any children? (less than 12 years)

[ ] No	[ ] One	[ ] Two	[ ] Three or more

7. Please indicate your age from the groups below

[ ] <25 years	[ ] 25-30 years	[ ] >30-35 years
[ ] >35-40 years	[ ] >40 years	

Section B: In the last 7 days...

1. How many patients did you care for who you consider were harmed by medical error? _____ patients
(i.e. a patient that had steroids stopped inappropriately with resultant profound hypotension requiring treatment, renal failure induced by NSAIDs that were supposed to have been stopped or pneumothorax following subclavian line insertion)

2. How many hours of formal teaching were you scheduled to attend in the last 7 days? _____ hours

3. How many hours of formal teaching did you attend in the last 7 days? _____ hours

centre | **Physician Trainee Record** | Daily Diary Study | participant number

In the month preceding the date on this page..... | date 30 APR 12 (day month year)

Section C: In the last 30 days...

1. How many days have you not worked? (including both weekends and weekdays and sick days) _____ days

2. How many duty periods that you worked included the hours 23:00-5:00am? _____ duty periods

3. How many times have you travelled from work to home or from home to work in a vehicle (driven by yourself), on bicycle or motorcycle (driven or ridden by yourself) or as a pedestrian? _____ times

4. Were you involved in any crashes (in a vehicle, on bicyle or motorcycle, or as pedestrian)? _____ crashes.
If you have been involved in one or more than one crash in the last month then please describe the most recent...
- The timing in relation to the most recent duty period that you worked (or were working):

Time of crash :	Time vs. most recent/ current duty period :	Duration of this duty period _____ hrs	Did this duty period include 0-6:00am?
[ ] 06:00-11:59am [ ] 12:00-17:59pm [ ] 18:00-23:59pm [ ] 23:00-05:59am	[ ] During a duty period [ ] <2hrs after [ ] >2hrs after		[ ] no [ ] yes

- What was the outcome of the crash?

Were you injured? [ ] no [ ] yes ...if yes..did you see a doctor? [ ] no [ ] yes ...were you hospitalised? [ ] no [ ] yes ...how much time off work? _____days	Were others injured? [ ] no [ ] yes	Please tick option that applies: Pedestrian [ ] Single vehicle [ ] Multiple vehicle [ ]

5. Have you fallen asleep while driving after working a duty period?
[ ] No [ ] While at a stop light [ ] While the car was moving

6. In the last month, did you have a needlestick injury or other unintended bodily fluid exposure while at work? _____ times
If you have had one or more unintended bodiliy fluid exposures in the last month then please describe the most recent...
- The time of day the exposure occurred...

Time of Exposure	Duration of this duty period :	Did this duty period include 0-6am?
[ ] 6 - 11:59am [ ] 12 - 18:59pm [ ] 19 - 23:59pm [ ] 23 - 05:59am	_____hrs	[ ] no [ ] yes

7. Were you the subject of inappropriate personal comments during a duty period? _____ times
By whom: [ ] colleague or [ ] patient or patient family member
Comment: [ ] overly familiar [ ] impolite [ ] overly sexual [ ] other

8. Did you do something that you were not proud of on a professional level during a duty period? _____ times

9. Were you physically assaulted or threatened by a patient or family member? _____ times

10. Did you take any sick leave? _____ days

centre | Physician Trainee Record | Daily Diary Study | participant number

Describing My Duty Period beginning on the ..... | date 30 APR 12 (day month year)

We have defined Duty periods are follows:

- Duty periods are periods of continuous duty
- Duty periods are worked either in hospital, from home, in a clinic, or in combinations of these.
- Duty Periods include the time allocated for academic half-days.
- Duty periods include regular work days, night shifts, and 'on-call'.
- They describe your time associated with scheduled academic and clinical activities.

Section D: Duty period

1. Did you work a duty period that began on the above date

[ ] No ... if not why?	[ ] None scheduled [ ] Leave: [ ] sick leave [ ] family leave [ ] study leave [ ] conference [ ] other I did _____ hours of study on the above date I did _____ hours of research on the above date
[ ] Yes ... if yes	**.... Please continue and complete the duty period survey**

If you did NOT work a duty period starting on this date then stop here. Thank you.

2. Which rotation did you work?

[ ] Internal Medicine (general)	[ ] Int. Medicine sub-speciality	[ ] Surgery - general
[ ] Paediatric Medicine (general)	[ ] Paed. Medicine sub-speciality	[ ] Surgical sub-speciality
[ ] Family Medicine	[ ] Psychiatry	[ ] Obstetrics- Gynecology
[ ] Anesthesia	[ ] Emergency Medicine	[ ] Other: single service rotation
[ ] Other: Multi-service rotation		

3. Was the rotation that you worked a 'core' rotation for your training program? [ ] Yes [ ] No
i.e.: you would answer 'Yes' if you are in a Neurosurgery training program you did a Neurosurgery rotation.

4. Where did you work this duty period? please check all that apply

[ ] In a hospital main Hosp. name: _____	[ ] in a clinic - not a hospital	[ ] from home (home call)

5. When was this duty period scheduled to start and finish??? please use DMY 24 hour time

Scheduled Start date & time	day | mon | year ____ :____	[ ] I don't know the start time
Scheduled End date & time	day | mon | year ____ :____	[ ] I don't know the end time

6. When did you Start and Finish work for this duty period?

Start time	day | mon | year ____ :____	**please use DMY 24 hour time**
Finish time	day | mon | year ____ :____	**please use DMY 24 hour time**

Centre for Safety Research | centre | **Physician Trainee Record** | Daily Diary Study | participant number

The BEGINNING of your duty period starting..... | date 30 APR 12 (day month year)

7. How many hours did you sleep in the 12 hours before the start of this duty period? _____ hours

8. At the start of this duty period how many patients did you assume responsibility for? _____

9. Did you receive hand over from the previous physician(s) when starting this duty period?

[ ] No, there were no clinical details / patients to hand over
[ ] No, I had no or limited contact with previous physician(s)
[ ] No, I was the previous physician (home call in previous duty period)
[ ] Some, but the handover was not completed
[ ] Yes, the handover from other physician(s) was completed

10. If you received some form of handover at the start of your duty period please describe....

[if not please go on to question 11]

10a. How you received the handover? **please indicate all that apply**

[ ] telephone | [ ] verbally in person | [ ] on paper | [ ] by email | [ ] online

10b. How many patients were handed over to you? _____

10c. How structured was the handover?

Not at all Structured [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] Completely Structured

10d. How involved were staff physician(s) in the handover? scale of 0 (not at all) to 10 (completely)

Not at all [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] Completely

10e. How many minutes did this initial handover take? _____ **(excluding interruptions)**

10f. How much time during this initial handover was dedicated to informal teaching?

None [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] The entire time

10g. How do you rate the accuracy of the information about the patients handed over to you?

Completely INaccurate [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] Completely accurate

10h. How well did the handover (teaching & information) prepare you to care for your patients?

Not at all [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] Completely

11. Were additional patients handed over to you during your duty period?

[ ] No | [ ] Yes | how many patients _____
| | from how many physicians _____

DURING your Duty Period that started .... | date 30 APR 12 (day month year)

12. Did you admit new patients during your duty period?

[ ] No	[ ] Yes	how many patients _____

13. Among the patients you were responsible for during this duty period, how many patients did you examine physically?

[ ] None	[ ] Some.... how many? _____	[ ] All

14. How many patients did you learn from?

[ ] None	[ ] 1-2	[ ] 3-6	[ ] 7-10	[ ] 11-14	[ ] >15

15. Did you attend formal education sessions during your duty period?

[ ] No... if not.... why?	[ ] There was none scheduled [ ] I had a better educational opportunity staying with a patient [ ] My clincal responsibilites prevented me [ ] I chose not to attend for some other reason
[ ] Yes... if yes...	How long were the formal education sessions _____ min For how long did you attend these sessions _____min How much did you learn in formal education sessions? Nothing [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] I learned a lot

16. Did you have contact with your staff physician(s) during this duty period? (apart from handover)

[ ] No	[ ] Once	[ ] Two or Three times
[ ] Four or Five times	[ ] More than Five times	[ ] Almost continuously

17. Approximately how long did you interact with your staff physician(s) for over the duty period (including handover)?

[ ] No time	_____ hours _____ minutes

18. Were other trainees looking after the same patients with you during this duty period??

_____ other trainees were supervising me
_____ other trainees were supervised by me
_____ other trainees were working with me

19. Overall, in this duty period, how much did you learn that was useful for your practice as a physician?

Nothing Useful [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] I learned a lot of Useful things

centre | Physician Trainee Record | Daily Diary Study | participant number

DURING your Duty Period that started .... | date 30 APR 12 (day month year)

20. How many caffeinated drinks did you drink during this duty period? (eg. coffee, tea, coke, sports drinks)

[ ] None	[ ] One	[ ] Two
[ ] Three	[ ] Four	[ ] Five or more

22. How would you rate the adequacy of your nutrition during this duty period? (content and timing of meals or snacks)

Completely INadequate [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] Completely adequate

21. Did you perform any procedures during this duty period?

[1] No		Number you were involved in	Time spent (min)
[2] Yes if yes.... ..... please indicate	Surgery in Operating room		
	Other Procedure in the OR (apart from giving anesthesia)		
	Peripheral IV or Arterial sample		
	Lumbar Puncture		
	Intubation		
	Central or Arterial Line insertion		
	Chest Drain insertion		
	Cardiopulmonary Resuscitation		
	Minor Procedures (not in OR)		
	Other		

22. How much sleep did you get during this duty period? ..... hours, ... minutes
If you slept, what was your longest period of uninterrupted sleep? ..... hours, ... minutes

23. How would you rate the accuracy of the information in the handover you gave to others?

Completely INaccurate [0] [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] Completely accurate

[ ] I did not handover patients at the end of this duty period

24. During the duty period described by this survey please indicate your agreement / disagreement with the statements...

[a] "My patients received the care they needed when they needed it."
[ ] Strongly agree [ ] Agree [ ] Neither agree or disagree [ ] Disagree [ ] Strongly Disagree

[b] "I felt I was able to provide patients with the care they needed when they needed it."
[ ] Strongly agree [ ] Agree [ ] Neither agree or disagree [ ] Disagree [ ] Strongly Disagree

Many thanks.

Appendix B: List of questions, number of responses expected, number of responses received, question response rate and summary of results.

Question	Number of responses expected	Number of responses received	Rate of response	Median (IQR) or No (%)
Section A				
[A1] Which Canadian training program are you primarily affiliated with?	132	131	99%	- Paediatric medicine: 71 (54.20) - Critical care medicine: 33 (25.19) - Paediatric medicine sub-specialty: 27 (20.61)
[A2] Which level of training are you within this program?	132	129	98%	- PGY 1: 9 (22.48) - PGY 2: 38 (29.46) - PGY 3: 15 (11.63) - PGY 4: 4 (3.10) - PGY 5 or more: 14 (10.85) - International medical graduate working as clinical fellow: 29 (22.48)
[A3] Since you graduated form medical school, how many years have you worked as a physician/ trainee physician?	132	131	99%	- One year or less: 30 (22.90) - Two years: 31 (23.66) - Three years: 10 (7.63) - Four years: 8 (6.11) - Five years: 13 (9.92) - Six or more years: 39 (29.77)
[A4] Do you have your 'core' specialty examinations/ certification either in Canada or another country?	132	130	98%	- No: 78 (60) - Yes: 52 (40)
[A5] How many times before have you completed this survey previously? (before this time)	132	131	99%	- 0 times: 90 (68.7) - 1 time: 36 (27.48) - 2 times: 3 (2.29)

				- 3 times: 2 (1.53)
[A6] Do you live with children? (less than 12 years)	132	131	99%	- 0 children: 101 (77.10) - 1 child: 15 (11.45) - 2 children: 8 (6.11) - 3 or more children: 7 (5.34)
[A7] Please indicate your age from the groups below?	132	130	98%	- <25 years: 4 (3.08) - 25-30 years: 65 (50.00) - >30-35 years: 44 (33.85) - >35-40 years: 11 (8.46) - >40 years: 6 (4.62)
Section B				
[B1] In the last 7 days, how many patients did you care for who you consider were harmed by medical error?	132	99	75%	- 0 patients: 71(71.72) - 1 patient: 21 (21.21) - 2 patients: 6 (6.06) - 10 patients: 1 (1.01)
[B 2] How many hours of formal teaching were you scheduled to attend in the last 7 days?	132	99	75%	- 6 (4 – 7.5)
[B 3] How many hours of formal teaching did you attend in the last 7 days?	132	99	75%	- 5 (3 - 6)
Section C: In the last 30 days….				
[C1] How many days have you not worked?	132	130	98%	- 6 (4-9)
[C2] How many duty periods that you worked included any hours between 23:00 and 05:00?	132	129	98%	- 5 (4-7)
[C3] How may times have you travelled from work to home or from home to work in a vehicle (driven by yourself), on bicycle	132	127	96%	- 30 (6-48)

or motorcycle (driven or ridden by yourself) or as a pedestrian?				
[C4] Were you involved in any crashes?	132	130	98%	- 0 crashes: 128 (98.46) - 1 crash: 2 (1.54)
[C5] Have you fallen asleep while driving after working a duty period?	44	42	95%	- No: 40 (95.23) - Yes: 2 (4.77)
[C6] Did you have a needlestick injury or other unintended bodily fluid exposure while at work?	132	129	98%	- 0 times: 118 (91.47) - 1 time: 9 (6.98) - 2 times: 2 (1.55)
[C7] Were you the subject of inappropriate personal comments during a duty period?	132	131	99%	- 0 times: 96 (73.28) - 1 time: 22 (16.79) - 2 times: 10 (7.63) - 3 times: 2 (1.53) - 5 times: 1 (0.76)
[C8] Did you do something that you were not proud of on a professional level during a duty period?	44	44	100%	- 0 times: 32 (72.7) - 1 time: 11 (25) - 5 times: 1 (2.3)
[C9] Were you physically assaulted or threatened by a patient or family member?	132	131	99%	- 0 times: 123 (93.89) - 1 time: 5 (3.82) - 2 or more times: 3 (2.29)
[C10] Did you take any sick leave?	132	132	100%	- 0 days: 112 (84.85) - 0.5 days: 2 (1.52) - 1 day: 14 (10.61) - 2 days: 2 (2) - 3 days: 2 (2)
Section D: In relation to duty period				

[D1] Did you work a duty period that began on the above date?	132	124	94%	- No: 32 (25.81) - Yes: 92 (74.19)[1]
- Reason for not working a duty period	32	26	81%	- None scheduled: 19 (73.07) - Study leave: 3 (11.54) - Conference: 1 (3.85) - Other: 3 (11.54)
[D2] Which rotation did you work?	101	97	96%	- Emergency medicine: 4 (4.04) - Other: multi service rotation: 1 (1.01) - Other: single service rotation: 5 (5.07) - Paediatric Medicine sub-specialty: 71 (71.72) - Paediatric Medicine (general): 13 (13.13) - Obstetrics-gynaecology (paediatric): 1 (1.01) - Surgery (general): 1 (1.01) - Surgery sub-specialty: 1 (1.01)
[D3] Was the rotation that you worked a 'core' rotation for your training program?	101	100	99%	- No: 10 (10) - Yes: 90 (90)
[D4] Where did you work this duty period?	101	101	100%	- Hospital: 96 (95.05) - Clinic (not hospital): 1 (0.99) - From home: 2 (1.98) - Hospital and home: 2 (1.98)
[D5] Duty period scheduled length (hours)?	101	86	85%	- 10 (9.5-24.5)
[D6] Duty period actual length? (hours)	101	86	85%	- 11 (9.5-25)
[D7] How many hours did you sleep in the 12 hours before the	101	97	96%	- 6.5 (6-7)

[1] A total of 101 duty periods were described – we interpreted that if a duty period were described we would assume a duty period was worked.

start of the duty period?				
[D8] At the start of the duty period how many patients did you assume responsibility for?	101	94	93%	- 5 (3-11)
[D9] Did you receive hand over from the pervious physician(s) when starting this duty period?	101	98	97%	- No, no details to hand over: 14 (14.29) - No, I had limited contact with previous physician: 3 (3.06) - No, I was the previous physician (home call): 5 (5.1) - Some, but the handover was not completed: 2 (2.04) - Yes, handover completed: 74 (75.51)[2]
[D10a] How did you receive the handover?	83	82	99%	- Telephone: 1 (1.22) - Verbally in person: 62 (79.27) - On paper: 2 (2.44) - By phone and verbally in person: 1 (1.22) - On paper and verbally in person: 10 (12.20) - By email and verbally in person: 1 (1.22) - By telephone, verbally in person and on paper: 2 (2.44)
[D10b] How many patients were handed over to you?	83	82	99%	- 8.5 (4-17)
[D10c} How structured was the handover? (Likert scale 0-10)	83	82	99%	- 7 (5-8)
[D10d] How involved were staff physician(s) in the handover? (Likert scale 0-10)	83	83	100%	- 6 (0-9)
[D10e] How many minutes did this initial handover take?	83	81	98%	- 30 (15-60)
[D10f] How much time during this initial handover was	83	83	100%	- 1 (0-3)

[2] Two respondents did not respond to this question but provided responses to the follow on questions regarding handover – it was decided that if responses were provided we would assume a handover was received.

dedicated to informal teaching? (Likert scale 0-10)				
[D10g] How do you rate the accuracy of the information about the patients handed over to you? (Likert scale 0-10)	83	82	99%	- 8 (7-9)
[D10h] How well did the handover (teaching and information) prepare you to care for your patients? (Likert scale 0-10)	83	82	99%	- 7 (6-8)
[D11] Were additional patients handed over to you during your duty period?	101	98	97%	- No: 67 (68.37) - Yes: 31 (31.63)
- D11 (a) If yes how many patients?	31	24	77%	Range of 1-30 patients
- D11 (b) If yes by how many physicians?	31	27	87%	Range of 0-10
[D12] Did you admit new patients during your duty period?	101	98	97%	- No: 60 (61.22) - Yes: 38 (38.78)
- D12 (a): If yes how many?	38	35	92%	- 1 patient: 11 (31.43) - 2 patients: 8 (22.86) - 3 patients: 10 (28.57) - 4 patients: 4 (11.43) - 6 patients: 2 (5.71)
[D13] Among the patients you were responsible for during your duty period, how many patients did you examine	101	95	94%	- None: 1 (1.05) - 1-2 patients: 6 (6.32) - 3-6 patients: 34 (35.79) - 7-10 patients: 15 (15.79)

physically?				- 11-14 patients: 4 (4.21) - >10 patients: 7 (7.37) Options changed in later iterations of questionnaire - None of patients: 0 - Some of patients: 11 (11.58) - All of patients: 17 (17.89)
[D14] How many patients did you learn from?	101	98	97%	- None: 5 (5.1) - 1-2: 25 (25.51) - 3-6: 42 (42.86) - 7-10: 21 (21.43) - 11-14: 1 (1.02) - >15: 4 (4.08)
[D15] Did you attend formal education sessions during your duty period?	101	100	99%	- No: 59 (59) - Yes: 41 (41)
- D15 (a) If not why?	59	46	78%	- None scheduled: 35 (76.09) - I had better educational opportunities staying with a patient: 2 (4.35) - Clinical responsibilities prevented me: 7 (15.22) - I chose not to attend: 2 (4.35)
- D15 (b) If yes how long was the session? (minutes)	41	41	100%	60 (60-120)
- D15 (c) If yes, for how long did you attend? (minutes)	41	36	88%	60 (60-120)
- D15 (d) If yes, how much did you learn in the session? (Likert scale 0-10)	41	42	102%	7 (6-8)

[D16] Did you have contact with your staff physician(s) during this duty period? (apart from handover)	101	99	98%	- No: 11 (11.11) - Once: 12 (12.12) - Two or three times: 27 (27.27) - Four or five times: 16 (16.16) - More than five times: 24 (24.24) - Almost continuously: 9 (9.09)
[D17] Approximately how long did you interact with your staff physician(s) for over the duty period, including handover? (minutes)	101	95	94%	- 60 (30-180)
[D18] Were other trainees looking after the same patients with you during this duty period?	101	92	91%	- None: 16 (17.39) - Other trainees were supervising me: 25 (27.17) - Other trainees were supervised by me: 20 (21.74) - Other trainees were working with me: 18 (19.57) - Other trainees were supervising me and other trainees were supervised by me: 1 (1.09) - Other trainees were supervised by me and other trainees were working with me: 3 (3.26) - Other trainees were supervising me and other trainees were working with me: 5 (5.43) - Other trainees were supervising me and supervised by me and other trainees were working with me: 4 (4.35)
[D19] Overall in this duty period, how much did you learn that was useful for your practice as a physician? (Likert scale 0-10)	101	99	98%	- 6 (5-7)
[D20] How many caffeinated drinks did you drink during this duty period?	101	101	100%	- None: 14 (13.86) - One: 33 (32.67) - Two: 27 (26.73) - Three: 17 (16.83)

				- Four: 6 (5.94) - Five or more: 4 (3.96)
[D21] How much sleep did you get during this duty period? (hours)	101	101	100%	0 (0-2.5)
[D22] How would you rate the adequacy of the information in the handover you gave to others? (Likert scale 0-10)	101	97	96%	8 (7-9)
[D23] Rate your agreement with the following statements: (Likert scale) "My patients received the care they needed when they needed it" "I felt I was able to provide patients with the care they needed when they needed it"	101 101	98 97	97% 96%	- Strongly agree: 30 (30.61) - Agree: 61 (62.24) - Neither agree or disagree: 4 (4.08) - Disagree: 3 (3.06) - Strongly disagree: 0 - Strongly agree: 30 (30.93) - Agree: 54 (55.67) - Neither agree or disagree: 10 (10.31) - Disagree: 3 (3.09) - Strongly disagree: 0

Appendix C: Statement of contributions

The questionnaire was designed, implemented and refined over multiple iterations. The following people contributed to the questionnaire development prior to the commencement of this thesis project: Drs. C.S. Parshuram, H. Kirpalani, A. Atkinson, R. Schneider, K. Shojania, and was reviewed by Drs. G. Bandiera, P. Bragg, S. Edwards, L. Flynn, S. Ginsburg, A. Kotsakis, G. Norman, R. Schneider, K. Shojania, S. Spadifora, M. Topps, M. Walton, and H. Yang.

My supervisor Dr. Chris Parshuram and committee members Dr. Kaveh Shojania and Dr. Shiphra Ginsburg, alongside contribution to the initial questionnaire, helped with analysis of the results and provided me with guidance on the interpretations of the findings as they relate to the field of medical education.

Dr. A. Douglas provided me with assistance with biostatistics for the analyses.