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Interprofessional Team membership Stability, Collective Team Competence, and Patient Outcomes in Emergency Departments

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This is to certify that the doctoral dissertation by

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Abstract

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MN, Athabasca University, 2011

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Dissertation Submitted in Partial Fulfillment

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Abstract

Medical errors in emergency departments (EDs) have been researched extensively but people who use EDs have continued to be at risk. A gap in knowledge existed as to what the relationship is between interprofessional (IP) team membership stability (TMS), work experience, collective competence, and ED patient outcomes. Guided by the collective competence theory, this quantitative correlational study sampled three rural EDs, a 33% response rate. IP participants rated collective competence as high. Using regression analysis and 3 months of existing data, IP ED core teams showed low temporal stability and the relationship between TMS and medical errors was not statistically significant, but work experience was related to a decrease in time to physician and length of stay. TMS and work experience correlated positively (r = .42) and moderating effects were tested. TMS had a negative moderating effect on work experience. Also, neither TMS nor work experience were statistically significant when patient volumes and levels of acuity were controlled. In contrast, when team size was controlled, TMS had a large effect size on time to physician. Conclusion: (a) structured organizational processes were present to buffer low TMS; (b) high team cohesiveness existed within the low TMS and groupthink may have been present; and (c) determining the ceiling effect for optimal team size was needed. These results may benefit ED patients, point of care providers, administrators, and funders to strengthen collective knowledge at the organizational level by using standardized processes to buffer low TMS, implement strategies to mitigate groupthink to prevent collective failures, and consider team size for effecting a responsive and effective healthcare system to improve the quality of ED patient care.

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Dedication

I dedicate this dissertation to all the people who lack access to education because "education is the most powerful weapon which you can use to change the world" (Nelson Mandela, 23 June 1990) and to all who do have access and embrace lifelong learning.

I also dedicate this dissertation to my husband Perry – my champion. Without his unconditional support and many sacrifices this journey would not have been possible.

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I would like to acknowledge some of the people who without their support during this journey, this dissertation would not have been possible.

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Chapter 1: Introduction to the Study

In 2016, medical errors continued to be the third leading cause of hospital deaths occurring primarily in the emergency departments (EDs), intensive care units, and operating rooms (Makary & Daniel, 2016). The Institute of Medicine (also known as National Academy of Medicine [IOM/NAM], 2000) challenged healthcare organizations to shift the focus of strategies to eliminate medical errors from individual care providers to modifying factors at the healthcare system (HCS) level. One recommendation was the use of teams in providing care. Subsequently, a move towards interprofessional (IP) collaborative practice was embraced, and IP collaborative practices in healthcare were linked to a decrease in patient complications, length of stay (LOS), hospital admissions, errors, and mortality rates (World Health Organization [WHO], 2010). However, existing healthcare organizational practices did not adequately address this problem. That is, in 2016, Mayo and Woolley reported teamwork failures as causing 70% to 80% of serious medical errors.

IP collaborative practice involves two or more healthcare providers from different professions delivering services for the same patient or patient population (Ambrose-Miller & Ashcroft, 2016; WHO, 2010). A move to provide patient care by IP teams has occurred, but highly competent professionals have continued to create incompetent teams with delays or compromises in patient care (Lingard, 2009, 2017). Furthermore, some teams are highly functioning even when one/some member(s) are not competent while one incompetent member paralyzes other teams (Lingard, 2009, 2017). Thus, in spite of the move towards IP collaborative practice, medical errors have continued to cause deaths in U.S. hospitals (Makary & Daniel, 2016), and teamwork failures have been identified as one root cause of the problem (Mayo &

Woolley, 2016). Therefore, because teamwork failures continue to place ED patients at risk, further research was indicated to explore elements related to effective IP teams.

Boreham (2004) and Lingard (2009, 2017) argued that effective collaborative IP practice requires collective competence. Boreham (2000) asserted that teamwork failures in EDs occur from lack of collective competence, and Ulrich and Crider (2017) reported that instability in team membership is one element that can undermine effective teamwork. Shiftwork schedules in healthcare introduce instability in team membership. Hence, why IP teamwork continued to fail and the role that team membership stability (TMS) and collective team competence (CTC) have on IP team effectiveness required further exploration. This study addressed this gap in the literature.

IP practice is at the core of care delivery (Mayo & Woolley, 2016). EDs are one of the high-risk care areas associated with a high number of patient deaths related to errors (Ulrich & Crider, 2017). Boreham (2004) asserted that individual and collective competence are constitutive in effecting positive patient outcomes. Thus, the purpose of this study was to explore the relationship between IP TMS based on shiftwork schedules, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. A comprehensive literature review provided the evidence that informed the issues identified above and the purpose for this study. Findings from this study about these relationships provide insights into the relationship between these predictors and medical errors within EDs.

The findings from this study are important. ED direct care providers and managers/administrators can benefit through an increased understanding that (a) working within teams with short-term low temporal stability should not impede their success at promoting patient safety; (b) the size of the team matters; (c) groupthink could lead to collective failures; and (d) standardized policies, guidelines, and processes can strengthen collective knowledge at the organizational level. Incorporating these findings within ED settings can result in a more responsive and effective HCS, improving quality of ED patient care, and render it safer, more accessible, comprehensive, coordinated, and patient-centered.

Within this chapter, information is presented that summarizes current knowledge related to medical errors, IP collaboration, and CTC (the variables of interest), captured in the background section. Based on an extensive literature review related to these factors, the need for more knowledge was identified. The important societal problem is medical errors that place many Americans and Canadians at risk, further described in the problem statement segment. An explanation of the purpose of this study and the research questions that has informed the selected research processes then follow. Furthermore, the premises of collective competence theory (CCT) as the theoretical framework that guided this research and the nature of this study are presented. This chapter closes with definitions of the variables and conceptual terms used; assumptions; scope, delimitations, and limitations; and explanation of the significance of this study.

Background

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. A comprehensive literature review related to these concepts was completed. A summary of some of the themes identified in the review follows.

Medical Errors

IOM/NAM (2000) classified medical errors into three categories: (a) diagnostic, (b) related to treatment, and (c) other types (including at the system level). Diagnostic errors from inadequate assessments that missed the severity of the patients' conditions were the most common type of medical errors that resulted in life threatening events or deaths (Zhang et al., 2018). Reported treatment errors included delays in initiating treatment and incorrect interventions and prescription and medication errors. Some of these treatment errors required changes in care management, operative interventions, invasive procedures, and/or use of medications (Boreham et al., 2000; Carlson, 2016; Linnebur et al., 2018; Solano et al., 2017). Reported system errors were evidenced in extended LOS, loss of key patient information, and inappropriate disposition decisions (Dolejs et al., 2017; Eriksson et al., 2018).

System-level factors associated with medical errors included excessive workload, insufficient number of nurses, fatigue, exhaustion, and burnout (Källberg et al., 2017; Kiymaz & Koç, 2018; Weigl et al., 2016). However, subjective perception (and not objective measures) of workload was found by Abadi et al. (2017) to be significantly related to the incidence of adverse events. From these medical errors, adverse events extended to compromises in physical, cognitive, and psychological functioning that resulted in increased morbidity, disability, or mortality (Dolej et al., 2017; Eriksson et al., 2018; Flaatten et al., 2017; Klasco et al., 2015; Solano et al., 2017). Nonetheless, medical errors are frequently multifactorial in nature and include patient factors, human errors, the work environment, and teamwork failures (Källberg et al., 2017). Doupe et al. (2017) and the Wait Times Reduction Task Force (WTRTF, 2017) recommended that future studies consider throughput factors (such as staffing mix and team effectiveness).

Interprofessional Collaboration

Kitto and Grant (2014) found that the creation of teams through coordination of people situated in designed institutional positions/roles and tasks did not automatically result in respectful, meaningful, and effective team behavior, which would be indicative of collaboration. Effective IP collaborative practice requires team members to be able to speak up (Ginsburg & Bain, 2017) as well as team psychological safety, stable core membership, power sharing, and knowledge cogeneration (Buljac et al., 2013). Similarly, the levels of trust, reciprocity, communication, and sharing a common goal affect patient care and job satisfaction (Dahlke et al., 2018). One strategy identified as key to improving IP collaboration was IP education (IPE; Interprofessional Education Collaborative [IPEC], 2016). IPE was also associated in effecting positive IP practices through an increase in cognitive, psychomotor, and affective domains (Behan & Van Der Like, 2017).

IPE was successful in increasing knowledge at the individual level (Ferrie & Sturrock, 2017; Goolsarran et al., 2018; Tsai et al., 2016) and as shared knowledge, distributed across team members (He & Zheng, 2016; James et al., 2016). Learning extended beyond the acquisition of new knowledge to improvements in communication and collaboration (Blue et al., 2015; Ferrie & Sturrock, 2017; Fewster-Thuente & Batteson, 2016; King et al., 2016; Kreuger et al., 2017; Weller et al., 2016).

Researchers also identified IPE as an effective intervention for improving

- individual confidence (Brewster et al., 2017);
- self-efficacy (Egenberg, Karlsen, et al., 2017; Egenberg, Øian, et al., 2017; Sauter et al., 2016; Sexton & Orchard, 2016);
- team efficacy (Egenberg, Øian, et al., 2017; Tsai et al., 2016);
- professional identity (Goolsarran et al., 2018); and
- understanding of roles of other providers, including the language needed to collaborate (Fewster-Thuente & Batterson, 2016).

However, inconsistent findings were reported in relation to changes in attitudes to enhance IP collaboration. James et al. (2016), Krueger et al. (2017), and Yang et al. (2017) reported positive outcomes while Smith et al. (2015) and Ginsburg and Bain (2017) found that IPE alone was not successful in changing underlying assumptions and recommended longitudinal training and modeling. Furthermore, participation in IPE consistently improved technical skills and response time, but Murphy et al. (2018) and Sauter et al. (2016) found that IPE had no significant impact on patient outcomes. The inconsistent findings supported Borham's (2004) assertion that effective collaborative IP practice requires CTC and that team learning is a by-product of group processes within the sociocultural work context. Furthermore, Kaba et al. (2016) also challenged researchers to use patient-centered performance measures and not process outcomes to evaluate the effectiveness of teamwork interventions.

Collective Team Competence

Boreham (2004) and Lingard (2009, 2017) argued that effective collaborative IP practice requires CTC. A collective sense of workplace events, a collective knowledge base, and interdependency among team members characterize CTC (Boreham, 2004). CTC correlated with average social sensitivity, equal distribution of conversational turn-taking, and the proportion of females in the group (Woolley et al., 2010). Shared mental models built using team reflexivity trigger team adaptation and learning (Schmutz & Eppich, 2017), while inclusive collaboration and open communication maximize collective intelligence (Mayo & Woolley, 2016). Furthermore, group cognition emerges from the coordination of individual cognition during social interactions (Curşeu et al., 2013), and individual and collective musical performances improve when learning occurs within a team setting (Hager & Johnsson, 2009a). In addition, team capacity develops over time through intragroup learning, actualizing competencies that generate new understanding (Tardiff,1999, as cited by Canadian Interprofessional Health Collaborative [CIHC], 2010). Through intragroup learning a social construction of reality emerges: the process for knowledge development, transmission, and its maintenance within a team's environment (Hollan et al., 2000). Thus, CTC develops from purposeful and active interactions between team members within a specific setting.

Proposed strategies to promote an enhanced collective state of team functioning include decreasing IP team tensions through shared motivation, clear roles and scopes, and other practices that minimize divergent behaviors (Lingard et al., 2017). An effective strategy that decreases team tensions is team reflexivity (Schmutz & Eppich, 2017). However, lack of deliberate organizational efforts to develop collective competence impedes the creation of synergy and "generat[es] lower benefits for the industry" (Bertolini et al., 2016, p. 112). Other organizational factors that undermine collaborative IP practice include power inequities (Amborse-Miller & Ashcroft, 2016) and variations in team membership (Ulrich & Crider, 2017). In addition, Kitto et al. (2015) linked distinct intraprofessional clinical decision-making pathways (highly hierarchical pathway in nursing; more autonomous pathway in medicine) and IP communication barriers to the absence of collective competence. These researchers also reported that when team members encountered problematic IP communication, they did not address it directly but used work-around tools (Kitto et al., 2015). Similarly, collective failures occur when team members deny the existence of problems. Gardiner and Chater (2013) explained that collective failures occur through pluralistic ignorance (when everyone thought the same but assumed that everyone else thought differently, resulting in no-one taking action) and through diffusion of responsibility based on the assumption that everyone knows something that they do not. Thus, CTC was needed to counter opportunities for collective failures, and effective

IP functioning was important because when teamwork failed, it became a predisposing factor to medical errors. Hence, Weiss (2013) proposed that CTC is the means to leverage best practices to promote health, safety, sustainability, and stewardship within the HCS.

The Need for More Knowledge

A move towards IP collaborative practice was embraced by HCS organizations, but medical errors have continued to cause deaths in U.S. hospitals (Makary & Daniel, 2016). Teamwork failures have been identified as the root cause of this problem (Mayo & Woolley, 2016). Thus, in spite of the move towards IP collaborative practice, medical errors have continued to place patients at risk for adverse events, the unintended consequences of health care. EDs were one of the high-risk care areas associated with a high number of patient deaths related to errors (Ulrich & Crider, 2017). Boreham (2004) and Lingard (2009, 2017) argued that effective collaborative IP practice requires CTC.

Boreham (2000) asserted that teamwork failures in EDs occur from a lack of collective competence. TMS was identified as an important factor in effective teamwork (Buljac et al., 2013; Fernando et al., 2016; Goldszmidt et al., 2014; O'Leary, 2016; Ulrich & Crider, 2017). Doupe et al. (2017) and the WTRTF (2017) recommended that future studies consider throughput factors (such as staffing mix and team effectiveness). Shiftwork schedules in healthcare are a system throughput factor that introduce instability in team membership. IP team membership and how often members interact together can make a difference in team dynamics and patient outcomes (Fox, 2015). Hence, more research was needed to explore why IP teamwork continued to fail in EDs, with a focus on TMS, individual collaborative IP competence, and CTC. This research addressed this gap in the literature and defined the purpose of this study.

The purpose of this study was to explore the relationship between IP TMS based on shiftwork schedules, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. Because EDs are high risk areas for medical errors (Ulrich & Crider, 2017), exploring these relationships provided insights into how to further reduce medical errors within this patient care area. These findings can be used by ED direct care providers and HCS managers/administrators to promote patient safety through decreasing delays to care/medical errors.

Problem Statement

Any person who accesses health care services is at risk for adverse events, the unintended negative consequences of health care (IOM/NAM, 2000). Individuals within the system and the system itself are sources of risks (Boreham et al., 2000; IOM/NAM, 2000). In 1999, medical errors caused between 44,000 and 98,000 U.S. deaths, primarily occurring in EDs, intensive care units, and operating rooms (IOM/NAM, 2000). In 2016, medical errors remained the third leading cause of U.S. hospital deaths (Makary & Daniel, 2016). Because almost one-half of the American population (National Center for Health Statistics, 2017) and one-third of Canadians (Canadian Institute for Health Information, 2018) use EDs as their HCS access point, many people are at risk of medical errors. The IOM/NAM (2007) stated that "when illness or injury strikes, Americans count on the emergency care system to respond with timely and high-quality care" (p. xi). Furthermore, medical errors have translated into costs to society and the HCS itself. Some of the costs incurred by society relate to lost income, household production, disability, and other physical and psychological trauma. Some of the costs incurred by the HCS are from opportunity costs, loss of trust in the system, and patient and employee dissatisfaction

(IOM/NAM, 2000). Thus, studies into the types of medical errors occurring in EDs and their contributing factors are ongoing.

Reported medical errors in EDs have included

- diagnostic errors from inadequate assessments that missed the severity of the patients' conditions (Zhang et al., 2018);
- multiple treatment errors, such as delays in initiating treatment and incorrect interventions (Carlson, 2016), some of which required changes in care management, operative interventions, invasive procedures, and/or medications (Linnebur et al., 2018; Solano et al., 2017);
- system errors, such as extended LOS, loss of key patient information, and inappropriate disposition decisions (Dolejs et al. 2017; Eriksson et al., 2018).

Contributing factors are frequently multifactorial in nature and include (a) patient factors, (b) human errors, (c) ED environment, (d) hospital environment, (e) external environment, and (f) teamwork failures (Källberg et al., 2017).

Human factors as a source of medical errors that have received attention by researchers include cognitive errors that result in delayed or missed diagnoses (Källberg et al., 2017), and proficiency errors from knowledge deficits or the inability to apply knowledge and skills due to ED environmental factors (Freund et al., 2015). Okafor et al. (2016) posited that cognitive and proficiency medical errors may be linked to faulty information verification, information processing, faulty data gathering, and faulty knowledge. From a system's perspective, human factors associated with medical errors included excessive workload, insufficient number of nurses, fatigue, exhaustion, and burnout (Källberg et al., 2017; Kiymaz & Koç, 2018; Weigl et al., 2016) as well as frequent interruptions, multitasking, and unpredictable workload demands

(Weigl et al., 2016). However, subjective perception (and not objective measures) of workload was found by Abadi et al. (2017) to be significantly related to the incidence of adverse events. Additionally, Freund et al. (2015), Graber et al. (2017), and Thomas and Newman-Toker (2016) concluded that a team approach, where one or more providers are involved in the decision making, is associated with a decreased incidence of these errors. Thus, changing these negative patient outcomes requires collaborative IP practices and CTC.

Researchers have also looked at CTC. However, most of these studies have focused on teams with stable membership and were qualitative in nature (e.g., Lingard et al., 2014; 2017; Lamb, 2018). In contrast, Fox (2015) observed that which professionals participated in case reviews made a difference, with a change in the focus of sense-making. These findings allude to the importance of stable team membership in team dynamics. Within healthcare environments that provide 24-hour care (such as EDs), provider schedules may vary with each shift, modifying team membership and dynamics. Furthermore, Kannampallil et al. (2011) maintained that due to the extensive interrelatedness of components within EDs and the nonlinear response to internal and external environments, studying teamwork within EDs is difficult. However, Kannampallil et al. proposed that identifying a functional slice of a complex adaptive system (CAS), and characterizing it in terms of the discernable interrelations with other elements, is an appropriate approach.

As discussed above, studies were identified through an extensive literature review that addressed the types of medical errors occurring in EDs and contributing factors. Instability in team membership was identified as one element that could undermine effective teamwork (Ulrich & Crider, 2017). Individual providers and system human factors were another source, and although researchers have explored CTC mostly through qualitative designs, its absence was also linked to poorer teamwork. Thus, because no studies were identified that specifically discussed the relationship between TMS, individual collaborative IP competence, CTC, and medical errors within EDs, this was the knowledge gap that existed in the literature and the functional slice through which IP teamwork was explored. The findings from this study can inform ED direct care providers and managers or administrators what areas to focus on to further decrease delays to care/medical errors.

Purpose of the Study

The purpose of this study was to explore the relationship between differences in IP team membership due to shift work schedules (as TMS), individual collaborative IP competence, CTC, and medical errors as patient outcomes within EDs. Furthermore, I attempted to test the predictions that CCT posits. That is, both individual and collective competence are required to effect positive patient outcomes and that these are constitutive (Boreham, 2004). Thus, the variables of interest were TMS, individual collaborative IP competence, CTC, and medical errors. A quantitative, cross-sectional, correlational research method explored the relationship between these variables.

The primary independent variable (IV) was TMS. The number of shifts that members of the IP core team in the ED worked together during the 3 months preceding the measurement of the other variables (the dates when sampling/data collection occurred) defined TMS. The second IV was individual collaborative IP competence, calculated from worked experience, which was defined by the number of shift that each ED core team member worked during the 3 months preceding data collection. The third IV was CTC, and the fourth IV was the cumulative effect from both individual and collective competence.

CTC was one dependent variables (DV) of TMS, measured using a self-rating questionnaire, the Collective Team Competence Questionnaire (CTCQ), and a third IV for medical errors. The results from the participants' responses using the CTCQ instrument provided the data to test the predictions of CCT. The ultimate DV of interest was medical errors as ED patient outcomes, measured in delays to care. Similar to the medical errors reported by Boreham et al. (2000), ED medical errors selected to report on were as follows:

- delays in time to triage (from time of registration to triage), defined using the Canadian Association of Emergency Physician (CAEP) indicator (Bullard et al., 2017)
- delays in time to be seen by physician/alternate prescriber, measured as time to physician/alternate initial assessment (PIA), defined using CAEP indicators (Affleck et al., 2013)
- delays in time in obtaining essential diagnostics (based on time of first diagnostic imaging test performed or first laboratory result)
- extended LOS in the ED, defined using CAEP indicators
- delays in time to admission to an inpatient bed, defined using CAEP indicators
- number of patients who left without being seen (LWBS) by a physician/alternate prescriber within 4-hour intervals.

Although patient levels of acuity, as captured by the Canadian Triage Assessment Scale (CTAS), were assigned to each patient, and volumes were not considered medical errors, these metrics were also obtained and analyzed as potential confounding variables.

The selected variables studied were naturally occurring within the participating EDs. Thus, the selected research design for this study was a quantitative cross-sectional one, using a survey method and accessing administrative data. This research approach was appropriate for researching variables under naturally occurring conditions, within social situations (see Campbell & Stanley, 1963). Statistical methods provided the means to control moderating and mitigating influences from the covariates, strengthening the correlational design (see Campbell & Stanley, 1963; Warner, 2013).

Research Questions and Hypotheses

The research question (RQ), and the associated null hypothesis (*H*0) and alternate hypothesis (*H*A) explored were as follows:

> RQ: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors?
>
> *H*0: There is no statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors.
>
> *H*A: There is a statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors.

However, to explore the multiple possible relationships amongst these variables, the RQ and hypotheses were subdivided, resulting in the following:

> RQ_{1a}: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS) and medical errors?
>
> $H0_{1a}$: There is no statistically significant relationship between the frequency of providers working together due to shiftwork schedules (IP TMS) and medical errors.

HA_{1a}: There is a statistically significant relationship between frequency of providers working together due to shiftwork schedules (IP TMS) and medical errors.

RQ_{1b}: What is the relationship between individual collaborative IP competence and medical errors?

H0_{1b}: There is no statistically significant relationship between individual collaborative IP competence and medical errors.

HA_{1b}: There is a statistically significant relationship between individual collaborative IP competence and medical errors.

RQ_{1c}: What is the relationship between CTC and medical errors?

H0_{1c}: There is no statistically significant relationship between CTC and medical errors.

HA_{1c}: There is a statistically significant relationship between CTC and medical errors.

RQ_{1d}: What is the relationship between TMS, individual collaborative IP competence, and medical errors?

H0_{1d}: There is no statistically significant relationship TMS, individual collaborative IP competence, and medical errors.

HA_{1d}: There is a statistically significant relationship between TMS, individual collaborative IP competence, and medical errors.

RQ_{1e}: When controlling for CTAS and patient volumes, what is the relationship between TMS and medical errors?

H0_{1e}: When controlling for CTAS and patient volumes, there is no statistically significant relationship between TMS and medical errors.

HA_{1e}: When controlling for CTAS and patient volumes, there is a statistically significant relationship between TMS and medical errors.

RQ_{1f}: When controlling for CTAS and patient volumes, what is the relationship between individual collaborative IP competence and medical errors?

$H0_{1f}$: When controlling for CTAS and patient volumes, there is no statistically significant relationship between individual collaborative IP competence and medical errors.

HA_{1f}: When controlling for CTAS and patient volumes, there is a statistically significant relationship between individual collaborative IP competence and medical errors.

RQ_{1g}: When controlling for team size, what is the relationship between TMS and medical errors?

$H0_{1g}$: When controlling for team size, there is no statistically significant relationship between TMS and medical errors.

HA_{1g}: When controlling for team size, there is a statistically significant relationship between TMS and medical errors.

The number of shifts that members of the IP core team in the ED worked together during the 3 months preceding the measurement of the other variables (the dates when sampling occurred) defined TMS. Individual collaborative IP competence was based on worked experience defined by the number of shifts that each IP core team member worked during the 3 months preceding data collection. The self-ratings on items within the CTCQ provided data to assess collective competence. The frequency of medical errors within the sampling time intervals was quantified using administrative data, the Emergency Department Information System (EDIS).

Theoretical Framework for the Study

The theoretical underpinning selected for this study was the CCT, as postulated by Boreham (2004). It is rooted in social learning, social constructionism, distributed cognition, CAS, and activity theories (Boreham, 2004; Lingard, 2009, 2017). Singly, these theories were unable to explain differences in IP team effectiveness within dynamic healthcare environments, such as EDs. However, Boreham integrated key concepts from these theories into the CCT and posited that, for a team to perform effectively, there must also be at least (a) a collective sense of workplace events, which includes a collective mind and team consciousness; (b) a collective knowledge base; and (c) a sense of interdependency. Boreham referred to these as the three normative principles for effective teamwork. CCT also recognizes both individualistic and collectivistic ways of construing competence and that these are mutually constitutive. CCT was the blueprint (see Creswell, 2014; Grant & Osanloo, 2014) used to explore these constructs because it identified and described interrelated elements defined as necessary for successful IP teamwork. That is, although Boreham focused on the need for collective competence, he asserted that both individualistic and collectivistic ways of construing competence were mutually constitutive for the elimination of medical errors. A summary of CCT's key concepts follows (see Chapter 2 for a detailed explanation).

Collective Sense of Workplace Events

Boreham (2004) asserted that team effectiveness is dependent upon the existence of a collective sense of workplace events, requiring group consciousness and a collective mind. Group consciousness is about knowing what needs to be done in relation to what others are doing in the organization (Boreham, 2004), and a collective mind refers to the team's ability to address problems or uncertainties that arise through self-organizing collective behaviors and adaptability (Birdsey et al., 2017; Boreham, 2004). Group consciousness and a collective mind are grounded in shared goal(s) (or the objectives of the team's activities), dependent upon an understanding of system-level consequences of individual and collective actions (Boreham, 2004).

Collective action requires situational awareness of and responses to workplace events by the activity system within a CAS. The activity system is the core team (Boreham, 2004). Complex interrelationships between people and their environment define CASs (Birdsey et al., 2017). Within a CAS, effective communication between team members is required, using context-specific language, which can be verbal or with the use of artifacts and other media (e.g., the use of communication boards or care maps). In response to problems, a collective reinterpretation of events would ensue, further enhancing group consciousness (Boreham, 2004). This process is iterative throughout the time the team is functioning as an activity system.

Collective Knowledge Base

CCT recognizes knowledge as collective and public, possessed by workgroups and not privately held by the individuals who comprise these teams (Boreham, 2000). Within group/team processes, reality is socially constructed. This process uses language for knowledge development, transmission, and its maintenance within socio-cultural situations, used to guide everyday work life (Berger & Luckmann, 1966). However, achieving organizational goals also requires division of labor and rules for interactions, focusing on the activity system or the functional group (Boreham, 2004; Kaptelinin & Nardi, 1997; Lingard, 2009). Social interactions between team members produce new meanings. Then, purposeful and conscientious actions embed these new meanings within the team's collective knowledge (Berger & Luckmann, 1966).

Collective knowledge stems from the integration of specialized individual knowledge, only acquired at work through social interactions and shared experiences (Boreham, 2000). Learning occurs through direct and vicarious observations of others, and with the use of symbols (e.g., written materials), reinforced through repeated observances and with mental and/or performance rehearsal (Bandura, 1971). It requires placing individual knowledge within the context of learning how to learn and how to access situated and context-linked distributed knowledge (e.g., organizational resources, such as communication tools and policies; Lingard, 2009). Thus, collective knowledge emerges through social interactions, shared experiences, and tacit knowledge, shaped by the physical, social, and organizational contexts of the work setting, existing within heedful interactions among team members (Boreham, 2004; Lingard, 2009, 2017). The expectation is "a system that can dynamically configure itself to bring subsystems into coordination to accomplish various functions" (Hollan et al., 2000, p. 176).

Interdependency

A key premise of collective competence is that it is a constantly evolving set of multiple, interconnected behaviors achieved through participation, enacted in time and space (Boreham, 2004). When interdependency exists amongst team members, collective responses within the workplace reality are based on a here-and-now awareness of being dependent upon one another, shared mental models, and mutual understanding. The team acts as a single unit, evidenced in coordinated responses to overcome problematic situations (Boreham, 2004). To achieve coordinated responses, nonhierarchical interactions exist where all members are empowered and all contributions are valued equally, creating a psychologically safe place that supports speaking up. It also requires identifying and acknowledging internal divisions, using conflict resolution techniques and negotiations to overcome fragmenting tendencies from different perspectives, and to foster positive interrelationships (Boreham, 2004).

Individual and Collective Team Competence

CCT recognizes both individualistic and collectivistic ways of construing competence and that these are mutually constitutive (Boreham, 2004). Individual IP competencies refers to the integration of knowledge, skills, attitudes, values, and judgments to perform effectively within IP teams (CIHC, 2010, p. 24; IPEC, 2016, p. 8). In contrast, collective competence is work-related competence, developed through group processes, used to direct a team to work as a single unit, guided by a collective mind (Boreham, 2004, p. 8). To be effective as a team, goals and expectations are attained through processes that are free of errors (Buljac et al., 2013, p. 95). Thus, for this study, CTC refers to the integration of collective knowledge, skills, abilities, and judgment by a group of professionals working within an IP teamwork environment to realize shared desired outcomes (e.g., patient goals, sustainable HCS), evidenced in error-free practices. Hence, using CCT as the blueprint (see Creswell, 2014; Grant & Osanloo, 2014) for this quantitative, cross-sectional correlational study was appropriate for exploring the relationship between TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs.

Nature of the Study

I used a quantitative cross-sectional correlational survey approach of IP core team members within EDs to study the relationships between differences in team membership due to shift work schedules (as TMS), individual collaborative IP competence, CTC, and medical errors as patient outcomes. A quantitative research method enables generalizability of results across the populations of interest, the ED teams and ED patients. The cross-sectional approach is appropriate for collecting a large amount of data at a single point in time and provides a cost-effective means of reaching many potential participants, required for generalization of the results (see Creswell, 2014; Leedy & Ormrod, 2005). Using the correlational method enabled me to explore constructs within the natural environments of EDs (see Campbell & Stanley, 1963; Creswell, 2014). Although causation cannot be established using a correlational design, this method enables studying the corelationships between IP TMS, competences, and medical errors as patient outcomes (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005). Strengthening the correlational research design occurred by statistically controlling for covariance, moderating, and mediating effects from other factors associated with medical errors as identified within the literature (see Campbell & Stanley, 1963; Warner, 2013).

The primary IV was TMS. Based on administrative data, the number of shifts that members of the IP core team in the ED worked together during the 3 months preceding the measurement of the other variables (the dates when sampling occurred) quantified TMS. The second IV was individual collaborative IP competence, which was quantified based on worked experience defined by the number of shifts that each IP core team member worked during the 3 months preceding data collection. CTC was the third IV for medical errors and the first DV of TMS. Results from the CTCQ, a self-rated questionnaire, provided data to quantify CTC and to test the predictions of CCT. Administrative data was the source used to measure the ultimate DV of interest, medical errors as ED patient outcomes. Statistical methods provided the means to control moderating and mitigating influences from the covariates, strengthening the correlational design (see Campbell & Stanley, 1963; Warner, 2013). The selected covariates from the literature review were patients' levels of acuity and volume.

Preliminary validity and reliability of CTCQ was to be established by assessing content adequacy, factor loading/extraction, and the amount of variances explained by each item (see Hinkin et al., 1977; Williams et al., 2010). However, the number of survey responses did not meet the minimum number required for statistical analyses, and the validity and reliability of CTCQ was not established.

For data from the main study, preliminary data screening preceded any processes involving data analysis, enabling the identification of potential problems and taking steps to maximize data integrity. Data analyses processes selected to inform inferences from the sampled to the general population of ED IP practitioners were (a) bivariate regression, (b) multiple regression, and (c) analysis of variance (ANOVA). The detailed data analysis plan is found in Chapter 3, and the results are located in Chapter 4.

Definitions

The primary variables of interest for this study were IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes. However, in exploring the relationship between these variables, a shared understanding of these and some associated concepts is required. To this end, definitions of these key variables and conceptual terms used follow.

Adverse events: The unintended consequences of health care. These events are not due to the patient(s)' underlying medical condition but result from medical errors or negligence that fail to meet standards of care (IOM/NAM, 2000).

Collective team competence: Work-related competence that develops through group processes and the integration of knowledge, skills, abilities, and judgment by a group of professionals working as a single unit within an IP teamwork environment to realize shared desired outcomes/goals, such as patient safety and a sustainable HCS (Boreham, 2004; Buljac et al., 2013; CIHC, 2010; IPEC, 2016).

Interprofessional competencies: The integration of knowledge, skills, attitudes, values, and judgments required by an individual health care provider to effectively perform within IP teams and specific work settings (CIHC, 2010; IPEC, 2016).

Interprofessional practice: Purposeful interaction of two or more professionals from different disciplines delivering healthcare services for the same patient or patient population, replacing the terms interdisciplinary, cross-disciplinary, and trans-disciplinary (Ambrose-Miller & Ashcroft, 2016; McEwen et al., 2018; O'Brien, 2015; WHO, 2010).

Interprofessional collaboration*:* The process of working with others, sharing ideas, and engaging in collective action to provide a service, achieved through effective IP relationships; integrating competencies and resources; and applying knowledge, skills, and attitudes to inform team decisions (CIHC, 2010; D'Amour et al., 2005).

Medical errors: Incorrect plans of medical interventions (errors in planning) or correct plans not implemented as intended (errors of execution; IOM/NAM, 2000).

Patient characteristics: Individual characteristics of patients when presenting to an ED for care, which includes but are not limited to the level of acuity and the complexity of their care needs (Flaatten et al., 2017; Källberg et al., 2015; Okafor et al., 2016).

Patient safety: Freedom from medical errors and harm when patients access the HCS (IOM/NAM, 2000; WHO, 2019).

Team effectiveness: Team processes that achieve shared goals and expectations within an error free environment (Buljac et al., 2013).

Team membership stability: The extent to which the same team members have consistently interacted or worked together (have a history) and have an expectation of continued future interactions to achieve shared goals (Hollenbeck et al., 2012; Ulrich & Crider, 2017).

Assumptions

Numerous assumptions informed the research question and the selected method to explore how medical errors can be further decreased within the ED environment, one area where the majority of these medical errors occur (see IOM/NAM, 2000). These assumptions were informed by works located in the literature and personal experience, and were a source of bias in the interpretation of the research findings. Assumptions related to this study include the following:

- ED care occurs within a very CAS, characterized by complex relationships and interconnections (Kannampallil et al., 2011).
- A CAS can present as a wicked problem, requiring a holistic HCS approach that include collaborative strategies to achieve win-win solutions (WTRTF, 2017).
- To eliminate medical errors, both individual and collective competence are required, and these are mutually constitutive in nature (Boreham, 2004).
- A real world may exist out there but how we make sense of it becomes our personal reality. For example, subjective perceptions of workload (and not objective measures) were found to be significantly related to the incidence of adverse events (Abadi et al., 2017).
- Team dynamics within the workplace are not static but active in nature, and impact the quality and safety of care provided and job satisfaction (Mathieu et al., 2015; Ulrich & Crider, 2017). Teams require intentional and ongoing attention and nurturing, which should be a shared responsibility amongst members.
- ED providers who self-select to participate in the study will provide honest responses.

These assumptions were integral elements that guided the study as I explored the relationship between differences in IP team membership due to shifting work schedules (as TMS), individual collaborative IP competence, CTC, and medical errors as patient outcomes within EDs.

Scope and Delimitations

People who use EDs to access the HCS are at risk of medical errors due to teamwork failures (Mayo & Woolley, 2016). Highly competent professionals have continued to create incompetent teams, with delays or compromises in patient care (Lingard, 2009, 2017). Boreham (2004) postulated that effective teams require competence to exist not only at the individual level but also as a collective. However, one element required for team effectiveness is TMS and shiftwork introduces variability in team composition. Thus, the key aspects of medical errors (the research problem) explored in this study were the relationships between TMS, individual collaborative IP competencies, CTC, and medical errors. This study was quantitative and correlational in nature, exploring medical errors as patient outcomes, captured as delays to care within EDs only.

Due to ethical constraints, the study of social situations and factors (e.g., access to healthcare) are frequently not amenable to classical research designs (see Campbell & Stanley, 1963; Frankfort-Nachmias & Nachmias, 2008). Thus, a nonexperimental, quantitative, cross-sectional, correlational design enabled studying the identified variables within the natural environments of EDs, providing a cost-effective means of reaching many potential participants within a predefined space and time (see Creswell, 2014). Furthermore, this design minimized constraints due to limited resources (e.g., personal financial costs, participating organizational resources, and participants' time). Because there was no control group, diffusion of treatment through intergroup communication, intergroup compensatory or resentful demoralization, and rivalry (see Creswell, 2014) should not have posed a threat to this study's validity. Similarly, regression artifacts from pre- and posttest extreme scores, as well as the possible bias from instrumentation (see Bielenia-Grajewska, 2018; Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008) were eliminated. In addition, a cross-sectional approach for data collection mitigated potential risks of history effects from external events and participants' maturation effects over time (see Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008). However, effects of asking the participants to report on their teamwork experiences during a worked shift may have introduced testing effects (see Bielenia-Grajewska, 2018; Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008). That is, the participants had access to the CTCQ in advance, noting the items that they were reporting on at the end of their shift, which could have influenced their performance and patient outcomes. This was a limitation of this study.

The sampled EDs were those using EDIS electronic health records and located in Manitoba (MB), Canada. Administrative data available from EDIS reports informed the selection of which medical errors to quantify. Potential participants were limited to ED staff involved in direct patient care and those who worked in the participating EDs on data collection dates. Excluded were direct patient care providers not working during data collection days as well as management and students (e.g., the facility manager was excluded but the ED nurse-in-charge was included). Data used to measure individual collaborative IP competence was worked experience defined by the number of shifts each ED core team member worked during the 3 months preceding data collection. A CTCQ consisting of a rating scale provided quantitative data to measure CTC. Because no instrumentation that measured CCT’s three normative principles was located, the CTCQ was developed.

This study’s aim centered only on exploring the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors. Thus, I did not explore other factors associated with IP collaboration (e.g., patient centered care), and neither the quality of team dynamics within the workplace nor other qualities associated with effective IP teamwork (e.g., leadership or culture). Generalizability of the findings are limited by the characteristics of the participants sampled, the settings, when the study occurred in time, and the selected study design (see Bielenia-Grajewska, 2018; Creswell, 2014). That is, because manipulating team membership in EDs over time was assessed as not being practical, I selected a nonexperimental correlational research design. This research approach decreased the amount of control over the variables, reducing the ability to infer causation (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005). A more robust experimental design where IP TMS was maintained over an extended period and the use of a control group would have enhanced the generalizability of the results. However, data from correlational studies "are relevant to causal hypotheses inasmuch as they expose them to disconfirmation … if a high correlation occurs, credibility of the hypothesis is strengthened" (Campbell & Stanley, 1963, p. 64).

Limitations

There are multiple limitations associated with this study. Methodological weaknesses and biases can introduce limitations and can translate into threats to the interpretation of study results and their generalizability from the sampled to the general population (Frankfort-Nachmias & Nachmias, 2008; Simon & Goes, 2013). The following are this study's identified limitations and measures used to minimize their impact.

There are limitations inherent in any research method selected (Simon & Goes, 2013). The correlational research method and the cross-sectional approach selected limited the ability to infer causation between the variables of interest and the generalizability of the findings (see Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008). A lack of a control group also contributed to limited generalizability of findings. However, strengthening the correlational research design occurred by statistically controlling for covariance, moderating, and mediating effects from other factors associated with medical errors as identified within the literature (see Campbell & Stanley, 1963; Warner, 2013). Although causation was not determined using correlational analyses, this analytical approach quantified the strengths of the relationships amongst all identified variables (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005). Rudestam and Newton (2015) claimed that “statistical methods are appropriate for looking at relationships and patterns and expressing these patterns in numbers” (p. 30).

Limiting the sampling to participants working within an ED with EDIS and only within MB, Canada also negatively impacted the generalizability of the results. That is, this was only one group of care providers within the HCS who work shift work, which creates variations in TMS. In addition, the IP core ED team composition consisted only of nurses and medical doctors, which introduced a threat for interpreting the relationship between TMS, individual collaborative IP competence, CTC, and medical errors. Furthermore, the extent to which ED practitioners inputted information in a timely manner and completed all data fields for each patient who accessed these EDs during the sampling period resulted in some empty fields in EDIS, somewhat limiting the data’s reliability. Also, because participants self-selected to participate (or declined participation), inadequate sample size was another factor that limited statistical analyses, the generalizability of the findings, and introduced responder bias. Furthermore, recruitment of participant strategy introduced testing effects. That is, the participants had access to the CTCQ in advance, noting the items that they were reporting on at the end of their shift, which may have influenced their performance and patient outcomes. Identifying other shifts when the same team members worked together and comparing patient outcomes could have served as a control group. However, obtaining these data from participating organization would have required a greater investment of resources, which may have further limited the number of organizations willing to participate. Replicating the study using a control group and with different participants, in other settings, and at different times is recommended.

Another limitation was that the newly developed CTCQ used to measure CTC introduced reliability and validity issues. The CTCQ was not a validated tool, and a pilot study was conducted, in which three participants responded. Due to the limited sample size, no further analyses were performed and no changes to the CTCQ were made.

Biased and faulty interpretation of the results was another limitation. As a HCS practitioner who has been involved in addressing staffing issues that only focused on individual competencies within a single profession, the concept of CTC as a missing link was personally appealing. Furthermore, as a novice researcher, interpreting statistical outputs was a daunting task. However, personal biases and being a novice researcher were buffered through consultation with an experienced statistician.

Significance

IP practice is at the core of care delivery (Mayo & Woolley, 2016), but effective teamwork continues to be elusive, evidenced in the reported high morbidity and mortality rates related to medical errors (Makary & Daniel, 2016; WHO, 2019). I identified a gap in the literature in relation to what role TMS, individual collaborative IP competence, and CTC played as potential sources of medical errors. This research addressed this gap.

Because current interventions aimed at improving teamwork lacked good quality data and there was substantive evidence that brought to question the utility of collaborative decision-making (see Kaba et al., 2016), the findings from this study are important. Kaba et al. (2016) challenged researchers to use patient-centered performance measures and not process outcomes to evaluate teamwork interventions. In this study, I focused on patient outcomes as a function of TMS, independent collaborative IP competence, and CTC. Understanding these relationships has the potential to promote a positive social change for ED direct care providers and managers/administrators, and can inform HCS policies and guidelines that ultimately maximize patient safety for those accessing the HCS through EDs.

The results from this study allude to the importance of individual competence from work experience as more relevant than team stability in decreasing delays to care within rural ED environments. Thus, ED direct care providers can benefit through an increased understanding that working within teams with short-term low temporal stability should not impede their success at promoting patient safety. However, a negative moderating effect of TMS on individual competence based on work experience was noted. This result was attributed to cohesive IP core teams that resulted from a long history of team members consistently working together (see Hollenbeck et al., 2012), and highly cohesive teams are at the greatest risk for groupthink (see Kaba et al., 2016; Schmidt, 2021). Thus, ED direct care providers and managers/administrators should be motivated to increase their understanding of the perils associated with groupthink that can lead to collective failures. In addition, identifying the point at which increasing the number of staff no longer results in positive patient and staff outcomes (ceiling effect for team size) may translate into greater efficiencies. Furthermore, the results can provide managers and HCS administrators the evidence suggestive of the existence of collective knowledge at the organizational level and rules for interaction as effective in decreasing medical errors. That is, because collective knowledge is a component of organizational capacity that endures when membership changes (Boreham, 2004), and Karam et al. (2016) reported that without integration policies data and information exchange remains poorly developed, these results were suggestive that structured processes existed, reflective of a collective knowledge base at the organizational level that buffered low temporal team stability. Thus, standardized HCS policies, guidelines, and processes can result in a more responsive and effective HCS, improving the quality of ED patient care, and rendering it safer, more accessible, comprehensive, coordinated, and patient centered. This is the positive social change that the results from this study can contribute to.

Summary

The HCS itself introduces a societal problem in the form of a risk of medical errors to any person who accesses EDs for care. The IOM/NAM (2007) asserted that “when illness or injury strikes, Americans count on the emergency care system to respond with timely and high quality care” (p. xi). The move to IP collaborative practice had positive outcomes (WHO, 2010), but existing HCS practices have not adequately addressed medical errors, and teamwork failures were identified as one of the root causes (Mayo & Woolley, 2016). Boreham (2004) and Lingard (2009, 2017) argued that effective IP practice requires both individual and collective competence. However, a gap in the literature existed in relation to the role that IP TMS plays in the establishment of CTC and medical errors. To this end, I explored the relationship between IP TMS, individual, CTC, and medical errors.

The theoretical framework selected for this study was the CCT as postulated by Boreham (2004). CCT recognizes both individualistic and collective ways of construing competence and that these are mutually constitutive (Boreham, 2004). However, Boreham posited that a collective sense of workplace events, collective knowledge base, and interdependency are required for effective teamwork to occur. For this study, CTC is defined as work-related competence that develops through group processes and the integration of knowledge, skills, abilities, and judgment by a group of professionals working as a single unit within an IP teamwork environment to realize shared desired outcomes/goals, such as patient safety and a sustainable HCS. This definition integrates the definition of individual collaborative IP competence by CIHC (2010) and IPEC (2016), with Boreham's definition of collective competence and Buljac et al.'s (2013) definition of team effectiveness.

I selected a quantitative, cross-sectional, correlational survey approach of IP core team members within EDs to explore the relationship between IP TMS, individual, CTC, and medical errors as patient outcomes. Although causation was not established, this approach was a cost-effective means of reaching many potential participants to collect a large amount of data that increases the generalizability of the research findings (see Creswell, 2014; Leedy & Ormrod, 2005). Understanding the relationships between the predictors and outcomes has the potential to promote a positive social change for ED direct care providers and managers/administrators, and can inform HCS policies, guidelines, and processes that ultimately maximize patient safety for those accessing the HCS through EDs.

The evidence supporting the need to address this research problem and appropriateness of this research in addressing a gap in knowledge related to medical errors was located through an extensive literature review. Within the review, evidence was also located that supported the use of the selected theory – the CCT. Details of the literature review results follow in Chapter 2

Chapter 2: Literature Review

Introduction

A literature review provided the framework to explore the constructs of IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. Although collaborative IP practices in healthcare have decreased patient complications, LOS, hospital admissions, errors, and mortality rates (WHO, 2010), teamwork failures have continued to cause 70% to 80% of serious medical errors (Mayo & Woolley, 2016). Furthermore, in 2016 medical errors continued to be the third leading cause of hospital deaths, occurring primarily in the EDs, intensive care units, and operating rooms (Makary & Daniel, 2016). Boreham (2004) and Lingard (2009, 2017) argued that to prevent team failures and medical errors, effective collaborative IP practice requires CTC. However, differences in team membership were also found to undermine effective IP teamwork (Ulrich & Crider, 2017), possibly by jeopardizing CTC. Shiftwork schedules in healthcare introduce instability in team membership. Thus, the purpose of this study was to address a gap in the literature in relation to the role that IP TMS and CTC have on IP team effectiveness in preventing medical errors.

Because any person accessing health care services is at risk for adverse events and medical errors, identifying the underlying associated factors within the literature is ongoing. Personal professional responsibilities for the identification of strategies to decrease these risks to patients within EDs motivated this search. However, starting in 2015, a deliberate comprehensive literature search ensued to identify what areas related to IP collaborative team practices and medical errors in EDs might benefit from further exploration. This search involved accessing multiple search engines and databases. A description of the literature search strategies used, the theoretical foundation selected for this study, and an analysis of the literature review follows.

Literature Search Strategy

A deliberate comprehensive literature search to identify what areas related to collaborative IP team practices, CTC, and medical errors that might benefit from further exploration involved accessing multiple search engines and databases. Databases selected were those identified as best within the health sciences, found in the Walden University library. These consisted of (a) CINAHL & MEDLINE Combined Search; (b) CINAHL Plus with Full Text; (c) MEDLINE with Full Text; (d) ProQuest Health & Medical Collection; (e) ProQuest Nursing & Allied Health Source; and (f) PubMed. Furthermore, ProQuest Dissertations and Theses Global, Google Scholar, and a few government agencies and professional organizations were accessed. Appendix A provides a summary of search terms used, the results yielded, how I screened the results for relevancy, and the number of relevant sources selected. Over 400 documents were identified as potentially relevant.

As can be seen in Appendix A, searches yielded thousands of results of varying applicability. To identify those studies and documents relevant to the research problem and question, search terms were further refined, and search limits were applied to focus and narrow the findings. The key concepts and variables of interest related to collaboration within IP teams, CTC, and medical errors as patient outcomes. Managing the results required a systematic approach.

The use of software management tools as a means of managing search results were considered and explored. However, in spite of the advantages associated with the use of software management tools, I deemed an annotation process using Microsoft Word and a literature map as more valuable for integrating the literature search results. That is, Microsoft Word possessed a search of key terms functions while the literature map provided a visual representation of relationships amongst the various variables, generating a taxonomy of themes. A review of selected articles from the initial screening led to the annotation of 392 documents. These were further summarized based on their relevancy to this study.

Theoretical Foundation: Collective Competence Theory

The role of theories in research is to provide a blueprint for the exploration of a phenomenon of interest (Grant & Osanloo, 2014). A theory posits a set of propositions that describe how interrelated constructs of key elements are predictive of how a phenomenon of interest exists in the real world (Creswell, 2014). The purpose of this study was to explore the relationship between differences in IP team membership due to shift work schedules (as TMS); individual IP collaborative competencies, CTC; and medical errors as patient outcomes within EDs. CCT identifies and describes interrelated constructs defined as necessary for CTC to exist. Thus, the theoretical underpinning selected for this study was CCT as posited by Boreham (2004).

Individual Collaborative Interprofessional Competencies and Collective Team Competence

CCT recognizes both individualistic and collectivistic ways of construing competence and that these are mutually constitutive. Individual IP collaborative competencies refer to the integration of knowledge, skills, attitudes, values, and judgments to perform effectively within IP teams (CIHC, 2010; IPEC, 2016). In contrast, collective competence is work-related competence, developed through group processes, used to guide a team to work as a single unit, and guided by a collective mind (Boreham, 2004, p. 8). Furthermore, Buljac et al. (2013) defined team effectiveness as “the absolute level of attainment of goals and expectations that depends on the degree to which work processes are free of errors" (p. 95). Integrating these definitions, for this study, CTC refers to work-related competence that develops through group processes and the integration of knowledge, skills, abilities, and judgment by a group of professionals working as a single unit within an IP teamwork environment to realize shared desired outcomes or goals, such as patient safety and a sustainable HCS.

Collective Competence Theory

CCT is rooted in social learning, social constructionism, distributed cognition, CASs, and activity theories (Boreham, 2004; Lingard, 2009; 2017). Singly, these theories were unable to explain differences in IP team effectiveness within dynamic healthcare environments, such as EDs. However, Boreham (2004) integrated key concepts from these theories into the CCT and posited that for a team to perform effectively, there must also be at least (a) a collective sense of workplace events, which includes a collective mind and team consciousness; (b) a collective knowledge base; and (c) a sense of interdependency. Boreham referred to these as the three normative principles for effective teamwork. CCT also recognizes both individualistic and collectivistic ways of construing competence and that these are mutually constitutive.

Mitigating medical errors in EDs requires individual team members to possess profession-specific competence. For example, the CAEP (2017) reported that variations in individual competence exist amongst medical doctors providing ED care in Canada. The need for national standards that define required physician competencies to deliver excellent emergency patient care was identified (CAEP, 2017; Collaborative Working Group [CWG], 2016; McEwen et al., 2018). However, IOM/NAM (2000) reported that the root of medical errors extended beyond the individual healthcare provider competence to systemic latent factors and challenged healthcare organizations to shift the focus of strategies to eliminate medical errors from individual care providers to the system. The IOM/NAM (2001) identified collaborative IP practice as the means to minimize errors within the complex healthcare environment.

Collaborative IP practice involves two or more healthcare providers from different professions delivering services to the same patient or patient population (Ambrose-Miller & Ashcroft, 2016; WHO, 2010). A move to provide patient care by IP teams has occurred, but highly competent professionals have continued to create incompetent teams with delays or compromises in patient care (Lingard, 2009, 2017). Furthermore, some teams are highly functioning even when one/some member(s) are not competent while one incompetent member paralyzes other teams (Lingard, 2009, 2017). Thus, in spite of the move towards collaborative IP practice, in 2016, medical errors continued to be the third leading cause of death in U.S. hospitals (Makary & Daniel, 2016), and teamwork failures were reported as causing 70% to 80% of serious medical errors (Mayo & Woolley, 2016). Boreham (2000) asserted that team failures in the ED occur from a lack of collective competence. Therefore, more research was needed to further explore IP teamwork failures, and to what extent CTC influences IP team effectiveness and medical errors.

Because a theory posits a set of propositions that describe how interrelated constructs of key elements are predictive of how a phenomenon of interest exists in the real world (Creswell, 2014), the interrelated constructs of key elements related to CTC should be predictive of how IP teamwork and medical errors exist in the real world. With the addition of the three normative principles to the key concepts from social learning, social constructionism, distributed cognition, CAS, and activity theories, CCT is the appropriate theory to provide the lens to explore how CTC relates to the effectiveness or failures of IP team practice in mitigating medical errors in EDs.

Key Concepts Underlying Collective Competence Theory

Boreham (2004) integrated the key concepts from social learning, social constructionism, distributed cognition, CAS, and activity theories in the CCT. These included

- how learning occurs at the individual and team levels (Bandura, 1971)
- collective interactions as the sources of creating sociocultural and psychological environments (Berger & Luckman, 1966)
- knowledge development, transmission, and maintenance within social environments (Hollan et al., 2000)
- role of language (Berger & Luckman, 1966)
- creating shared realities and distributed cognition (Hollan et al., 2000)
- activity system as the unit of analysis (Sannino & Engeström, 2018)
- goal-oriented action (Kaptelinin et al., 1995) and
- the CAS characteristics of nondecomposability, nonlinear behaviors, self-organization, and adaptability (Birdsey et al., 2017; Kannampallil et al., 2011)

CCT integrates these concepts within its underlying assumptions, captured in the three normative principles that include a collective sense of workplace events, a collective knowledge base, and a sense of interdependency.

Collective Sense of Workplace Events

Boreham (2004) asserted that team effectiveness is dependent upon the existence of a collective sense of workplace events. A collective sense of workplace events refers to the existence of group consciousness and a collective mind, posited as required for effective IP teamwork that included dealing with problems as these arose.

Group consciousness refers to each team member knowing what needs to be done in relation to what others in the organization are doing (Boreham, 2004). It is a collective sense of workplace events, centering on a clearly defined and shared "object of their activity" (Boreham, 2004, p. 9), or the team's goal(s). Shared goals are one required element for a collective mind.

A collective mind is what guides teams to work effectively as a single unit (Boreham, 2004). It is distributed cognition at the team level, involving cognitive processes beyond the individual, capturing the interactive elements between people and the environment (Hollan et al., 2000). Thus, a collective mind is a product of interactive consciousness that arises when individuals consciously attend to system-level consequences of their actions (Boreham, 2004). It is about understanding the functional relationships between all the system elements and the interactions between the individual, environment, and shared representations of these processes (Hollan et al., 2000), a group-level consciousness. With the use of language, a team is able to make sense of what is happening through collective reinterpretation of verbal exchanges, resulting in a shared model of tactical reasoning that enables team members to understand their messages and anticipate each other's actions, distributing cognition and generating collective knowledge (Boreham, 2004; Lingard, 2017). Language is the key instrument that enables man to produce their socio-cultural and psychological worlds, providing order, direction, and stability for all (Berger & Luckmann, 1966).

According to Boreham (2004), contradictions in priorities and goals within the workplace jeopardize the team's ability to maintain a clear object of their activity (or goal). Examples of contradictions arising from conflicting organizational goals within the HCS are the need to be fiscally responsible but providing care that is of the highest quality; or prescribing treatments to patients that are unaffordable for them (Boreham, 2004). For a team to be competent in dealing with problems that arise is dependent upon making sense of these contradictions in the workplace, which requires collective knowledge (Boreham, 2004). However, when available collective knowledge is insufficient to guide responses, it leads to uncertainty, doubt, anxiety, and questioning of personal identity (Boreham, 2004). To address contradictions in the workplace, team members benefit from spontaneous discussions as they seek solutions to problems. Furthermore, when an exchange of feelings also occurs during these discussions, Boreham postulated occupational boundaries are redefined and personal identity is preserved. Collective reinterpretation of events would ensue, generating group consciousness. Thus, CTC is dependent upon making collective sense of work place contradictions, achieved using language as the medium for sense making, distributing cognition; and for developing, transmitting, and maintaining collective knowledge within a social context (Berger & Luckmann, 1966; Boreham, 2004).

Collective Knowledge Base

CCT recognizes knowledge as collective and public, possessed by workgroups and not privately held by the individuals that comprise teams (Boreham, 2000). Within group/team processes, reality is socially constructed. This is a process of knowledge development, transmission, and its maintenance within socio-cultural situations, used to guide everyday work life (Berger & Luckmann, 1966). Developing and using a collective knowledge base requires placing individual knowledge within the context of learning how to learn and how to access situated or context-linked distributed knowledge (Lingard, 2009). When cognition is distributed, only the functional relationships between all participating elements can limit cognitive processes. The expectation is “a system that can dynamically configure itself to bring subsystems into coordination to accomplish various functions” (Hollan et al., 2000, p. 176).

CCT considers team members as nodes within a network, each possessing different kinds of knowledge, shared through their interactions (Boreham, 2000). Individuals learn from direct experiences, vicariously through the observation of others, by using symbols to represent external influences, and self-regulatory processes to control personal responses (Bandura, 1971). Mental and/or performance rehearsal act as important memory aids, reinforced by repeated observance of the same behaviors from frequent interactions with the same source of modeling (Bandura, 1971). Team members (or nodes) interact and develop networks, which are functional relationships. These networks (or functional relationships) were the basic concept that represented and guided collective activity (Boreham, 2000).

Collective Knowledge and the Organization. The interactive elements between people and the environment distributes cognition beyond the individual, and the cognitive processes that capture the functional relationships between all the system elements define the boundaries of the unit of analysis (Hollan et al., 2000). CCT explains that achieving organizational goals requires ordering collective activities into division of labor and rules for interactions, achieved by focusing on the activity system, which is the culturally and socially mediated functional groups and the unit of analysis (Boreham, 2004; Kaptelinin & Nardi., 1997; Lingard, 2009; Sannino & Engeström, 2018). The activity system itself, or the functional group, consists of an enduring system, characterized by internodal connections (Kaptelinin & Nardi, 1997; Sannino & Engeström, 2018), the functional relationships.

Improving internodal connections can strengthen networks and rich networks generate collective knowledge, which becomes embedded “in patterns of heedful interrelating” (p. 11), typifying collective activity (Boreham, 2000). Social interactions within teams produce new meanings, furthering the integration of existing team realities (Berger & Luckmann, 1966).

Activities habituated through repetition by more than one person generate a reciprocal typification and create a shared reality with predefined action patterns (Andrews, 2012; Berger & Luckmann, 1966). Language legitimizes knowledge that exists within a particular collective or setting but may require symbols to reaffirm its existence. Habituation leads to coordination of team actions, achieving efficiency (Denise, n.d.).

Knowledge Generation. Collective knowledge stems from the integration of specialized individual knowledge that can only be acquired at work through social interactions and shared experiences (Boreham, 2000). This is more than a collection of information but actual knowledge generation (Lingard, 2009). Collective knowledge is a component of organizational capacity that endures even when membership changes (Boreham, 2004), such as through policies, work routines, and communication patterns. However, Boreham (2004) also explained that collective team knowledge is also lost when the team disbands. That is, drawing from crew resource management, team knowledge exists within the heedful interactions of members, and from their collective interpretation of common experiences. Through this collective (or distributed knowledge), shared models of reasoning and team decision making become possible (Boreham, 2004). The team collectively produces knowledge and this distributed cognition affects team performance at a specific place and time. According to distributed cognition theory, distributed cognitive processes can be evidenced as (a) distributed across group members; (b) coordinated between internal and external/environmental factors; and (c) as processes distributed over time where the past informs and transforms the present and future activities (Hollan et al., 2000, p. 176). Thus, collective knowledge informs team performance within a specific place and time but also transcends place and time.

In summary, CTC requires a collective knowledge base. Although CCT recognizes both individualistic and collectivistic ways of construing competence and that these are mutually constitutive, CCT also maintains that work-related competence is collective in nature because individual behavior is a product of group processes (Boreham, 2004). Because collective competence is posited to emerge through social interactions, shared experiences, and tacit knowledge, and is shaped by the physical, social and organizational contexts of the work setting (Boreham, 2004; Lingard, 2009; 2017), a collective knowledge base is also required for collective teamwork and is a requirement for IP team effectiveness in mitigating medical errors.

Interdependency

A key premise of collective competence is that it is a constantly evolving set of multiple, interconnected behaviors achieved through participation, enacted in time and space (Boreham, 2004). Interconnected or collective activity needs communication and cooperation between subgroups to align goals systemically, as a whole. When interdependency exists amongst team members, shared mental models and mutual understanding that arise from having CTC are the basis for collective responses within the workplace reality (Boreham, 2004).

A sense of interdependency begins to grow during a crisis and may disappear if not cultivated after the crisis is over (Boreham, 2004). Strategies to maximize feelings of interdependency between team members include identifying and acknowledging any existing internal division, followed by negotiating and engaging in joint activity to transcend differences. These strategies include nonhierarchical interactions, empowerment, and valuing all contributions equally that create a psychologically safe place supporting all members to speak up (Boreham, 2004). The goal is to create a “here-and-now awareness of being dependent upon one another” (Boreham, 2004, p. 12). It is through this state of awareness that a team achieves collective competence at a specific time and place. This sense of interdependency between all subsystems (such as individuals or profession-specific groups) is required to prevent fragmentation that can arise from differing perceptions (Boreham, 2004).

Since the HCS is a highly complex adaptive one (Birdsey et al., 2017), it is characterized by highly interactive internal and external system processes that are required to respond to multiple sources of stressors (Nugus et al., 2010). Within this CAS, cultivating interdependency between team members to achieve collective competence and eliminate medical errors is influenced by non-decomposability of the unit of analysis, nonlinear responses to stressors by team members, and self-organization and adaptability of the team as a whole (Birdsey et al., 2017; Kannampallil et al., 2011). This explanation of the CAS response is consistent with distributed cognition theory, postulating that interactions between individual internal processes, manipulation of the environment, and shared representations of reality culminate in a reorganization of both internal and external processes (Hollan et al., 2000). Kannampallil et al. (2011) advocated that "complexity of healthcare practice [should be] an important consideration for patient safety and quality" (p. 943). Since parts of a CAS are not discrete but extensively interconnected, any weakness or change anywhere exerts partial or total systemic effects (Lingard, 2009; WTRTF, 2017). The here-and-now awareness of interdependency within a CAS leads to collective action that should decrease medical errors.

Analysis of Application of Collective Competence Theory in Research and Practice

The role of theories in research is to provide a blueprint for the exploration of a phenomenon of interest (Grant & Osanloo, 2014). A theory posits a set of propositions that describe how interrelated constructs of key elements are predictive of how the phenomenon of interest exists in the real world (Creswell, 2014). To this end, CCT has informed research activities across sectors and internationally. An analysis of how CCT has been applied within 11 research studies and two dissertations follows. Studying the presence and/or development of collective competence in teams generated varied responses.

Evidence of Collective Competence

Hager and Johnsson (2009a, 2009b), Hedjazi (2018), and Arnaud and Mills (2012) reported on the normative principles of a sense of workplace events, development and use of collective knowledge, and interdependency in differing work environments. First, Hager and Johnsson (2009a) used a case study approach and analyzed a multifaceted educational program applied to develop professional orchestral musicians. These researchers reported that acceptance into an orchestra required more than the individual's ability to perform brilliantly; it also required the ability to perform within a group. Reported findings were that individual and collective musicians' performances improved through practice, based within a team environment, peer-to-peer mentoring, tacit learning, and fitting within the group style (Hager & Johnsson, 2009a). Collective sense of workplace events was noted in the group sharing a collective mind, effectively working as a single unit while performing. Collective knowledge developed through frequent interactions for learning. Interdependency was evidenced in improved competence at both the individual and team levels (Hager & Johnsson, 2009a).

Similarly, Hager & Johnsson (2009b) reported the emergence of collective competence among newly formed teams during the move to IP team-based practices within a correctional institution. Using a case study approach, these researchers observed 40 IP team members to discover the nature of learning that emerged within a destabilizing environment that was undergoing rapid organizational change. The newly formed teams were observed to collectively produce practical solutions to problems that occurred though member interactions. Concurrently, relationships amongst individuals within the teams developed, creating learning opportunities to work together differently (Hager & Johnsson, 2009b). Although the transition was facilitated by change agents, Hager and Johnsson (2009b) reported that rather than having planned how to work together, these teams discovered how to work differently while preserving their individual member identity. Consistent with the findings by Hager and Johnsson (2009b), Hedjazi (2018) also used a case study analysis and reported that the use of group awareness tools was successful in developing and maintaining collective competency within the computer technology arena in an industrial maintenance workplace.

In exploring collaborative IP practice within the healthcare sector, Fox (2015) observed 4000 patient case reviews from 120 daily acute care team rounds involving three professions. Fox noted that IP team members demonstrated mindfulness of differences and attentiveness to expressions of uncertainty amongst colleagues, which invited others to “help resolve this uncertainty” (p. 222). However, which professionals participated during case reviews did make a difference. That is, when physicians were members of the IP team, a change in focus of the sense-making work occurred, which Fox referred to as medical dominance. Fox attributed this change in sense-making to shifting team membership. Furthermore, although elements of collective competence were identified, Fox reported that collective competence was not consistently embraced into IP teamwork culture.

Bitencourt and Bonotto (2010) studied collective competence within two self-managed teams in a petrochemical plant, where collective competence was defined as “people’s ability to work towards a common task in a sufficient way” (Hansson, 1998, as cited in Bitencourt & Bonotto, 2010, p. 175). Bitencourt and Bonotto reported that interaction processes, sense-making, and building the team’s identity differed between the teams, interpreted as “these elements are interrelated in such a manner that it becomes impossible to understand their meaning separately" (p. 189). However, these authors asserted that the development of collective competence is due to the team dynamics and interactive processes, where the quality of interactions between team members and not content of competence is the important factor. Furthermore, Bitencourt and Bonotto stressed that a learning process is an integral component of team's ability to develop collective competence.

Emergent collective competence was also noted in interfirm collaboration at the micro level and in virtual teams. That is, using an ethnographic approach, Arnaud and Mills (2012) analyzed communication processes between operation-level employees working in furniture manufacturing and distribution. The interfirm workers used conversations (language) to connect and produce enduring patterns of engagement that resulted in coordinated actions across organizations (Arnaud & Mills, 2012). Language was not only used to describe situations but also to create situations within this work environment. Due to the complexity of the processes involved, Arnaud and Mills concluded that one member alone cannot achieve this collective outcome but that collective competence exists as a product of collaborative action, achieved through communication and interactions. The coordinated activities were highly interdependent and successfully executed, indicative of the presence of collective sense of workplace events (Arnaud & Mills, 2012).

Similarly, Gray (2007) explored the development of CTC in distributed, interdependent virtual teams comprising of existing intact teams from American and Mexican manufacturing sectors who collaborated on interorganizational projects. Gray reported that collective competence was evidenced in how members engaged in distributed networks, and were able to construct meaning through collective intelligence and interactive consciousness. That is, pathways of connectivity situated within the context of team member interactions generate collective intelligence. These pathways of connectivity "operationalize collective activity through mutual frames of reference" (p. 191) and result in interactive consciousness while technology transparency enables collaboration and knowledge generation (Gray, 2007). Thus, the emergence of the normative principles of collective competence are not limited to traditionally structured teams but also exist in interorganizational teams.

Using a social perspective for the construction of collective sense making, Macke and Crespi (2016) proceeded to develop an instrument to measure collective competence among information technology teams. Macke and Crespi used multiple authors, including Boreham's (2004) CCT, to inform their social perspective of collective sense making and identified proactivity, communication, cooperation, and interpersonal relationships as the factors that defined CTC. These elements differ from the three normative principles for CTC identified by Boreham (2004), which consist of a collective sense of workplace events, collective knowledge base, and interdependency. This difference may be attributed to the predominance of individualistic work among IT professionals (Macke & Crespi, 2016), and not reflective of collective teamwork.

Absence of Collective Competence

Not all teams studied using CCT as their theoretical underpinning exhibited the normative principles of collective competence. One study by Avelino et al. (2017) involved three federal public organizations that adopted a strategic competency-based management model. This model aimed to maximize organizational performance by planning, capturing, developing, and evaluating competencies at the individual, group and the overall organizational level (Avelino et al., 2017). These researchers interviewed 10 employees and analyzed company documents to explore if having a competency-based model included a focus on collective competencies as well as at the individual level. They found that the focus remained on individual competencies and that collective competence was not adopted within the competency-based management model at these sites. A gap existed between the strategic organizational direction of “teamwork, cooperation between peers and sectors of the organization, and management practices, which focus on the individual” (Avelino et al., 2017, p. 205). However, the interviewees did report that a shared understanding of team goals and the use of shared language was present but a bureaucratic model prevailed (Avelino et al., 2017). However, Avelino et al. did not explore the impact of the existing gap on organizational performance.

Similarly, Bertolini et al. (2016) reported that collective competence within a wine industry organization was lacking the elements of cooperation, communication, and knowledge sharing. This conclusion was based on interviews and responses analyzed for sense-making, interactive action, know-how to communicate, and know-how to cooperate (p. 106). Lack of deliberate organizational efforts to develop collective competence was evidenced in the continued focus of developing isolated competencies, impeding the creation of synergy and “generating lower benefits for the industry” (Bertolini et al., 2016, p. 112). Kitto et al. (2015) also found consistent results within the healthcare sector.

Kitto et al. (2015) reviewed the rapid response system (RRS) within hospital settings from an IP and collective competence lens but collective competence was not evident. RRSs were used as a process to summon immediate expert assistance to a patient with an unstable medical condition. These researchers conducted 10 focus group interviews with participants from four hospitals to explore the social, professional, and cultural factors associated with missed use of RRSs. The rationales provided by the participants for not activating RRSs included differing intraprofessional decision making pathways for nursing and medicine; IP collaboration and communication that occurred horizontally across professional boundaries and vertically through the professional hierarchical structure; and the use of RRSs as a work-around tool when collaboration and/or communication was ineffective. Thus, Kitto et al. concluded that social, professional, and cultural factors, including IP hierarchical structure and communication barriers mediate the use of the RRSs within hospital settings. Consistent with premise that knowledge development is a reality that is socially constructed (Boreham, 2004), socio-cultural work environments influence CTC.

Lingard (e.g., 2009, 2016, 2017) presented at multiple symposia to advocate for a shift of looking beyond individual competence and consider collective competence in healthcare. Lingard also conducted qualitative studies to explore the phenomenon of collective competence but the theories that framed the studies were not CCT per se. For example, in the exploration of the tension between autonomy and interdependence within team members of an organ transplantation team, Lingard et al. (2014) used loose coupling theory. This study involved 39 healthcare professionals and 10 patients. Data collection included observation during patient rounds and individual team members, and spontaneous and formal interviews (Lingard et al., 2014). The core team was defined as including professionals who were members of the transplant team and shared regular interactions. A reported observation was that “although the team members’ roles were interdependent, each professional applied distinctive expertise and, as a group, they drew on one another strategically” (p. 6). Furthermore, although identified as resources for effective collaboration, the degree of autonomy and interdependence fluctuated (Lingard et al., 2014).

Additionally, in another study, Lingard et al. (2017) used constructivist grounded and CAS theories to explore the relationship between heart failure team members' goals, understandings, values, routines, actions, and collective competence from five sites in three Canadian provinces. Team members and patients were interviewed. Congruent with the element of adaptation explained by the CAS theory, this team of experts demonstrated the emergence of convergent and divergent behaviors, which had both a positive and negative effect on collective team functioning (Lingard et al., 2017). Convergence was noted as shared action or collective paralysis and, in circumstances when members differed in their understandings and actions (divergence), team processes were disrupted (Lingard et al., 2017). These researchers concluded that collective competence is compromised within these heart failure teams of experts.

Implications of Research Findings Using Collective Competence Theory

Research findings from studies that used CCT as their theoretical framework generated responses within the research and practice communities. For example, Schmutz and Eppich (2017) reported that when teams reflect collectively on their objectives, processes, actions, and future performance, shared mental models result that enable members to adapt. That is, Schmutz and Eppich identified reflective practice as one mechanism that promotes IP collaborative practice, and proceeded to develop a conceptual framework for team reflexivity. Lingard et al. (2017) also proposed strategies to promote a more collective state of team functioning applicable to any work environment. Proposed strategies include decreasing IP team tensions through shared motivation, clear roles and scopes, and other practices that minimize divergent behaviors (Lingard et al., 2017) while team reflexivity is a strategy that decreases team tensions (Schmutz & Eppich, 2017).

Evidence generated from research informed by CCT (or the study of interrelated elements predictive of collective competence) was also raising awareness about the role of CTC in IP team effectiveness. Monitoring individual competencies by professional agencies (e.g., College of Registered Nurses of Manitoba, 2019) and healthcare organizations continues to be the primary means for promoting patient safety. However, the focus of patient safety and the mandate for all who work in healthcare is to prevent medical errors, and attending to both individual and collective competence is required to promote effective IP teamwork (IOM/NAM, 2000; Lingard, 2009, 2017; Shinners & Franqueiro, 2017).

A move towards embracing collective competence as a critical element to promote safe care and decrease medical errors within healthcare has started. For example, Shinners and Franqueiro (2017) advocated for IPE to extend beyond utilizing simulation, role-playing, and case studies involving participants with differing perspectives and well-defined roles and responsibilities (which is context-free) to include assessing CTC during and following actual patient care situations. To achieve this, Shinners and Franqueiro proposed the use of debriefs that include how team members functioned as a team, and positioning the patient outcome within collective performance and competence. Similarly, Epstein et al. (2017) advocated for shifting medical aesthetics training to a collective competence approach, positioning the learning of technical skills within the context of learning interpersonal skills that should include IP competencies of collaboration, delegation, negotiation, and communication. Furthermore, Lingard has been addressing professional organizations, challenging audiences to view competence from both the individual and collective lenses, cautioning how each lens selects and deflects our attention (e.g. Lingard 2009; 2017). However, studies informed by Boreham's or other CCTs were qualitative in nature and the generalizability of the findings are limited. Thus, quantitative studies were needed.

Interprofessional Team Membership, Collective Competence, and Patient Outcomes

The IOM/NAM (2000) challenged health care organizations to shift the focus of strategies to eliminate medical errors from the individual care providers to modifying latent factors at the system level. The purpose of this study was to explore the latent factor of differences in team membership due to shift work schedules and how this related to collective competence and IP team effectiveness, as reflected in patient outcomes in EDs. The term collective competence within this document denotes an expected level of performance at a team level that produces desired outcomes, and is used interchangeably with CTC. For an IP team to demonstrate collective competence, it requires IP competencies evidence in the integration of knowledge, skills, attitudes, values, and judgment (CIHC, 2010) at a team level that generates collective knowledge, shared mental models of reasoning, and team decision making (Boreham, 2004).

I selected CCT as the theoretical framework for this study because it identifies collective competence at a team level as a requirement for a system to perform competently. Increasing an understanding of how IP team membership influences CTC and IP team effectiveness supports the IOM/NAM’s (2000) direction that healthcare organizations should focus on modifying system factors in order to eliminate medical errors. Thus, it is important to understand how differences in team membership due to shift work schedules relates to CTC, IP team effectiveness, and medical errors. CCT’s theoretical lens provides the structure to interpret results generated by this study, offering insights into how variations in team membership influence IP team competence, effectiveness, and medical errors as patient outcomes in the ED.

This study also provided an opportunity to test the predictions that CCT posits. CCT posits that teams are effective when minimally three normative principles are present, consisting of a collective sense of workplace events, a collective knowledge base, and interdependency amongst its members (Boreham, 2004). This study attempted to identify the presence/absence of these normative principles within IP teams in the ED environment, a CAS, when TMS is not constant. The unit of analysis was the culturally and socially mediated functional group (Boreham, 2004; Kaptelinin & Nardi, 1997; Lingard, 2009; Sannino & Engestrom, 2018) which, in this study, consisted of the IP core team members involved in providing care to persons who presented to the EDs during data collection time.

Literature Review Related to Key Variables and Concepts

The purpose of this study was to explore the relationship between differences in team membership due to shift work schedules, individual collaborative IP competencies, and CTC with medical errors in EDs. The literature review focused on these variables of interest. The interrelated elements associated with CTC as expressed by the CCT structured the review. These consisted of CCT's three formative principles - a collective sense of workplace events, a collective knowledge base, and interdependency amongst team members, all occurring within a specific unit of analysis, the activity system of the team's culturally and socially mediated environment (Boreham, 2004). Some of the elements subsumed within these CCT's principles are

- communication, use of language, and speaking up
- collective and collaborative work, cooperation, coordination, and the establishment of networks
- distributed cognition and shared mental models

- group consciousness, situational awareness and collective sense-making
- conflict
- roles and responsibilities
- team interactions
- CASs

An analysis of current knowledge about medical errors and these variables and constructs follows.

Medical Errors

In 1999, medical errors caused between 44,000 and 98,000 U.S. deaths, primarily occurring in EDs, intensive care units, and operating rooms (IOM/NAM, 2000). In 2016, medical errors remained the third leading cause of U.S. hospital deaths (Makary & Daniel, 2016) and teamwork failures caused 70% to 80% of the serious errors (Mayo & Woolley, 2016). The IOM/NAM (2000) identified failures in execution or planning of care as one cause of medical errors.

Errors in execution consist of correct plans of care not implemented, or do not go as intended to achieve the desired outcome(s). Errors in execution are observable as slips or, indirectly, as a lapse or delay in care (IOM/NAM, 2000). In contrast, errors in planning patient care are mistakes that result from care delivered as planned but the plan required to achieve the desired outcome is incorrect (IOM/NAM, 2000). Medical errors were further attributed to either actions that occurred at the point of care (referred to as active errors) or embedded within the system, latent in nature, beyond the control of the direct providers of care. The IOM/NAM (2000) recognized latent errors as those that posed the greatest risk to patient safety. This study examined the relationship between TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in the EDs. The focus was on system factors, latent errors in execution that could have contributed to delays in patient care.

Types of Medical Errors

The IOM/NAM (2000) classified medical errors into three types, as

- diagnostic, consisting of error or delay in diagnosis; failure to employ indicated tests; use of outmoded therapies; and/or failure to act on results of monitoring or testing
- related to treatment, where errors occurred in the performance of an operation, procedure, or test; in administering a treatment; in dose or method of using a drug; avoidable delay in treatment or in responding to an abnormal test; and/or inappropriate (not indicated) care
- other types, such as failure in communication, equipment failure, or other system failures (p. 36).

Similarly, Boreham et al. (2000) identified medical errors within EDs as (a) delays in beginning initial nurse assessment, (b) delays to medical investigations or the treatment, (c) failure to obtain essential diagnostic information, (d) misinterpretation of diagnostic information, and (e) administration of inappropriate treatment. Many medical errors can lead to adverse events, the preventable injuries sustained by patients unrelated to their underlying condition but are a consequence of the care provided (IOM/NAM, 2000). Researchers have continued to study diagnostic, treatment, other types of medical errors, and adverse events.

Diagnostic errors from inadequate assessments that missed the severity of the patients' conditions were the most common type of medical errors that resulted in life threatening events or deaths (Zhang et al., 2018). Diagnostic errors consisted of (a) incorrect diagnoses (Solano et al., 2017; Zhang et al., 2018), (b) specimen identification errors (Ning et al., 2016), (c) failure to order tests (Solano et al., 2017); (d) diagnostic test delays or delays in critical result notification (Okafor et al., 2016; Solano et al., 2017), and/or (e) failure to act on results generated by monitoring (Solano et al., 2017).

Research findings also included multiple treatment errors. Some were associated with delays in initiating treatment and incorrect interventions (Boreham et al., 2000; Chiu et al., 2018; Solano et al., 2017). Others required changes in care management, operative interventions, invasive procedures and/or medications (Linnebur et al., 2018; Solano et al., 2017). Treatment errors also included prescription errors (Murray et al., 2017) and medication errors (Abadi et al., 2017; Carlson, 2016; Solano et al., 2017).

Researchers also reported system errors that fell into the category of “other”. These included extended LOS in EDs (Dolejs et al., 2017; Eriksson et al., 2018), loss of key patient information (Eriksson et al., 2018), and inappropriate or errors in disposition decision (Klasco et al., 2015; Solano et al., 2017). Other reported system-level factors associated with medical errors in EDs included excessive workload, insufficient number of nurses, fatigue, exhaustion, and burnout (Källberg et al., 2017; Kiymaz & Koç, 2018; Weigl et al., 2016). Similarly, Dadashzadeh et al. (2011) identified three main causes for delays in time to triage as nursing shortages, large number of patients, and a shortage of medical staff. Furthermore, nurse-to-patient ratios were predictive of time to diagnostic evaluation (Shindul-Rothchild et al., 2017). However, subjective perception (and not objective measures) of workload was found by Abadi et al. (2017) to be significantly related to the incidence of adverse events.

Reported adverse events were iatrogenic in nature whereby new illnesses or injuries resulted as a consequence of medical errors and complications from treatment (Linnebur et al., 2018; Solano et al., 2017). Reported adverse events included but were not limited to

- compromised hydration, nutrition, activities of daily living (e.g. hygienic and elimination; Eriksson et al., 2018);
- discomfort, anxiety and/or altered mental status (Eriksson et al., 2018; Solano et al., 2017);
- patient falls (Abadi et al., 2017; Carlson, 2016; Eriksson et al., 2018);
- infections (Abadi et al., 2017; Carlson, 2016; Linnebur et al., 2018; Solano et al., 2017);
- pressure injuries (Abadi et al., 2017; Carlson, 2016; Eriksson et al., 2018);
- increased morbidity or deterioration in medical condition (Dolej et al., 2017; Eriksson et al., 2018; Klasco et al., 2015; Linnebur et al., 2018; Solano et al., 2017);
- permanent disability (da Silva & Krishnamurthy, 2016; Okafor et al., 2016); and
- mortality (Flaatten et al., 2017; Klasco et al., 2015).

As can be seen, active and latent factors have continued to pose risks to patient safety that lead to medical errors. Causes of medical errors are frequently multi-factorial in nature and include (a) patient factors, (b) human errors, (c) ED environment, (d) hospital environment, (e) external environment, and (f) teamwork failures (Källberg et al., 2015). Latent errors in execution as a function of system factors was the focus of this study. That is, TMS is a system factor that may be related to the frequency of latent errors occurring in EDs.

Patient Characteristics

Patient characteristics were identified as a contributing factor to medical errors in EDs. One such factor was the complexity of care needs that patients presented with to the ED. The highest incidence of medical errors was associated with patients presenting with multiple comorbidities, chronic conditions and/or communication disabilities (Flaatten et al., 2017;

Källberg et al., 2015). Patients who presented with atypical symptomatology and highly acute conditions encountered similar risks (Okafor et al., 2016). In addition, Houston et al. (2015) reported that frequently patients waited more than 10 minutes prior to being triaged and that the time to triage increased based on the number of patients who presented within the previous hour (from 12.4% when 0 to 5 new patients presented to 68% when more than 16 new ones arrived). Thus, patient factors can lead to medical errors in diagnosis, treatment, and other types. To understand the relationship between differences in team membership due to shiftwork schedules, individual collaborative IP competence, and CTC with medical errors in EDs, patient characteristics for levels of acuity and volume were statistically controlled.

Human Errors

Human factors as a source for medical errors have been reported. Cognitive errors by providers were most frequently associated with errors in planning from insufficient examination. These execution errors resulted in either delayed or missed diagnoses (Boreham et al., 2000; Källberg et al., 2015), and many started as early as during the triage process (Chiu et al., 2018). For example, patients triaged at higher acuity levels experienced less medical errors and adverse events (Zhang et al., 2017). Cognitive errors were also linked to faulty information verification, information processing, faulty data gathering, and faulty knowledge (Okafor et al., 2016).

Freund et al. (2015) studied adverse events as medical errors that required interventions or caused harm in a population of admitted patients from the ED. These researchers reported that proficiency errors caused adverse events and that these proficiency errors consisted of the need for enhanced technical and theoretical ED physician training, or the inability to apply their knowledge and skills due to ED environmental factors, such as overcrowding. Fatigue, inadequate experience, and inadequate supervision were also identified as causes of medical errors (Bari et al., 2016). However, the incidence of adverse events decreased when more than one physician became involved in the care of patients, irrespective of their levels of expertise. This buffering effect was attributed to crosschecking of medical decisions (Freund et al., 2015). Decreasing diagnosis errors also benefited from expanding the responsibility of diagnosis from physician-only to include the pathologist and radiologist (Graber et al., 2017), and the addition of allied health professionals, such as physical therapy (Thomas & Newman-Toker, 2016).

These findings discussed above were consistent with the IOM/NAM's (2001) direction that, to minimize medical errors, appropriate information exchange amongst clinicians is required. This is to occur through active collaboration, communication, cooperation and coordination of care across patient conditions, services, and settings over time, continuously advancing the effectiveness of IP teams. However, IP collaboration was not significantly related to core skills (Zabar et al., 2016) but individual competence influenced trust and capacity to dialogue (McCallin, 2006) required for IP collaboration. Furthermore, not all IP collaboration led to better outcomes. For example, Farrell et al. (2018) stated that the quality of care plans was the same whether developed by individuals or a team. Thus, a collaborative IP team approach to medical diagnosis may be indicative of the positive benefits of CTC but is IP collaboration required in all situations to buffer human errors in the eliminate medical errors?

The Environments

The interrelatedness of system components and the extent to which these components have the capacity to influence each other define the complexity of systems (Kannampallil et al., 2011). The ED is one care area that functions as a CAS within a larger CAS, continuously interacting with the hospital and external environments (Birdsey et al., 2017; Källberg et al., 2015). As one area where medical errors primarily occur, the EDs were the work environments selected for this study.

Within any work environment, an activity system exists which is the culturally and socially mediated functional group, considered the basic unit of analysis (Boreham, 2004; Sannino & Engeström, 2018). Understanding the unit of analysis requires attending to cognitive processes that capture the functional relationships between all system elements (Hollan et al., 2000). The activity system of interest for this study was the IP core team in EDs as the basic unit of analysis responding within this CAS and beyond.

The Emergency Department Environment

Many factors exist within ED environments that create opportunities for medical errors and adverse events. One factor unique to the ED environment is patient flow. Patient flow through the ED is a function of volume (or demand for service), patient characteristics (complexity of care needed), human factors (the number and competency of care providers available), and the physical environment within which care is provided (Emergency Nurses Association [ENA], 2018; IOM/NAM, 2000; Rice, 2016). Boreham et al. (2000) argued that a fundamental contradiction exists between how the work is organized in EDs with unrestricted patient access but finite resources, thereby increasing risks. When flow is impeded, overcapacity situations occur and patient ED LOS increases, associated with increased diagnostic and treatment errors (Dolej et al., 2017; Eriksson et al., 2018; Flaatten et al., 2017). However, the findings by Georgio et al. (2017) did not support that an increase in LOS within EDs occurred based on variations in patient volumes and patient acuity levels. Georgio et al. hypothesized that measures existed to meet increased demands but these authors did not identify what these measures were. Irrespectively, bottlenecks at triage increase the triage nurse’s workload, and creates crowding in the waiting room and delays in patients receiving appropriate care (Pryce et al., 2021). Thus, the extent to which volume and patient characteristics impact patient flow and ultimately medical errors may be mediated by other factors.

Other factors within the ED environment creating opportunities for errors include a lack of routines in initial triage or nursing assessment (Källberg et al., 2015). Also reported are frequent handover of care and reliance on verbal reports (Eriksson et al 2018; Farzi et al., 2017; Okafor et al., 2016), as well as workflow interruptions and multitasking (Weigl et al., 2016). Furthermore, associated with medical errors are frequent relocations of patients within the ED itself (Eriksson et al 2018) and other organizational factors outside of the influence of the ED (e.g., patient volumes; Driesen et al., 2018; von Thiele Schwarz et al., 2016).

Within this study, medical errors as patient outcomes within EDs were the dependent variables. Furthermore, since individual and collective competence are context-dependent (Shinners & Franqueiro, 2017), these ED environmental elements within this CAS were captured within this study through subjective ratings of the extent that CCT's normative principles for effective teamwork were present. It was this relationship between IP TMS, individual IP collaborative competence, CTC, and medical errors as patient outcomes that were explored.

The Activity System in the Emergency Department Environment

Due to the existence of extensive interrelatedness of components within the ED activity unit, and its nonlinear response to internal and external environments, Kannampallil et al. (2011) maintained that the ED cannot be understood by focusing on its components in isolation (element of nondecomposability), rendering studying teamwork within EDs difficult. For example, Zhang et al. (2018) reproduced an artificial ED environment with elements of chaos, need for communication, strategic thinking, differential diagnoses, teamwork, task delegation, and time constraints (p. 3). Responses from participants were that the simulation only involved low stakes/risks and cue-based linear processes. That is, Zhang et al. did not succeed in artificially emulating the extensive interrelatedness between CAS elements existing within EDs, interacting in nonlinear patterns. Thus, according to Boreham (2004) and the Agency for Healthcare Research and Quality (2014), for an ED team to function effectively and prevent medical errors, they must possess a collective sense of workplace events.

Similarly, using a computer-generated observation tool and ED metrics was inadequate in capturing the dynamic and evolving interrelationships among ED team members (Birdsey et al., 2017). However, Kannampallil et al. (2011) proposed that identifying a functional slice of the CAS, characterizing it in terms of the discernable interrelations with other elements, was appropriate. For example, Weigl et al. (2015) focused on the effects of interruptions under naturally occurring ED conditions. Weigl et al. were able to observe that ED care providers experienced frequent interruptions, engaged in multitasking, and responded to unpredictable workload demands. The functional slice identified for this study was TMS within the ED activity system, its core team, and its relationship with CTC and medical errors as patient outcomes.

Since EDs are complex and adaptive environments, there is extensive interrelatedness of components within the activity unit that can generate nondecomposable and nonlinear responses to the internal and external environments while self-organizing and adapting (Birdsey et al., 2017; Kannampallil et al., 2011). For example, through ethnographic observation, Nugus et al. (2010) reported that to coordinate processes of admissions and discharges, the ED team engaged with each other within the activity unit and beyond to address safe care needs of the people who presented, where ED processes were inextricably tied to the rest of the hospital and other external resources. The processes of IP collaboration, communication, cooperation, and coordination of care across patient conditions, services, and settings over time are complicated due to the many functional relationships between system elements. To eliminate medical errors in EDs, Birdsey et al. (2017) and Kannampallil et al. (2011) stressed that IP teamwork must be understood, implemented, and supported within a CAS environment. To prevent teamwork failures, each member of the IP core team is required to understand system-level consequences of their actions, generating a collective sense of workplace events (Boreham, 2004).

Teamwork Failures

The WHO (2010) reported that when utilizing collaborative team practices, teamwork is effective in decreasing medical errors, adverse events, hospital admissions, and mortality rates. However, "collaborative practice by itself will not guarantee the provision of optimal health services" (WHO, 2010, p. 28). According to the WHO, other practice level mechanisms are needed to be in place. These are (a) institutional supports captured in governance models, structured protocols, and shared operational procedures; (b) adequate time and space for collaboration and care delivery; (c) a working culture that embraces shared decision-making, routine team meetings, common goals, and patient management plans; and (d) structured information systems and processes that facilitate effective communication, conflict resolution, and regular dialogue (WHO, 2010, P. 28). A teamwork climate also mitigates teamwork failures and reduces the incidence of medical errors (Alzahrani et al., 2018). Similarly, shared mental models, mutual support through feedback, advocacy, assertion, and conflict resolution result in higher team functioning and lower mortality in EDs and critical care areas (Wu et al., 2016). However, collective failures still occur.

Organizational factors, such as power inequities and dynamics (Ambrose-Miller & Ashcroft, 2016) and variations in team membership (Ulrich & Crider, 2017) undermine collaborative IP practice, leading to teamwork failures and errors (Mayo & Woolley, 2016). Ineffective communication, inadequate information flow, and transfer of information between team members also increases the incidence of medical errors in the ED, intensive care units, and other hospital areas (Källberg et al., 2015; Okafor et al., 2016; Ugur et al., 2016). Furthermore, Grover et al. (2017) found that teamwork failed with inadequate resources and skills mix. However, Gardiner and Chater (2013) posited that collective failures result from (a) denying that a problem exists; (b) through pluralistic ignorance by accepting status quo, a situation when everyone thinks the same but assumes that everyone else in the group thinks differently, resulting in no-one taking actions; and (c) through a diffusion of responsibility, when every team member believes that everyone knows something that they do not. Thus, collective competence is needed to counter opportunities for collective failures and effective IP team functioning is important because, when teamwork fails, medical errors can occur.

Collective Interprofessional Team Competence and Team Effectiveness

Collaborative IP practice occurs "when multiple workers from different professional backgrounds provide comprehensive services" (WHO, 2010, p. 13). IP collaboration is about working with other(s), sharing ideas, and engaging in collective action in providing a service (D'Amour et al., 2005). It is a process aimed at developing and maintain IP relationships, integrating competencies and resources; and applying knowledge, skills, and attitudes to inform team decisions (CIHC, 2010). IP team collaboration in healthcare requires IP competencies, expressed in (a) the ability to keep the focus of all activities on the recipient of care, (b) respectful communication and relationships, (c) leadership, (d) clear roles and responsibilities, (e) attention to team dynamics and processes, and (f) conflict resolution (CIHC, 2010, p. 9). Eliminating medical errors in healthcare requires highly competent individuals functioning within highly competent IP teams. Amir et al. (2018) proposed that the complexity of problems encountered and the ability of team members to solve these defines team effectiveness.

WHO (2010) identified IPE as a prerequisite to effective IP collaborative practice. Similar to IP competencies identified by CIHC (2010), the IPEC (2016) identified (a) mutual respect, (b) shared values, (c) roles, (d) communication, and (e) team dynamics and relationships as IP competencies that informed the framework for curriculum development within educational institutions. IPEC defined IP competencies in healthcare as "the integrated enactment of knowledge, skills, values and attitudes that define working together across the professions … in specific care contexts" (p. 8). IP competencies are characteristics of IP teams that possess collective competence, evidenced in their collective knowledge base, a collective sense of workplace events, and interdependency between IP team members (Boreham, 2004).

Collective Knowledge Base

The WHO (2010) identified IPE as the mechanism to effect IP collaborative practice. Collaboration is about working cooperatively with others instead of independently or competitively (National Center for Healthcare Leadership, 2006). Educational institutions and workplaces responded, incorporating IPE into the curricula and staff development activities. IPE is about learners participating in "scheduled activities where trainees learn with, from and about one another" (D'Angelo et al., 2016, p. 1405). Learning at a group level is a by-product of group processes within the social context of the learning environment, integrating individualistic and collectivistic ways of constructing competence (Bandura, 1971; Boreham, 2004). Capacity develops over time through the actualization of competencies that generate new understanding (CIHC, 2010). For example, at Ringerike, through repeated collective learning and training, habituation increased resilience that positioned the hospital to effectively respond to a crisis that outstripped its resources (Gauss & Cook, 2017). This was the result of a social construction of reality during group learning, the process for knowledge development, transmission, and its maintenance within a team's environment (Hollan et al., 2000). Multiple studies have captured the outcomes of IPE for populations of students from different health care professional studies and workplace IP teams.

Reported positive outcomes of IPE are increases in cognition, psychomotor, and in affective domains (Behan & Van Der Like, 2017). IPE is successful in increasing knowledge at the individual level (Ferrie & Sturrock, 2017; George, 2018; Goolsarran et al., 2018; Tsai et al., 2016), and as shared and distributed across team members (He & Zheng, 2016; James et al., 2016). Improvements in communication and collaboration were perceived by IPE participants (Blue et al., 2015; Ferrie & Sturrock, 2017; Fewster-Thuente & Batteson, 2016; King et al., 2016; Kreuger et al., 2017; Weller et al., 2016). An increased ability to evaluate decisions by other professional within the context of applying enhanced therapeutic knowledge was also observed (Ferrie & Sturrock, 2017) and learning was independent of previous work experience (Sauter et al., 2016). Similarly, attitudes toward teamwork and collaboration improved during simulated patient rounds amongst students representing eight professions (Fewster-Thuente & Batteson, 2016). Learning extended beyond the acquisition of new knowledge to include a change in attitudes to enhance IP collaboration as an outcome of IPE (James et al., 2016; Krueger et al., 2017; Yang et al., 2017). Through IPE, professionals learned about the importance of non-technical skills in effective teamwork within clinical care (Jorm et al., 2016). Researchers also reported that IPE is an effective intervention for improving individual confidence (Brewster et al., 2017), self-efficacy (Egenberg, Karlsen et al., 2017; Egenberg, Øian et al., 2017; Sauter et al., 2016; Sexton & Orchard, 2016), and professional identity

(Goolsarran et al., 2018). Through IPE, team efficacy (Egenberg, Øian et al., 2017; Tsai et al., 2016), the understanding and appreciation of the roles of other IP providers, and the language needed to collaborate develops (Fewster-Thuente & Batterson, 2016; King et al., 2016).

Role clarification is about understanding one's own role and the role of other professionals within the work context, enabling all to work to their full scope (CIHC, 2010). By predefining roles and responsibilities during deliberate practice using simulations, IPE is successful in enhancing teamwork. For example, teamwork was enhanced when IPE focused on specific scenarios/situations, such as resuscitation (Calder et al., 2017), obstetrical emergencies (Black, 2018), advanced cardiac life support (Brewster et al., 2017), trauma (Brown et al., 2016; Murphy et al., 2018), postpartum hemorrhage (Egenberg, Karlsen et al., 2017; Egenberg, Øian et al., 2017), and sedation (Sauter et al., 2016). Loud verbalization of activities and closed-loop communication by the leader promotes an understanding of the role during training (Zimmerman et al., 2015). Participants in IPE perceived the role of the supervisor as important to maintain continuity in team activities and to provide encouragement (Ericson et al., 2017). However, assuming a leadership role without adequate training was met with reluctance (Hudson et al., 2017) and hierarchy in IP teams was reported as a source of anxiety by leaders of simulation training in resuscitation (van Schaik et al., 2015). Thus, socio-cultural factors within educational settings exert a mediating influence on IPE outcomes.

Quantitative analysis of IPE outcomes generated conflicting results. For example, Smith et al. (2015) reported that one IPE session was not successful in modifying underlying assumptions (or stereotypes) of professional roles and responsibility, leading these researchers to recommend longitudinal training and modeling. Likewise, Ginsburg and Bain (2017) concluded that, even with the use of a multifaceted approach to improve teamwork, education alone is not sufficient to produce statistically significant changes in behaviors. Improvement in mentoring team collaborative working relationships following training occurred but the changes where not statistically significant (Grymonpre et al., 2016). Similarly, Goolsarran et al. (2018) reported that, although improvements occurred in teamwork and collaboration, only positive professional identity was statistically significantly. In contrast, Lochner et al. (2018) found significant improvements in communication, teamwork, and IP learning after a three-day course on non-technical skills but not for IP interactions and relationships. In a comparison of patient outcomes before and after simulation, Murphy et al. (2018) reported a decrease in time to critical operations but overall ED LOS increased, and there was no reduction in patient mortality. Similarly, Sauter et al. (2016) found no significant changes in complications related to use of sedation but time to procedure improved.

Although delivery modalities of IPE and team membership differed across studies, evidence existed that IPE did influence IP team effectiveness. However, IPE occurred within artificial environments and its contribution to a collective knowledge base at an IP team level produced mixed results. That is, team learning is a by-product of group processes (Bandura, 1971; Boreham, 2004) and capacity develops over time (CIHC, 2010). For example, among operating room teams of highly skilled individuals, coordinated collective activity decreased morbidity and mortality (Wakeman & Langham, 2018). Similarly, a group of professionals responding to the Ebola outbreak began collective predeployment training, which produced collective competence, confidence, and team cohesion but was strengthened throughout their field work, resulting in resilience in their collective response to the multiple stressors encountered (Lamb, 2018). Learning that occurred through IPE became habituated through practice, leading to coordinated action (Gauss & Cook, 2017). Thus, for a team to act as a single unit, it requires a collective mind/distributed cognition (Hollan et al., 2000). When cognition/knowledge is distributed, the expectation is a “system that can dynamically reconfigure itself to bring subsystems into coordination to accomplish various functions” (Hollan et al., 2000, p. 175). A collective knowledge base interplays with both a collective sense of workplace events and interdependency among IP team members to maximize collective team competence.

Collective Sense of Workplace Events

Collective competence grows within the social, cultural, and physical environments, and team effectiveness requires that team members share a collective sense of workplace events to enable the team to be collectively competent in dealing with problems (Boreham, 2004). Key elements for effective teamwork are effective communication strategies and a shared mental model of the overarching team goal (the object of the team’s activity). A shared mental model supports collective sense making of workplace events through situational awareness and group consciousness (Boreham, 2004; CIHC, 2010; IPEC, 2010; Nancarrow et al., 2015; Ulrich & Crider, 2017).

Group Consciousness, Situational Awareness, and Object of Team’s Activity. Collaborative IP practice is most effective when organized around the needs of the population served and where healthcare services are delivered (WHO, 2010). The ED environment is complex and adaptive (Birdsey et al., 2017), with instability in its teams’ membership. A state of group consciousness enables IP team members to know intuitively what others are doing, informed by a shared goal, the object of the team’s activity (Wu et al., 2018). CIHC (2010) identified the overarching goal of collaborative IP practice to be person-centered care and to provide the best care possible. These goals are widely accepted by care providers (e.g., Lingard et al., 2012; Pype et al., 2018). However, due to the complexity associated with providing health care, other system factors introduce contradictions in priorities (Boreham, 2004; Cuvelier & Falzon, 2014; Lingard et al., 2012).

Some sources of contradictions in priorities are from resources allocation and workload, and from within the team itself. The work of others creates uncertainty and dynamicity within the situation while the overall sense making is not sequential (Cuvelier & Falzon, 2014). In an effort to manage workload, a trade off at the individual level occurs between understanding the situation and acting within it. Collectively, in an attempt to preserve team cognition, a collective risk management response occurs whereby the team seeks efficiency over time, with a tacit acceptance of potential errors that are unrelated to the nature of risks to patients (Cuvelier & Falzon, 2014). Inability to manage collective cognition results in failure to cope as a team, expressed as both the inability to act within the situation and lack of trying to understand it (Cuvelier & Falzon, 2014). Furthermore, convergent and divergent patterns of behaviors occurred within teams studied by Lingard et al. (2017), resulting in either shared action, collective paralysis, or production disruption. Thus, an object of a team's activity is required to guide collective team action but should center on realistic contextual priorities, expressed in shared mental models.

Shared mental models informs a shared team purpose, and a shared purpose is linked with positive team and patient experiences (Ciemins et al., 2016). However, differences in mental models exist in practice settings, such as in relation to perceived professional responsibilities within the team (Nakarada-Kordic et al., 2016). IP cultural differences also inform preferred decision-making practices (Agreli et al 2017; Kirschbaum et al., 2018) but preconceptions lead to devaluing the clinical knowledge of others (Fernando et al., 2016). Shared perceptions of organizational events, practices, and procedures define a team's culture (Agreli et al., 2016), elements required for IP situational awareness and group consciousness.

Chang et al. (2017) defined situational awareness as "the ability of the individual to maintain an adequate internal representation of the status of the environment in complex, dynamic circumstances" (p. 529). Situational awareness requires the ability to identify salient information in order to comprehend what is occurring within a situation that enables anticipating how the situation would evolve, its future state (Chang et al., 2017). Shared mental models and situational awareness of what is occurring, depicting who is doing what, are created through sharing of information and expectations, and by spending time together (Arnaud & Mills, 2012; Gundrosen et al, 2016; Page et al., 2016). Facing emergent issues requires trust, also developed over time through repeated intragroup interactions (Arnaud & Mills, 2012). However, Kemper et al. (2016) reported that the existence of a high level of situational awareness was not observed in oral communication, which may be indicative of a well-developed intuitive intrateam awareness of collective activity (Wu et al., 2018).

In relation to situational awareness and patient outcomes, conflicting results were reported. For example, Morgan et al. (2015) found that the relationship between situational awareness reflected in team scores and patient outcomes were not statistically significant. In contrast, Wu et al. (2018) reported that an interplay of team's situational awareness and the nature of the interactions within teams did result in lower mortality rates, and fewer ED visits and hospital admissions. Wu et al. attributed these outcomes to how cognitive and team processes influenced each other over time. However, collective or coordinated activity in the operating room were attributed to improved communication (Wakeman & Langham, 2018), and effective communication is required for collective team competence.

Communication and Collective Sense Making. The IOM/NAM (2001) recommended appropriate information exchange amongst clinicians through active collaboration, communication, cooperation, and coordination of care across patient conditions, services, and settings over time. Evidence exists where improvements in communication improves team function.

The introduction of a tailor-made intervention within an intensive care unit (a CAS) optimized teamwork. The intervention included IP team meetings with shared decision-making, clear communication, goal-oriented actions; and organizing and supporting effective information exchange over time (Van den Bulcke et al., 2016). Using a pre- and postintervention comparison, positive changes were noted on organizational factors and care processes across the IP team as a whole and in the subgroups. The changes extended to (a) clarity of IP team structure during meetings; (b) regular and structured communication about patient care and work situations; (c) time for shared thinking, decision making, and reflection; and (d) systematic reviews of team meetings (Van den Bulcke et al., 2016). Van den Bulcke et al. (2016) concluded that IP meetings improve collaboration, especially when complemented with opportunities for formal and informal communication occurring within a safe atmosphere. Similarly, Obenrader et al. (2019) used a pre- and postquality improvement intervention that involved IPE. Participants perceived improvement in both teamwork and communication.

Hashemian et al.'s (2016) reported that the preferred method of communicating is face-to-face or over the phone, where collaboration is occurring, synchronous, in real time. However, the amount of information exchanged varies between team members. For example, within an ED and in real time, not every team member communicated and the frequency of communications varied over time and by shift worked (Patterson et al., 2013). Patterson et al. (2013) found that concentration of communication occurred between subgroups or cliques of teammates, and attributed a high degree of communication pattern to team members who are powerful, influential, or critical to the flow of information. However, Paquin et al. (2018) asserted that copresence only overcomes some of the communication difficulties encountered within teams.

According to Paquin et al. (2018), within a group of medical doctors from three specialties, copresence did not eliminate miscommunication. These authors posited that close interactions alone may not be sufficient to align priorities because the root cause of medical errors and poor patient outcomes is miscommunication. Furthermore, other modes of communication exist that influence IP team outcomes, such as nonverbal cues and the use of communication aids. For example, Härgestam et al. (2016) studied the role of nonverbal communication by team leaders and reported that (a) where leaders positioned selves in relation to other members, (b) gaze direction, (c) vocal nuances, (d) gestures, and (e) verbal commands influenced team members awareness of each other's roles and tasks, and when each member was to act. Härgestam et al also noted that when the leader used a hesitant voice and ambiguity existed in the nonverbal communication, the team adapted with a change in leadership, demonstrating the strength of nonverbal communication on team behavior. Similarly, clinical pathways are another nonverbal communication strategy, effective in converging team behaviors and improving communication and collaborative problem-solving skills but require a high level of trust between members (de Beijer et al., 2016). Thus, IP team meetings, IPE, verbal communication occurring in real time, and nonverbal communication are factors that influence team function and communication but do not assure that miscommunication leading to medical errors will not occur.

Interdependency

Interdependency is the third normative principle identified by Boreham (2004) required for CTC. Teams are a network of individuals interacting (Shoham et al., 2016). Interdependency between individuals is about creating a "here-and-now" awareness of being dependent upon one another (Boreham, 2004, p. 12). It involves nonhierarchical interactions, empowerment, speaking up within a psychologically safe space, and valuing all contributions equally. It is about reconciling conflict to prevent fragmentation from differing perspective (Boreham, 2004). Interdependency is required for CTC to exist within the ED core team and beyond, to effect an elimination of medical errors.

Functional Relationships and Roles. Positive functional relationships among IP team members are reflected in effective team functioning, defined by a high degree of trust and team psychological safety (de Beijer et al., 2016; Larsen et al., 2017; O'Leary, 2016). Knowing each other through shared work experiences enhances relationships and strengthens trust that enables team members to seek advice and make collective decisions (Karam et al., 2016). When psychological safety existed, participants reported that they experienced trust and mutual respect, freeing them to take emotional risks, such as admitting knowledge deficits (O'Leary, 2016). Conversely, lack of respect was associated with anxiety and poor team functioning (Gordon et al., 2017; Hepp et al., 2015). Similarly, negative relationship experiences were associated with distrust, professionals ignoring their own knowledge and expertise, and not speaking up (Pype et al., 2018). Being able to speak up is influenced by relations and hierarchy within the team, perceived efficacy, sense of safety versus fear of retaliation, time constraints, and IPE (D'Agostino et al., 2017; Nembhart et al., 2015). Speaking up is about being able to raise concerns, agree/disagree, and actively contribute to care planning. However, conflicts result from IP disagreements and interference (Jerng et al., 2017).

Attending IPE conflict resolution training is predictive of increased ability to resolve conflict (Sexton & Orchard, 2016). Amongst a team of anesthetists, the preferred method for conflict resolution was to work together towards finding a solution (Kirschbaum et al., 2018). Power sharing developed with emergent safety climate (O'Leary, 2016) and team cohesion was evident in team members' commitment to realizing team goals (Mathieu et al., 2015; Thompson et al., 2015). Kumar (2009) reported that cohesiveness among team members has a direct impact on pediatric cardiac patient outcomes and system efficiency However, conflict, lack of role clarification, and ineffective leadership pose challenges with IP care coordination (Hepp et al., 2015).

Within IP teams, assumptions related to roles and responsibilities exist which benefit from honest discussions about professional differences. For example, role clarification between general practitioners and ED physicians engaged in collaborative practice increased confidence and improved the referral process (Karam et al., 2016). Role understanding includes knowing tasks that each member of the team routinely perform (Harrod et al., 2016), an awareness of one's contribution to the team, and of the role of others (Ambrose-Miller & Ashcroft, 2016). However, Lingard et al. (2012) asserted that there are no stable professional roles within the workplace but that roles are fluid and subject to context. Job titles and descriptions can be constraints that limit what professionals can and cannot do, and can lead to team failures (Trujillo, 2016). However, when IP team membership expanded, Graber et al. (2017) began with differentiating roles and responsibilities, and recommend this as the first step. Role clarification supports IP team members' understanding of what is expected of them in relation to other team members’ task and responsibilities, and is a key element in collaborative and effective IP teamwork (Boreham, 2004).

Team Membership. Stable team membership is an important element for healthy team processes and effectiveness, including building trust and speaking up (Buljac et al., 2013; Lee et al., 2015; O’Leary, 2016). Teams that consistently work together share experiences and develop routines through repeated collaboration, improving performance and capacity to respond to unexpected situations (Finnesgard et al., 2018). By working together, team members share experiences and develop their collective work history, which translates into open communication, mutual trust, and prevents role conflicts (Pype et al., 2018). When stable teams continued to work together in training situations, improvements in clinical effectiveness and teamwork were noted (Joshi et al., 2018). When team membership was consistent, team cohesion and team performance related positively and reciprocally with each other over time (Mathieu et al., 2015). That is, the team is able to form, develop roles, interact and then disband (Mathieu et al., 2015). However, dynamic teams only demonstrated improvements in teamwork following training but not in clinical effectiveness (Joshi et al., 2018).

In studying team climate, Agreli et al. (2017) set the inclusion criteria for team members with a minimum of six months on the team and, even after six months of being members on a team, communication problems, anxieties about how much personal opinion was valued, and independent decision-making persisted. When team membership changed, a lack of continuity of providers resulted and new information shared was not valued and was not used (Goldszmidt et al., 2014). Within established teams, the addition of new team members was met with resistance and acceptance was not automatic, unconditional or implied (Coyle & Gill, 2017; Thomas & Newman-Toker, 2016). Acceptance is contingent upon demonstrated trustworthiness, valuing learning, and complementing not competing with established ED practices (Coyle & Gill, 2017). Thus, consistent team membership is necessary for developing a collective knowledge base, collective sense of workplace events, and interdependency necessary for an activity system to act.

Summary and Conclusions

A literature review provided the framework to explore the constructs of IP team membership, individual IP collaborative competence, CTC, and medical errors as patient outcomes. The search included CINAHL & MEDLINE Combined Search, CINAHL Plus with Full Text, MEDLINE with Full Text, ProQuest Health & Medical Collection, ProQuest Nursing & Allied Health Source, and PubMed databases. Furthermore, the search extended to ProQuest Dissertations and Theses Global, Google Scholar, and a few government agencies and professional organization. This process yielded over 400 relevant documents. The results were managed with the use of Microsoft Word and a literature map.

The IOM/NAM (2000) reported that the root cause of medical errors extended beyond the individual healthcare provider to systemic latent factors. Subsequently, the WHO (2010) reported that IP collaborative practices were key in effecting positive outcomes within the HCS. Collaborative IP practice involves one or more healthcare provider from different professions to deliver services, embracing an IP team approach. IP teamwork requires a shift in assessing competencies from the individual to the team (Lingard, 2009; 2017).

CCT recognizes both individualistic and collectivistic ways of construing competence and that these are mutually constitutive, both required by a system to perform competently (Boreham, 2004). However, Boreham (2004) focused on the collectivistic ways of construing competence and asserted that effective teams possess a collective sense of workplace events, a collective knowledge base, and interdependency between members. Since collaborative IP practice is collectivistic, this theory is appropriate to provide the lens in assessing competencies of IP teams.

From the literature review, evidence was located indicating continued occurrences of medical errors and outcomes from using IP teams. Reported medical errors were related to diagnostics (e.g., by Ning et al., 2016; Okafer et al., 2016; Solano et al., 2017; Zhang et al., 2017); from errors in treatment (e.g., by Abadi et al, 2017; Boreham, 2000; Linnebur et al., 2018; Murray et al., 2017); and from system errors, including within the ED environments (e.g., by Dolejs et al., 2017; Eriksson et al., 2018; Klasco et al., 2015; Kiymaz & Koc, 2018). Evidence was also located that identified IPE as an effective strategy to strengthen IP collaboration and CTC, leading to increases in individual and team cognition, communication, and collective actions (Behan & Vander Like, 2017; Goolsarran et al., 2018; He & Zheng, 2016; Lochner et al., 2018). However, IPE alone was not sufficient to modify underlying assumptions and produce long-lasting changes in practice (Smith et al., 2015; Ginsburg & Bain, 2017). Furthermore, researchers identified organizational factors that undermined IP collaborative practices, such as power inequities (Amborse-Miller & Ashcroft, 2016) and inconsistent team membership (Ulrich & Crider, 2017). Although many researchers explored IP collaboration, only 11 qualitative studies were located that explored collective competence and incompetence.

For the elements of CTC to exist, time and space are necessary for socially constructed distributed cognition to occur, to learn together, and to habituate activities through repetition, leading to coordination of team actions and efficiency (Boreham, 2004; Denise, n.d.). Thus, one systemic latent factor identified as potentially contributing to medical errors was inconsistent IP team membership (Ulrich & Crider, 2017). Shift schedules introduce instability within the ED core team membership. To contribute to the existing knowledge on how collaborative IP practice can effect positive changes in eliminating medical errors, it was important to explore the relationships between IP TMS, CTC, and medical errors as patient outcomes. To explore these relationships, the selected research design, rationale, the methodology, threats to validity, and ethical considerations used are presented in Chapter 3.

Chapter 3: Research Method

Introduction

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. To fulfill this purpose, a quantitative cross-sectional correlational research design was implemented, using survey and administrative data. A description of this selected research design and the rationale for its appropriateness follows. Further within this chapter, the selected methodology is explained, identifying the target population sampled, sampling procedure implemented, data sources and collection instruments, and the data analysis plan. In addition, a discussion of threats to validity and ethical considerations ensue.

Research Design and Rationale

The selected research design to study the relationship between differences in IP team membership due to shift work schedules, CTC, and medical errors as patient outcomes within EDs was nonexperimental, quantitative, cross-sectional, and correlational. These were the variables of interest. However, from the literature review, researchers identified individual competence (e.g., McEwen, et al., 2018) and patient characteristics (e.g., Flaatten et al., 2017; Okafer et al., 2016) as variables that also influenced medical errors, as covariates or by exerting moderating and mediating effects. Thus, I added individual collaborative IP competence as a second IV. The potential confounding effects of patient volumes and levels of acuity were controlled statistically. An explanation of these variables within this study follows.

Variables

The variables of interest consisted of IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes. The IP TMS was the primary IV of interest.

Administrative data in the form of deidentified worked schedules from participating EDs were the source for identifying IP core team members and to calculate TMS.

Finnesgard et al. (2018) posited that increased frequency of working together increased team member familiarity. Thus, the frequency of shifts that the members of IP core teams in the ED worked together during the 3 months preceding the measurement of the other variables (i.e., the dates when sampling/data collection occurred) defined IP TMS. By adding the number of shifts that IP core team members worked together prior to sampling, temporal order of IP TMS as preceding the measurement of the other variables was established. This priori reason was used to define unidirectional influence between the predictor variables and medical errors as the outcome. Temporal order enables making inferences as to the possible influence that the IVs have on the DVs (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005).

Based on CCT, both individual and collective competence are required to effect positive patient outcomes (Boreham, 2004). Formal and informal education as well as professional experience are key factors that define individual IP competence (CIHC, 2010). The source of data for formal education, participation in IPE, and professional experience as a measure of individual collaborative IP competence was self-reported information captured on a survey (see Appendix B). Worked experience was calculated from deidentified worked schedules that captured the frequency that each IP core team member worked during the 3 months preceding data collection.

Individual collaborative IP competence was considered a moderating factor on the relationship between TMS and medical errors. Moderating factors can interact with the IV (i.e., IP TMS) to effect changes in all of the values of the DVs, which were the patient outcomes as medical errors (see Warner, 2013). That is, the strength of the relationship between TMS and medical errors would have increased with higher levels of individual collaborative IP competence if a moderating effect existed (IPEC, 2016; WHO, 2010). In contrast, CTC was considered a mediating factor, whereby CTC was expected to be a DV of TMS but also exert its own and combined/additive influence on medical errors, the ultimate DV, by interacting with other variables (see Warner, 2013).

According to Boreham (2000, 2004), direct interactions among team members is required for CTC to develop. Hence, stable team membership was expected to provide the opportunity for CTC to develop. However, CTC was expected to have only a partial mediating effect on TMS and individual collaborative IP competence because not all ED interventions require a team approach. For example, ED practitioners worked independently to fast-track patients who presented with low acuity medical problems (WTRTF, 2017). The level of CTC was determined from responses to the CTCQ as a component of survey data.

Other moderating factors had the potential to generate plausible alternate hypotheses and, to strengthen the correlational research design, their influence was measured and controlled for statistically (see Campbell & Stanley, 1963; Warner, 2013). These included patient characteristics related to volume (demand for services) and the levels of acuity of their presenting complaints (see Källberg, et al., 2017; Kiymaz & Koç, 2018; Weigl et al., 2016). Statistical operations controlled the effects of these covariates on the DV (see Frankfort-Nachmias & Nachmias, 2008; Harring, 2012), the medical errors in EDs.

Medical errors within EDs were the DV. Medical errors of interest were as follows:

- delays in time to triage (from time of registration to triage), defined using the CAEP indicator (Bullard et al., 2017)

- delays in time to be seen by physician/alternate prescriber (time to physician/alternate initial assessment), defined using CAEP indicators (Affleck et al., 2013)
- delays in time in obtaining essential diagnostics (based on time of first diagnostic imaging test performed or first laboratory result)
- LOS in the ED, defined using CAEP indicators
- delays in time to admission to an inpatient bed, defined using CAEP indicators
- number of patients who LWBS by a physician/alternate prescriber within 4-hour intervals

Although patient levels of acuity (as captured by the CTAS assigned to each patient) and volumes were not considered medical errors, these metrics were also obtained and analyzed as potential confounding variables.

The frequency of medical errors within the sampling time interval were quantified using administrative data from EDIS. Medical errors were considered the outcome of the influence of IP TMS, individual collaborative IP competence, and CTC. However, covariates and intervening or mediating variables were expected to influence the relationship between these IVs and DV (see Creswell, 2014; Harring, 2012).

Correlational Research Design

The selected research design was nonexperimental, quantitative, cross-sectional, and correlational. Nonexperimental designs are appropriate for exploring relationships amongst variables at a specific point in time, when the IV is not manipulated but requires a well-articulated research problem and a theoretical framework to act as its blueprint (Grant & Osanloo, 2014). Although the IV (i.e., IP TMS within ED core teams) can be manipulated and practitioners can opt to pick up unfilled/vacant shifts, maximizing core TMS captured in IP shift schedules would require multidisciplinary cooperation and coordination of schedulers, all with pre-prescribed scheduling parameters defined through collective agreements (e.g., Manitoba Nurses Union, 2017). To effect a change in current scheduling practices, evidence was required. Although causation cannot be established using a correlational design, this method enabled me to study the co-relationships between IP TMS, competences, and medical errors/patient outcomes (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005).

Strengthening the correlational research design occurred by statistically controlling for covariance, moderating, and mediating effects from other factors (see Campbell & Stanley, 1963; Warner, 2013) as identified within the literature associated with medical errors. Data sources included deidentified worked shift schedules, a survey with self-reported elements for individual collaborative IP competence (e.g., formal education and informal education, work experience, and participation in IPE), the CTCQ, and administrative data from EDIS. Although causation cannot be determined using correlational analyses, this analytical approach quantified the strengths of the relationships amongst all identified variables (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005). Rudestam and Newton (2015) claimed that “statistical methods are appropriate for looking at relationships and patterns and expressing these patterns in numbers” (p. 30). The cross-sectional approach was appropriate for collecting a large amount of data at a single-points in time (see Creswell, 2014; Leedy & Ormrod, 2005).

Rationale

Due to ethical constraints, the study of social situations and factors (e.g., access to ED services) are frequently not amenable to classical research designs (Campbell & Stanley, 1963; Frankfort-Nachmias & Nachmias, 2008). Thus, a nonexperimental, quantitative, cross-sectional, correlational design enabled me to study the identified variables within the natural environments of EDs, providing a cost-effective means of reaching many potential participants within predefined spaces and times (see Creswell, 2014). Furthermore, this design minimized constraints due to limited resources (e.g., personal financial costs, participating organizational resources, and participants' time). Addressing a gap in knowledge located through the literature review contributes to the discipline. That is, it furthered the understanding of the relationship between IP team membership defined by shift work schedules, work experience, and CTC with medical errors as patient outcomes captured in delays to care. A description of the methodology I used to study these variables follows.

Methodology

The elements of methodology to be considered in quantitative research include target populations, sampling, data collection strategies and instrumentation, a data analysis plan, threats to validity, and ethical considerations (Walden University, 2021). A description of these elements ensues.

Population

The sampled population for the pilot and main study differed. Thus, each population is described separately

Pilot Study

A pilot study occurred prior to the conduction of the main study. Because no instrumentation was identified in the literature review to measure CTC, a questionnaire was developed. Similar to Lee et al. (2015), a deductive approach to scale development based on a theory was used. The scale items were based on the CCT defining factors for the three normative principles. Indicators were generated from these descriptors, which were then translated into CTCQ scale items (see Appendix C). The purpose of the pilot study was to serve as the first step to establish the reliability and validity of this CTCQ used in the main study. The target population of interest was Walden University participation pool of healthcare professional students and faculty who worked in IP teams.

Main Study

To determine if a relationship existed between differences in IP team membership due to shift work schedules, individual collaborative IP competencies, CTC, and medical errors, the population of interest was IP core teams working within EDs. Recruitment strategies for IP core team members to participate in this study extended to 15 EDs, equipped with the electronic health record EDIS, and located within the province of MB, Canada. The IP core teams in the EDs were the unit of measure for analyzing the relationship between the variables of interest. However, a pilot study preceded this main study.

Sampling and Sampling Procedures

Different sampling and sampling procedures were used for the pilot and main study. Thus, each is described separately.

Pilot Study

For the pilot study, a convenience sampling procedure was used to access participants from multiple professions (e.g., nurses, medical doctors, occupational therapists, public health practitioners) engaged in healthcare practices. To achieve this, the target population sampled was from Walden University College of Health Sciences. Following Walden’s Institutional Review Board (IRB) approval, an invitation to participate was posted on Walden University’s participant pool site for 3 months. The participant inclusion criteria extended to all Walden University’s faculty and students who worked as either employees or were self-employed. Thus, all faculty members were eligible to participate, but some students were excluded based on their employment status (e.g., if they were only engaged in their studies and were not working at that time). An adequate sample size was required to enable inferential statistical analyses to validate the CTCQ scales.

A lack of consensus exists in relation to what an optimal sample size is to validate scales (Boateng et al., 2018; Williams et al., 2010). One recommendation to validate scales within instruments measuring intangible and complex phenomena in health, social, and behavioral health is “10 respondents per survey item and/or 200-300 observations” (Boateng et al., 2018, p. 3). The CTCQ contains 49 items. However, attaining statistical significance is influenced by the size of the sample (Hinkin et al., 1997). That is, it is easier to attain significance as the number of participants increased. Thus, for the pilot study, the target number of responders was set at 300 participants.

Main Study

For the main study, I implemented a multi-staged convenience sampling strategy. An application to access EDIS data was initially sent to the Health Information Privacy Committee for Manitoba Health, Seniors and Active Living (HIPC), a provincial overseer of health information. However, since EDIS data was site specific, approval to access this data from HIPC was not required.

Fifteen EDs and urgent care centres (referred collectively as EDs) met this study’s inclusion criteria. To be eligible, the ED was located in the province of MB, Canada and used the EDIS as their electronic patient record. Since data from EDIS reports were required, any hospital with an ED but without EDIS in place was excluded. Requests to conduct research at EDIS sites required organization-specific applications, some defined by regional service delivery organizations and others by specific hospitals. To protect organizational identities, no further details are provided.

A letter of introduction and completed organization-specific applications were submitted during the months of June, July, and August 2020. After sending the initial requests to participate, reminders were limited to two follow-ups. Data collection occurred during 72-hour periods concurrently at all sites. Receipt of permission to participate from sites determined the data collection dates.

The final sampling stage involved recruitment of participants at each consenting ED site. Professional groups whose shift schedules were generated and housed within the participating ED were included as members of the IP core teams (e.g., nursing or physician groups with ED schedules). However, professional providers working to fulfill ED schedules during the sampling period from the permanent ED team or from a staffing relief pool were also eligible to participate. That is, all ED providers who were members of professional groups routinely scheduled to work in the ED, and who were scheduled and working on the selected data collection dates were eligible to participate. All students and employees not involved in direct patient care were excluded from participating (e.g., the facility manager was excluded but the ED nurse-in-charge was included). An adequate sample size was required to enable inferential statistical analyses to evaluate the relationship between the IVs and DVs.

Predetermined statistical power, alpha levels, and an effect size determine sample size (Burkholder, 2012; Creswell, 2014; Faul et al., 2009). The statistical power selected for this study was .80, whereby the sample size would be adequate to reasonably detect that a relationship truly existed within the population sampled, thus decreasing the probability that the findings were due only to chance (see Burkholder, 2012; Creswell, 2014). That is, within social science research, it is acceptable to set the statistical power at .80, enabling the null hypothesis to be correctly rejected 80% of the time, and a 20% chance that a false one is accepted (Burkholder, 2012). Similarly, an acceptable alpha value within social science research is .05, signifying that a wrong conclusion could occur 5% of the time and a right conclusion 95% (Burkholder, 2012). For this study, the unit of analysis was the ED core team and the null hypothesis posited was that there was no statistically significant relationship between differences in IP team membership due to shift work schedules (i.e., TMS), individual collaborative IP competence, CTC, and medical errors as patient outcomes within EDs. Thus, if the sample size was appropriate and using these parameters, inferences that a relationship did not exist amongst these variables (the null hypothesis) could be correctly rejected with a 95% confidence 80% of the time. However, the effect size is required to inform how strong the relationships is between variables of interest. To identify the appropriate sample size requires finding the effect size, one of the correlation coefficients (r^2, R^2, or ω^2) from the literature review (Burkholder, 2012)

Since the aim of this study was to explore the relationship between TMS and medical errors, a correlation between these two variables was sought in the literature but none located. However, Buljac et al. (2013) reported a correlation between team stability and team effectiveness as $r = .46$. Buljac et al. defined team effectiveness as “the absolute level of attainment of goals and expectations that depends on the degree to which work processes are free of errors” (p. 95). This definition of team effectiveness was reflective of the purpose of this study. Thus, this effect size of $r = .46$ between team stability and team effectiveness was used to calculate the sample size needed.

The first method involved accessing a table for computing sample size, accessed from http://fsweb.berry.edu/academic/education/vbissonnette/tables/tables.html. From this table and using a power of .80, alpha of .50, and the *r* value of .45, the appropriate sample size was a minimum of 35 participants. This result was confirmed using G*Power 3.1. Similarly, for correlation and regression for two-tailed, power of .80, alpha of .50, and an effect size of .46, the calculated minimum sample size was 32 (see Faul et al., 2009). Thus, the minimum number of participants required for this study was set at 35 participants in the sampled populations.

Procedures for Recruitment, Participation, and Data Collection

Procedures for the recruitment of participants for the pilot and main study addressed ethical considerations but entailed different approaches. Similarly, data collection processes were unique to each component of this study.

Recruitment of Participants

Ethical considerations for the recruitment of participants adhered to the principles of respect for human dignity, concern for welfare, and justice as defined by the Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada (TCPS; 2014) and Walden University (n.d.). Throughout all phases of this study, respect for human dignity included respect for each organization and individual participant's autonomy, to choose freely to participate or decline without coercion, and being transparent and accountable. This was achieved through information dissemination about the purpose, methodology and data usage, and obtaining an informed consent. Concern for welfare was demonstrated through respecting privacy and ensuring that the benefits from this study outweighed potential harm from participating. Confidentiality and anonymity of all information was maintained, potential risks shared, and the process selected to generate valid data was the least intrusive. The inclusion and exclusion criteria were also be made explicit.

Pilot Study. A convenience sampling procedure was used to access participants from multiple healthcare professions either employed by or students at Walden University. To achieve this, the target population sampled was from Walden University College of Health Science, including all faculty and students. The only other inclusion criterion was that participants were actively engaged in the work force, as either employees or self-employed. Thus, all faculty members were eligible to participate but excluded students who were not employed.

Recruitment procedures began by seeking Walden University IRB approval. Following IRB approval, an invitation to participate was posted on Walden University's participant pool site. This site was accessible via a virtual platform, asynchronously linking researchers to interested participants. The posting included an explanation of the purpose of the pilot study and how the data was to be used, informed consent section, a request for participants' demographics data, and the questionnaire to be validated (see Appendix D). Informed consent was implied by participants completing the survey. Responses received through the participant pool site ensured participants' anonymity. Within the Pilot Study Participant Survey, a statement thanking the participant was also included and the participant was invited to contact me via the email address provided if they chose to receive the study's results.

Main Study. Recruitment procedures for this study began by seeking approval to access EDIS data from HIPC, followed by organization-specific applications, some defined by regional service delivery organizations and others by specific hospitals. To protect organizational identities, no further details are provided.

A letter of introduction and completed organization-specific applications were submitted during the months of June, July, and August 2020. These applications requested access to 15 eligible EDs in MB, Canada. Upon request from one ED, a virtual presentation occurred with senior organizational representative. A power-point presentation was shared in advance and information submitted was elaborated on, clarifying the type of data requested, and the expected role of managers. Based on confirmation received from organizations by September 2020, data collection was set to occur over a 72-hour period of time, starting at 0800 hour on October 15 to 0800 hour on October 18, 2020.

To respect potential participant time and organizational responses to the COVID-19 pandemic, no in-person or virtual presentations were delivered as initially planned for recruitment. However, an "Invitation to Participate" poster and copies of the consent and questionnaire (the survey) were made available at each participating ED during the two weeks preceding data collection dates. Within these documents, the purpose of the study and information enabling an informed consent to participate was provided. Walden IRB and researcher (my) contact information were provided as the means to address any questions from potential participants. No inquiries were received. The survey included demographic information, information to inform individual collaborative IP competence, and the CTCQ (see Appendix B).

Data Collection

Data required to enable answering the research question included information to determine IP TMS, individual collaborative IP competence, CTC, and medical errors. Data source to determine IP TMS were deidentified worked schedules that covered the 3 months preceding the sampling dates, capturing the frequency of shifts that members of the IP core teams worked together during this period of time. The frequency of shifts that participants previously worked together with the other IP core team members were entered on an excel worksheet (see Appendix E for an example). The use of a professional designation and a numerical digit deidentified these participants, maintaining their anonymity. The source of data for the ultimate DV (i.e., medical errors) were administrative data through EDIS reports. In contrast, data related to individual and collective competence were collected using a survey questionnaire, directly completed by eligible ED core team members, the participants (see Appendix B).

The survey questionnaire captured participants’ demographic information as well as data on covariates and CTC. Demographic information collected from participants included professional designation, employment status, formal and informal educational background (including IPE history), and practice experience. To capture the activity during the sampled worked shift, participants were asked to identify by professional designation team members with whom they interacted with, as well as the number of patients whose care delivery they actively participated in and their CTAS levels. This information was required to control for effects from covariates. The survey questionnaire was also be the source for data to quantify the DV of CTC. Using a Likert scale, this component asked the participants of the pilot study to rate their agreement with each item. In contrast, within the main study, the participants were asked to rate their perception of the percentage of time that, individually or as a team, they engaged in the identified behaviors.

The surveys for the main study were in the printed format. To ensure confidentiality and anonymity, a secure box was provided at each participating location. Upon request, an opportunity to discuss the results with each participating organization and participant will be provided.

Operationalization of Variables

The variables of interest consist of IP TMS, individual collaborative IP competence, CTC and medical errors. The IP TMS was the IV of interest. IP TMS "depends on the amount of turnover in a team" (Buljac et al., 2013, p. 93) and, within this study, TMS was based on the frequency of shifts that the members of IP core teams in an ED worked together during the 3 months preceding the measurement of the other variables, the dates when sampling/data collection occurred. A ratio level of measurement was attained, such as three members of the IP core team who were scheduled to work on the date that sampling occurred worked together 20 shifts during the preceding 3 months. Members of the IP core team were those professionals within provider groups routinely scheduled to work in the participating ED. The data source was 3 months of organizational deidentified worked shift schedules for all professions comprising the ED core team. Temporal order of IP TMS and its relationship with CTC and medical errors was established.

Individual collaborative IP competence was considered a second IV in relation to medical errors. Individual collaborative IP competence was to be defined based on formal and informal education and worked experience. Formal educational background was collected at a categorical level (e.g., degree from a university, diploma, and/or certificates). Informal education involved participation in IPE. Examples of IPE included formal sessions provided by educational institutions, professional development activities delivered external to the organization, and professional development activities delivered internally by the employer. Measurement of IPE were self-reported number of sessions attended within the previous 2 years, and the number of these sessions attended within 12, 6, and 3 months prior to the date that sampling occurred. IPE was measured at the ratio level. Past experience was measured in months (a ratio level of measurement) for the time since licensure, working within an ED environment, and the length of time working within the ED sampled. However, because the sampling threshold of survey data was not met, work experience based on the number of shifts that each member of the ED core team worked within the 3 months preceding data collection was used as an indicator of individual collaborative IP competence. Thus, a ratio level of measurement was attained for individual collaborative IP competence as well.

CTC was considered a DV of IP TMS and of IPE but also as an IV to medical errors. CTC was quantified using a Likert scale (this measuring instrument is described below). The ultimate DV of interest studied were medical errors in EDs, as an outcome of IP TMS, individual collaborative IP competence, and CTC, as well as the combined effects of IP TMS and CTC. The indicators selected to measure medical errors within EDs during the selected shifts of interest were as follows:

- delays in time to triage (from time of registration to triage), defined using the CAEP indicator (Bullard et al., 2017)
- delays in time to be seen by physician/alternate prescriber (time to physician/alternate initial assessment), defined using CAEP indicators (Affleck et al., 2013)
- delays in time in obtaining essential diagnostics (based on time of first diagnostic imaging test performed or first laboratory result)
- LOS in the ED, defined using CAEP indicators
- delays in time to admission to an inpatient bed, defined using CAEP indicators
- number of patients who LWBS by a physician/alternate prescriber within 4-hour intervals

Although patient levels of acuity (as captured by the CTAS assigned to each patient) and volumes were not considered medical errors, these metrics were also obtained and analyzed as potential confounding variables. Administrative data/reports from EDIS were used to quantify these selected indicators of medical errors within the specific time periods, the sampled worked shifts. These data were at the ratio level of measurement.

Instrumentation for Collective Team Competence

Measuring instruments are arbitrary scales that indirectly measure intangible and complex phenomena (Boateng et al., 2018; Frankfort-Nachmias & Nachmias, 2008; Leedy & Ormrod, 2005), such as CTC, IP collaboration, and teamwork. The selected measuring procedure and scale should capture the variables of interest as expressed within the real world (Frankfort-Nachmias & Nachmias, 2008). One variable of interest for this study was CTC and no measuring instrument was located within the literature that specifically measured this construct. Thus, a CTCQ was developed and was for it to be validated using data from the pilot study. The process for scale construction began with defining the domain of interest (see Boateng et al., 2018).

The domain of interest was CTC and the scales for CTCQ were identified based on CCT's three normative principles. The scale items for the CTCQ were informed by the definitions articulated by CCT and items found within published validated scales that measure different aspects of IP collaboration and teamwork. CTCQ asks participants to rate their perception of the frequency that each scale item (indicator of CTC) was experienced during a specific time frame which, for this study, was a worked ED shift. Since strong correlations linked perceptions of patient safety culture with patient outcomes (Mardon et al., 2010; Smith et al., 2017), surveying self-perceptions was considered appropriate. A pilot study was conducted to establish CTCQ's validity and reliability.

Item Scaling

Within this study, CTC referred to the integration of collective knowledge, skills, abilities, and judgment by a group of professionals working within an IP teamwork environment to realize shared desired outcomes (e.g., patient goals; sustainable HCS), evidenced in error-free processes. For a team to be competent, Boreham (2004) stated that three normative principles must be present in the workplace. The three normative principles are (a) collective sense of workplace events, (b) collective knowledge base, and (c) interdependency. These three principles became the factors or scales within the CTCQ. A deductive method for item generation was used (see Boateng et al., 2018; Hysong et al., 20159This was an iterative process, informed by a literature review related to effective team work as a means to eradicate medical errors; identifying and reviewing other existing scales; and drilling down within the descriptions of the three normative principles of collective competence espoused by Boreham (2004). From this process, indicators were defined and scale items generated (see Appendix C). Furthermore, the constructs and items within six validated instruments related to teamwork were compared with each other and to the key elements defined by the three normative principles of CCT.

Preliminary convergent validity for the CTCQ was established through a comparison of scale items from existing validated instruments. The instruments selected for comparison were (a) Teamwork Perceptions Questionnaire (T-TPQ; Agency for Healthcare Research and Quality, 2014); (b) Assessment of Interprofessional Team Collaboration Scale (AITCS-II; Orchard et al., 2018); (c) Team Emergency Assessment (TEAM; Cooper et al., 2016); (d) Reciprocal Learning (Leykum et al., 2011); (e) Interprofessional Socialization and Valuing Scale (ISVS; King et al., 2010); and (f) the Interprofessional Collaborative Competency Attainment Survey (ICCAS; Schmitz et al., 2017). None of these existing instruments contained items to effectively measure

CTC. However, the items and scales from these six instruments collectively supported the generated CTCQ items (see Appendix F).

The principles for the writing of these scale items included (a) addressing only a single issue within each item; (b) consistency in terms of perspective, thus written from the perspective of individual team member experience; (c) simple and as short as possible; (d) reverse-scored items limited to two out of 49; (e) language used understandable to participants who were professionals within their field; (f) redundancy included as a means of establishing internal consistency reliability; and (g) a minimum number of items to adequately assess CTC achieved after factor analysis of responses (see Hinkin et al., 1977). To ensure that variance was created to examine the relationship amongst items and scales, a five-point Likert scale was used for item scaling (see Hinkin et al., 1977).

Construct Validation

Preliminary validity and reliability of CTCQ was to be established by assessing content adequacy, factor loading/extraction, and the degree of variances explained by each item (see Hinkin et al., 1977; Williams et al., 2010). This was to be achieved using data from the pilot study where the participants were asked to rate the extent to which each item corresponded to the definitions of factors (i.e., scales) that were identified by Boreham (2004) as the three normative principles of collective competence (see Appendix C). Exploratory factor analysis (EFA) was to be used to decrease the number of items, resulting in a leaner set (see Hinkin et al., 1977). Prior to these analyses, the suitability of the responses for factor analysis was to be established using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, ranging from 0 to 1 and accepting a 0.50 value or greater as demonstrating suitability (see Williams et al., 2010). Retention of factors/items were to be based on Kaiser's criteria, accepting an eigen value of greater than 1, as well as a scree-test for a cumulative percentage of variance greater than 50 to 60% (see Hinkin et al., 1977; Williams et al., 2010). Since the factors were assumed to be correlated, an orthogal analysis with an oblique rotation was to be considered, with the plan to retain items with a loading of greater than 0.40 on a single factor (Hinkin et al., 1977). A confirmatory factor analysis (CFA) was to be used to assess goodness of fit of the retained items for each factor. CFA was to be based on the use of chi-square analysis, where the fit was best if the chi-square value approximated the degrees of freedom but was to be acceptable up to two to three times that value (see Hinkin et al., 1977). However, since chi-square is sensitive to sample size and to control for the effects of sample size, a comparative fit index was to be considered as well. The values of this index range from 0 to 1, and a value of greater than 0.90 is indicative of a good fit (Hinkin et al., 1977). However, construct validation did not occur due to insufficient number of participant responses.

Sufficiency of Instrument to Measure Collective Team Competence

The items selected to measure CTC were based on identified indicators for each of the three normative principles, which are the factors/scales. The items were reflective of existing ones within other validated scales, measuring similar constructs related to effective teamwork. Once the items were statistically assessed for their correlation with each other, their discriminating ability between the three factors, and collectively able to account for 50% to 60% or more of cumulative variance, the expectation was that the CTCQ would generate valid responses for an analysis of whether a relationship existed between TMS, CTC, and patient outcomes (the medical errors).

Data Analysis Plan

IBM SPSS Statistics software was used to analyze the data collected during the main study, and was to be used for the results from the pilot study. IBM SPSS Statistics is a statistical software program that requires only inputting of raw data, eliminating the need for coding (Green & Salkind, 2014). Once the data is entered, it becomes the platform for aggregating and transforming variables for statistical analyses (Green & Salkind, 2014), which began with data cleaning and screening.

Pilot Study

Cross sectional data over a 3-month period of time from participants in the pilot study was considered appropriate to assess the internal consistency of CTCQ subscale items in measuring the same characteristic (see Boateng et al., 2018; Hellman et al., 2016). Through EFA a Cronbach α between 0.70 and 0.90 is considered as demonstrating adequate internal consistency whereby the items adequately measure the construct of interest without redundancy (Hellman et al., 2016).

Tilden et al. (2016) explained that “convergent validity refers to evidence of validity that results from a comparison of scores with another instrument assessing the same or similar content” (p. 291). Although preliminary convergent validity was assessed through a comparison of scale items, to further strengthen convergent validity, a repeat study was considered that would provide participants the option of completing the AITCS II and/or TeamSTEPPS T-TPQ as well as the CTCQ. Request to use the AITCS II was received from Carole Orchard (the developer). Permission to use T-TPQ was provided within the manual. Both the AITCS II and T-TPQ were validated scales (see below) that measured different aspects of teamwork. Participant responses across these three questionnaires were to be compared and analyzed for their similarity in measuring constructs related to effective team work. However, this repeat study was deferred but, because during the development of CTCQ scale items these were compared to those of AITCS and TeamSTEPPS, the reliability of these two instruments is presented.

Assessment of Interprofessional Team Collaboration Scale II Reliability. The AITCS was developed in 2012 to measure team-based practice as evidenced in collaboration, later updated to AITCS II (Orchard et al., 2018). It includes three subscales of partnership, cooperation and coordination that together define collaborative practice. The initial internal consistency for these subscales ranged from 0.8 to 0.97 (Hellman et al., 2016). The original AITCS instrument was used extensively across practice settings and globally, translated into multiple languages (Orchard et al., 2018). For example, a Swedish version now exists (Hellman et al., 2016). Using CFA, AITCS II instrument was re-validated using the original AITCS scales and items, resulting in the elimination of 14 items. IP team membership in the participant pool consisted of 23 professions. However, participants had worked together on an average of 8.95 years (Orchard et al., 2018), denoting TMS. Internal consistency for the 23-item AITCS II was reported using Cronbach α coefficient, consisting of 0.90 for partnership, 0.92 for cooperation, and 0.90 for coordination. These results were interpreted as the AITCS II retaining the reliability of AITCS internal consistency (Orchard et al., 2018).

TeamSTEPPS Teamwork Perception Questionnaire Reliability. The TeamSTEPPS program was based on extensive research findings related to team performance and released for use in 2006 (American Institute for Research [AIR], 2010). T-TPQ is a self-reported measure of teamwork, consisting of 35 items within five subscales (team structure, leadership, communication, mutual support, and situation monitoring), that “measures individuals’ perceptions of group-level team skills and behavior” (AIR, 2010, p. 2). T-TPQ items were linked to specific TeamSTEPPS training curriculum components, initially tested and refined through cognitive interviews, small group trial, and field tested with hospital personnel (AIR, 2010). Cronbach α reliability coefficients for the five constructs were team structure α = 0.89, leadership α = 0.95, communication α = 0.88, mutual support α = 0.90, and situation monitoring α = 0.91 (AIR, 2010).

Keebler et al. (2014) re-examined T-TPQ construct reliability and validity by analyzing responses from 1700 participants. An overall T-TPQ reliability Cronbach α of 0.978 was obtained, with each sub-scale exceeding 0.9 level. This high internal consistency demonstrated that the items were related to the construct that they were to be measuring, presenting a "reliable measure of individual perceptions of teamwork" (Keebler et al., 2014, p. 723). The subscales within T-TPQ can be administered separately and maintain the integrity of what the subscale should be measuring (AIR, 2010).

Main Study

The analysis of data from the main study began with data cleaning and screening, followed by regression analyses.

Data Cleaning and Screening. Preliminary data screening preceded all processes involving data analysis, enabling the identification of potential problems and taking steps to maximize data integrity. Some of the potential problems that could impact data analysis were (a) errors in data entry, (b) inconsistent responses, (c) missing values, (d) outliers, (e) non-normal distribution, (f) inadequate within-group sample size, and (g) nonlinear relationship between variables (see Warner, 2013, p. 125). The steps taken to clean and screen the data collected were as follows:

- Addressing potential errors introduced during the data collection phase of the study included screening the self-reported data for social desirability bias, misinterpretation of questions, deliberate falsification of responses, missing responses; and identifying measurement errors (such as when counting the number of shifts that participants worked together preceding the sampling date). The values from calculations were compared with original data multiple times.
- Frequency distribution tables were used to identify outliers or unreasonable scores (see Warner, 2013), such as time to diagnostics was greater than the patient's LOS.
- To minimize errors in data analysis and interpretation, data points should demonstrate independence and be normally distributed within the sampled population (Warner, 2013). Thus, graphic methods consisting of a scatter plots and histograms were used to visually assess data points distribution shape, outliers (disproportionate influential scores), and for ceiling and floor effects.
- For multiple regression and multivariate analyses, a linear relationship is required between the IVs and DVs (Warner, 2013). Because the analysis involved multiple predictors and outcome variables, graphic methods were used to visually inspect the data for linearity/curvilinearity in the distribution of scores on individual variables as well as between pairs and subsets. This approach enabled the identification of outliers (see Warner, 2013).
- Since prediction errors occur when variances in the DV values are greater for some values of the IV, heterogeneity of variance was assessed. That is, without homoscedasticity of variance, the DV would change as the IV changes but the

variance in the DV would also increase and would create errors in the interpretation of the data (Warner, 2013).

Research Questions. The RQ, the *H*0, and the *H*A that were explored were as follows:

RQ: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors?

*H*0: There is no statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors.

*H*A: There is a statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors.

However, to explore the multiple possible relationships amongst these variables, the RQ and hypotheses were subdivided, resulting in the following:

RQ_{1a}: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS) and medical errors?

$H0_{1a}$: There is no statistically significant relationship between the frequency of providers working together due to shiftwork schedules (IP TMS) and medical errors.

HA_{1a}: There is a statistically significant relationship between frequency of providers working together due to shiftwork schedules (IP TMS) and medical errors.

RQ_{1b}: What is the relationship between individual collaborative IP competence and medical errors?

$H0_{1b}$: There is no statistically significant relationship between individual collaborative IP competence and medical errors.

HA_{1b}: There is a statistically significant relationship between individual collaborative IP competence and medical errors.

RQ_{1c}: What is the relationship between CTC and medical errors?

$H0_{1c}$: There is no statistically significant relationship between CTC and medical errors.

HA_{1c}: There is a statistically significant relationship between CTC and medical errors.

RQ_{1d}: What is the relationship between TMS, individual collaborative IP competence, and medical errors?

$H0_{1d}$: There is no statistically significant relationship TMS, individual collaborative IP competence, and medical errors.

HA_{1d}: There is a statistically significant relationship between TMS, individual collaborative IP competence, and medical errors.

RQ_{1e}: When controlling for CTAS and patient volumes, what is the relationship between TMS and medical errors?

$H0_{1e}$: When controlling for CTAS and patient volumes, there is no statistically significant relationship between TMS and medical errors.

HA_{1e}: When controlling for CTAS and patient volumes, there is a statistically significant relationship between TMS and medical errors.

RQ_{1f}: When controlling for CTAS and patient volumes, what is the relationship between individual collaborative IP competence and medical errors?

$H0_{1f}$: When controlling for CTAS and patient volumes, there is no statistically significant relationship between individual collaborative IP competence and medical errors.

HA_{1f}: When controlling for CTAS and patient volumes, there is a statistically significant relationship between individual collaborative IP competence and medical errors.

RQ_{1g}: When controlling for team size, what is the relationship between TMS and medical errors?

$H0_7$: When controlling for team size, there is no statistically significant relationship between TMS and medical errors.

HA_{1g}: When controlling for team size, there is a statistically significant relationship between TMS and medical errors.

Data Analysis Processes. Data analyses processes selected to inform inferences from the sampled to the general population of ED IP practitioners were (a) bivariate regression, (b) multiple regression, and (c) ANOVA. The predictive strength between IVs with the DVs was assessed using regression analysis. Furthermore, a general linear model (GLM) generated the predictive strength of each IV on the DV when controlling for the influence of the other IVs (see Warner, 2013). Additionally, regression statistical analysis provided the statistical means to control for moderation and mediation effects of other variables on the DV, which in this study were medical errors.

Moderation effects are noted when an interaction exists between two or more IVs on the DV where the value of the DV from the first IV differs based on the value of a second or more IVs (Warner, 2013). Thus, if an interaction existed between TMS and the other IVs, changes in medical errors were considered to be related to the combined effects of two or more of these variables. In contrast, a mediation effect from one or more IVs on the relationship between an initial IV and the DV would be observed only if the second or more IVs (the intermediaries) were present as a consequence of the initial IV, and then become related to the DV (Warner, 2013). That is, the relationship between the initial IV (i.e., TMS) and the DV (i.e., medical errors) would not exist unless the second (or more) IV was present within population of interest. For example, the influence of CTC on medical errors may not be present unless individual collaborative IP competence and/or TMS were included in the analysis. Other possible covariates identified from the literature review included patient characteristics, such as patient volume and level of acuity. Data related to these factors was collected and their potential effects on the relationship between the IVs and medical errors were statistically controlled.

Interpretation of Results. An acceptable *p* or *α* for statistical testing of the null hypotheses within social science research was .05, providing the opportunity to correctly reject the *H*0 within a larger rejection zone, signifying that a wrong conclusion could occur 5% of the time and a right conclusion 95% (Burkholder, 2012). However, *p* values depend on sample size (Allen, 2017; Hochster, 2008). For example, when the sample size is over 50 participants per cell, small effect sizes may reach the level of statistical significance (Hochster, 2008) and testing for heterogeneity of variance would be more reliable if the α level is set at .01 (Warner, 2013). However, effect sizes (the *r*, R^2, and Adjusted R^2) do not depend on sample size (Allen, 2017). Thus, means, sample sizes, effect sizes and confidence intervals were reported (see Chapter 4). A 95% confidence interval was used to measure the probability that the true value of the effect size existed 95% of the time in the general population (see Leedy & Ormrod, 2005).

In summary, to maximize the legitimacy of the data used for inferential statistics, screening the data was required and the approaches used, identified problems and their mitigating strategies were reported (see Chapter 4). For example, missing values may be indicative of nonresponse bias. Thus, rather than just omitting missing values from the data analysis, a "systematic evaluation of missing values" (see American Psychological Association, 2010, p. 125) included the amount and pattern, the impact that they may have had on the values of other variables, as well as why it was missing (see American Psychological Association, 2010; Warner, 2013). To enhance correct interpretation of the results from statistical analyses, the means, sample sizes, effects sizes, confidence intervals, and *p* values were reported.

Threats to Validity

Validity in research is about achieving the correct interpretation and understanding of the relationship between independent/predictor variable(s) and outcome(s) in relation to a phenomenon of interest (Bielenia-Grajewska, 2018; Creswell, 2014). Thus, threats to validity impede the interpretation of study results and their generalizability from the sampled to the general population. However, by identifying potential threats, taking measures to minimize their impact, and considering their potential influence on the results during the research process strengthened the validity, establishing covariation between the variables of interest and that the covariation was nonspurious (Frankfort-Nachmias & Nachmias, 2008). Threats to this proposed study existed that could jeopardize internal, external and construct validity. An explanation of these threats and measures taken to minimize these follows.

Internal Validity

Internal threats to validity arise from the research methodology that included data collection processes, how the variables are defined, and from the participants (Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008). Potential internal threats to validity include effects from (a) history, (b) maturation, (c) selection, (d) regression, (e) mortality, (f) diffusion of treatment, (g) compensatory demoralizations and/or rivalry, (h) testing, and (i) instrumentation (Bielenia-Grajewska, 2018; Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008).

A cross-sectional approach for data collection was used to mitigate potential risks of history effects from external events (e.g. a pandemic) and participants' maturation effects over time (see Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008). Furthermore, since there was no control group, diffusion of treatment through intergroup communication, intergroup compensatory or resentful demoralization, and rivalry (see Creswell, 2014) were not considered a threat to this study's validity. Similarly, regression artifacts from pre- and postextreme scores, as well as the possible bias from instrumentation (see Bielenia-Grajewska, 2018; Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008) were eliminated. Irrespectively, extreme scores were expected and existed, posing the risk of regression toward the mean that would occur over time (see Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008; Warner, 2013). Thus, outliers were identified and how they were included in the analysis was explained (see Chapter 4). However, testing effects may have introduced minimal bias.

Effects of asking the participants to report on their teamwork experiences during a worked shift may have introduced testing effects (see Bielenia-Grajewska, 2018; Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008). That is, the participants had access to the survey/CTCQ in advance, noting the items that they were asked to report on at the end of their shift, which could have influenced their performance and patient outcomes. Identifying another shift where the same team members worked together and comparing patient outcomes would serve as a control group. However, obtaining this data from participating organization required a greater investment of resources, which may have further limited the number of organizations willing to participate in this study.

External Validity

Threats to external validity for this study also existed. External validity threats position the researcher to incorrectly understand and interpret the results and can arise from multiple sources. Sources of threats to external validity can arise from the characteristics of participants sampled, the setting, from when the study occurs in time, and the study design selected. All of these can lead to incorrect generalizations of the results from the sampled to the general population of interest (Bielenia-Grajewska, 2018; Creswell, 2014).

The sampled population was from EDs in MB, Canada. This was only one group of people within the HCS that worked shiftwork, which is a source of differences in team membership. In addition, the IP core ED team composition sampled was limited to medical doctors (MDs) and nurses who worked in rural EDs during the COVID-19 pandemic whereby the required pandemic responses from each hospital in MB, Canada differed based on its location. These factors could have introduced a threat to the results and the interpretation of the relationship between TMS, CTC, and medical errors. Replicating the study with different participants, in other settings, and at different times would address this threat.

Since manipulating team membership in EDs over a prolonged period of time was assessed as not practical, a nonexperimental correlational research design was selected. This research approach decreased the amount of control over the variables, reducing the ability to infer causation (see Campbell & Stanley, 1963; Creswell, 2014; Leedy & Ormrod, 2005). A more robust experimental design where IP TMS is maintained over an extended period of time and the use of a control group would enhance the generalizability of the results. However, data from correlational studies "are relevant to causal hypotheses inasmuch as they expose them to disconfirmation … if a high correlation occurs, credibility of the hypothesis is strengthened"

(Campbell & Stanley, 1963, p. 64). Thus, to maximize external validity, statistical procedures selected for the data analysis and my interpretation of the results as a novice researcher were buffered through consultation with an experienced statistician.

Construct Validity

Construct validity refers to the extent to which an instrument accurately measures the phenomenon of interest (Bielenia-Grajewska, 2018; Creswell, 2014; Frankfort-Nachmias & Nachmias, 2008; Heale & Twycross, 2015). For this study, one phenomenon of interest was CTC. To measure CTC, participants were asked to rate items intended to cumulatively measure this construct.

During the development stages, instruments measuring phenomena of interest are assessed for construct validity that describes the relationship between the measuring instrument and the theoretical framework informing the research (Frankfort-Nachmias & Nachmias, 2008). However, no preexisting measuring instrument for CTC was located within the literature. Thus, a CTCQ was developed.

The first step in the development of the CTCQ was domain identification (see Boateng et al., 2018). CTCQ domains were the three normative principles of CCT posited by Boreham (2004). Item generation was informed by validated questionnaires that measured similar constructs to those identified by Boreham as required for CTC for IP collaboration and teamwork. To maximize construct validity, a comparison of definitions from CCT (the theoretical framework informing this research) and those found in existing scales occurred. This process generated 49 items to measure the CCT's three normative principles (see Appendix F).

Cross sectional data from participants in the pilot and from the main study were considered appropriate to assess the internal consistency of CTCQ subscale items in measuring the same characteristic and the results were to be used to establish construct validity (see Boateng et al., 2018; Hellman et al., 2016). However, the number of responses were below the identified sample size required and the internal consistency of CTCQ subscale items as a measure of CTC remains outstanding. However, if the sample size was realized and using EFA, a Cronbach α between 0.70 and 0.90 would have been considered as demonstrating adequate internal consistency whereby the items adequately measured the construct of interest (i.e., CTC) without redundancy (see Hellman et al., 2016). Irrespectively, the CTCQ remains a novel instrument that lacks a measure of its internal construct validity. Thus, the interpretation of results from this study of whether a relationship existed between TMS, CTC, and medical errors was limited to a preliminary screening of effects.

A repeat study to establish CTCQ construct validity is required. Concurrently with obtaining data to establish construct validity, data can also be elicited to establish convergent validity by asking participants to complete the AITCS II and TeamSTEPPS questionnaires as well as the CTCQ and compare the responses across the three questionnaires.

Statistical Inclusion Validity

Threats to statistical inclusion validity may "arise when … inaccurate inferences from data [are made] because of inadequate statistical power or violation of statistical assumptions" (Creswell, 2014, pp. 176-177). An acceptable *p* or α value for statistically testing of the null hypotheses within social science research is .05 (Burkholder, 2012). However, *p* values depend on sample size (Allen, 2017; Hochster, 2008). For example, when the sample size is over 50 participants per cell, small effect sizes may reach the level of statistical significance (Hochster, 2008) and testing for heterogeneity of variance would be more reliable if the α value level is set at .01 (Warner, 2013). However, effect sizes (the r, R^2, and Adjusted R^2) do not depend on sample size (Allen, 2017). A 95% confidence interval (CI) was used to measure the probability that the true value of the effect size existed 95% of the time in the general population (see Leedy & Ormrod, 2005). Thus, to improve the accuracy of inferences made from the data, means, sample sizes, effect sizes, and confidence intervals were reported (see Chapter 4).

Ethical Procedures

All research studies carry benefits and risks for participants and stakeholders. The principles of justice, beneficence/concern for welfare, and respect for all should inform researchers' ethical conduct (TCPS, 2014; Walden University, n.d.). Organizations around the world translated these principles into ethical standards. Since my research was conducted in MB, Canada, the ethical standards used to maximize benefits and minimize harm for participants were those articulated by Walden University and the Government of Canada, captured in the Tri-Council policy statement. As a researcher, compliance with all applicable laws and regulations is required (TCPS, 2014; Walden University, n.d.). Thus, an analysis of the treatment of human subjects within this study ensued.

To maximize the benefits and minimize the risks to participants and organizations asked to be involved in my study, institutional permission from stakeholders was obtained. The process began by applying for approval from Walden University IRB. The application consisted of the completed "Form A" and the "Ethics Self-Check", both submitted via email. The Walden IRB assessed potential ethical impacts and requests for further clarification and modifications were addressed. Walden University IRB approval was received for the pilot and main study. Walden University's approval number for this study is 03-03-20- 0483601 and it expired on March 2nd, 2021**.** The participant surveys included the invitation to participate, consent form, and the CTCQ.

Following Walden University IRB approval, a request for access to health information was submitted to HIPC for Manitoba Health, Seniors and Active Living, seeking their approval to access data from EDIS reports. However, since EDIS data is site specific, HIPC declined any involvement. Requests to access ED employees and site-specific data related to 3 months of worked schedules (to calculate the frequency that IP core team members worked together) and EDIS data were submitted following each organization's application requirements. Within these applications, ethical concerns related to recruitment materials and processes, data collection and protection, informed consent, potential conflict of interest/power differentials, as well as incentives were addressed.

Recruitment

Fifteen EDs met this study's inclusion criteria. To be eligible, the ED was located in the province of MB, Canada and used EDIS as their electronic patient record. Since EDIS data was site specific, approval to access this data from the HIPC was not required. However, requests to conduct research at EDIS sites required organization-specific applications, some defined by regional service delivery organizations and others by specific hospitals. To protect organizational identities, no further details are provided.

A letter of introduction and completed organization-specific applications were submitted during the months of June, July, and August 2020. Upon request from one ED, a virtual presentation occurred with senior organizational representative. A power-point presentation was shared in advance and submitted information was elaborated on, clarifying type of data requested, and the expected role of managers.

To respect potential participant time and organizational responses to the COVID-19 pandemic, no in-person or virtual presentations were delivered as initially planned for recruitment. However, an “Invitation to Participate” poster and copies of the consent and questionnaire (i.e., the survey) were made available at each participating ED during the 2 weeks preceding data collection dates. Within these documents, the purpose of the study and information enabling an informed consent to participate were provided. Walden University IRB and my contact information were provided as the means to address any questions from potential participants. No inquiries were received.

Potential risks for individual participants included loss of personal time to complete the questionnaire, feelings of doubt about their performance as a member of the IP core team within an ED, stress related to being “studied”, and potential worry related to how the findings would be used at the organizational levels. Furthermore, organizations and individual participants could have experienced pressure to participate or abstain from participating from their peers. Other potential risks to participating organizations existed, such as threats to their organizational image. These potential risks were disclosed. For example, all organizations were informed about the strategies in place to ensure confidentiality of identity of participating ED professionals, the anonymity of the sites, how the data from all participating sites would be collated, and generating an analysis that was not site-specific. However, there were also potential benefits to participants and sites.

Potential benefits for individual participants and organizations included but were not limited to an increased awareness of the benefits of IP teamwork through collaboration, a greater understanding of CTC, and how, by participating, they were contributing to advancing the collective understanding of how shiftwork creates variations in TMS and its relationship to patient outcomes. Thus, by furthering an understanding of how differences in team membership due to shiftwork schedules and its relationship with patient outcomes, the study results can benefit ED direct care providers, managers/administrators, and policy makers, resulting in a more responsive and effective HCS by improving the quality of ED patient care, rendering it safer, more accessible, comprehensive, coordinated, and patient-centered. Irrespective of potential benefits, all organizations and individual participants had the right to refuse to participate and were reassured that all information would remain confidential and/or anonymous.

Post Participation

Each participating site within MB, Canada was sent a thank you card, thanking them as an organization and also their ED point-of-care IP practitioners for their support for this research project. My contact information was included in the letter of thanks and a synopsis of the results will be shared upon request. The data collected was stored in a secure locked cabinet. As per Walden University's (n.d.) requirements, the original data will be destroyed five years after the dissertation is approved and published.

Laws and Regulations

MB, Canada has two laws that directly applied to this study. The first is the Personal Health Information Act, which exists to protect the confidentiality of individual health information for all Manitobans. Health information is considered personal, sensitive, and its confidentiality must be protected (Legislative Assembly of Manitoba [LAM], 2019b). However, this did not apply to accessing information about patient outcomes in EDIS. That is, EDIS reports did not contain any specific patient identifiers. Secondly, the Freedom of Information and Protection of Privacy Act (FIPPA) also applied. One purpose of FIPPA is to control how personal information is collected from any individual and its unauthorized use (LAM, 2019a). This applied to patients and ED care providers/participants. However, personal identifiers were not used, and organizational anonymity was maintained throughout the research process.

Summary

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. I used a quantitative, cross-sectional, correlational research method to explore the relationship between these variables. This approach was appropriate to study factors that are not easily amenable to experimental designs and provided an efficient means of collecting a large amount of data within a short period of time (see Creswell, 2014).

Instability in team membership was one element that could undermine effective teamwork (Ulrich & Crider, 2017). Thus, the primary IV of interest was IP TMS, measured by the frequency of shifts that ED core team members worked together. The WHO (2010) and IPEC (2016) identified individual collaborative IP practice as necessary in increasing IP team effectiveness in eliminating medical errors and this predictor was selected as the second IV. Boreham (2004) asserted that CTC was required to mitigate teamwork failures in EDs. Thus, CTC was a DV of IP TMS and a third IV to medical errors. Deidentified worked schedules were the data source for TMS and individual collaborative IP competence. Survey data were the source to quantify CTC. Data from EDIS reports provided the evidence on medical errors that occurred.

The goal of recruitment was a minimum of 35 participants from ED core teams from qualifying EDs located in the province of MB, Canada. Sampling was self-selected, both at the organizational and individual participant levels. Regression analyses and ANOVA were used to calculate correlational coefficients representing the strength of the relationship between the variables of interest. This approach provided the statistical means for controlling the effect from other confounding variables, compensating for the lack of a control group. Identifying and taking measures to minimize threats to validity maximized the correct interpretation and understanding of research results, and the generalizability of the findings beyond the sampled population.

All research studies carry benefits and risks for participants and stakeholders. Complying with ethical standards and applicable legislation should have minimized the risks and maximized the benefits (TCPS, 2014; Walden University, n.d.). Steps in ensuring that compliance with ethical standards included seeking and obtaining IRB approval from Walden University. Furthermore, an informed consent from organizations and individual participants promoted self-selection for accepting or refusing to participate. Once an expression to participate from some of the organizations was received, data collection dates were established and the data collection phase of this research ensued. The results from this study are provided in Chapter 4.

Chapter 4: Results

Introduction

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. The RQ, and the associated *H*0 and *H*A explored were as follows:

> RQ: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors?
>
> *H*0: There is no statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors.
>
> *H*A: There is a statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS), individual collaborative IP competence based on worked experience, CTC, and medical errors.

However, to explore the multiple possible relationships amongst these variables, the RQ and hypotheses were subdivided, resulting in the following:

> RQ_{1a}: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (IP TMS) and medical errors?
>
> $H0_{1a}$: There is no statistically significant relationship between the frequency of providers working together due to shiftwork schedules (IP TMS) and medical errors.
>
> HA_{1a}: There is a statistically significant relationship between frequency of providers working together due to shiftwork schedules (IP TMS) and medical errors.

RQ_{1b}: What is the relationship between individual collaborative IP competence and medical errors?

$H0_{1b}$: There is no statistically significant relationship between individual collaborative IP competence and medical errors.

HA_{1b}: There is a statistically significant relationship between individual collaborative IP competence and medical errors.

RQ_{1c}: What is the relationship between CTC and medical errors?

$H0_{1c}$: There is no statistically significant relationship between CTC and medical errors.

HA_{1c}: There is a statistically significant relationship between CTC and medical errors.

RQ_{1d}: What is the relationship between TMS, individual collaborative IP competence, and medical errors?

$H0_{1d}$: There is no statistically significant relationship TMS, individual collaborative IP competence, and medical errors.

HA_{1d}: There is a statistically significant relationship between TMS, individual collaborative IP competence, and medical errors.

RQ_{1e}: When controlling for CTAS and patient volumes, what is the relationship between TMS and medical errors?

$H0_{1e}$: When controlling for CTAS and patient volumes, there is no statistically significant relationship between TMS and medical errors.

HA_{1e}: When controlling for CTAS and patient volumes, there is a statistically significant relationship between TMS and medical errors.

RQ_{1f}: When controlling for CTAS and patient volumes, what is the relationship between individual collaborative IP competence and medical errors?

$H0_{1f}$: When controlling for CTAS and patient volumes, there is no statistically significant relationship between individual collaborative IP competence and medical errors.

HA_{1f}: When controlling for CTAS and patient volumes, there is a statistically significant relationship between individual collaborative IP competence and medical errors.

RQ_{1g}: When controlling for team size, what is the relationship between TMS and medical errors?

$H0_7$: When controlling for team size, there is no statistically significant relationship between TMS and medical errors.

HA_{1g}: When controlling for team size, there is a statistically significant relationship between TMS and medical errors.

TMS was quantified from deidentified worked schedules spanning 3 months preceding data collection dates. Individual collaborative IP competence was to be defined based on self-reported survey data that captured formal and informal education and worked experience. However, because the sampling threshold of survey data was not met, work experience based on the number of shifts that each member of the ED core team worked within the 3 months preceding data collection was used. A measurement of CTC was generated from the self-ratings on items within the CTCQ. Lastly, administrative data from EDIS was used to identify the frequency of medical errors within the sampling time intervals.

Within this chapter, the data collection processes, the results of the data cleaning and screening, and the final results of this study conducted to answer the RQ and test the hypotheses ensue. However, prior to discussing these elements, I begin with a description of pilot study conducted as an initial attempt to validate the CTCQ.

Pilot Study

The CTCQ was not a validated tool, so a pilot study was conducted. Walden University students and staff who were engaged directly or indirectly in healthcare services as an employee or self-employed were invited to participate. The consent and the CTCQ were posted on Walden University's participant pool forum for 3 months. This was the recruitment strategy.

Participants were provided with a description of Boreham's (2004) CCT's normative principles and were asked to rate the CTCQ items as to the extent to which each item reflected the definitions of these principles. CCT principles were a collective sense of workplace events (CSWE), a collective knowledge base (CKB), and interdependency (INT). CTCQ contains 49 items.

Three participants responded, two females and one male. The formal educational background of the three respondents was at the university level. Their occupations were in the fields of psychology, respiratory therapy, and nursing (management and leadership), and years of employment within these occupations ranged from 3 to 32 years, respectively. The CTCQ questions were completed by all. An example of these ratings is found in Table 1.

With the exception of two of the CTCQ items, each participant rated each item the same for CSWE, CKB, and INT (47 out of 49 items). However, the ratings from individual participants on each item differed, with no items rated the same by all three; 34 items were rated the same by two of the participants; and 15 items were rated differently by all. Due to the limited sample size, no further analyses were performed and no changes to the CTCQ were made.

Table 1

Example of Pilot Study Participant Collective Team Competence Questionnaire Ratings

			Participants and their ratings								
			1			2			3		
CTCQ Item #	Collective Team Competence Scale Items	PS1 #	CSWE	CKB	INT	CSWE	CKB	INT	CSWE	CKB	INT
1	I had a clear understanding of what our team goal(s) was/were.	PS1	5	5	5	4	4	4	1	1	2
2	I knew what needed to be done to achieve our team goal(s).	PS13	5	5	5	4	4	4	5	5	5
3	I knew how to get the work done to achieve our team goal(s).	PS2	5	5	5	4	4	4	4	5	4
4	I knew what was expected of me in relation to other team members' roles and responsibilities.	PS14	5	5	5	4	4	4	5	5	5
5	I had tools available to guide my actions (e.g. ground rules; job aids; defined procedures).	PS17	4	4	4	3	3	3	5	5	5
6	I was able to anticipate the needs of team members.	PS18	4	4	4	3	3	3	5	5	5
7	I was aware of what the other team members were doing.	PS34	3	3	3	3	3	3	5	5	5
8	I understood how my role and responsibilities contributed to (and were shaped by) team dynamics and events in the workplace.	PS19	5	5	5	3	3	3	5	5	5
9	I was aware in a timely manner of changes within and beyond the team environment that affected our team's ability to achieve its goal.	PS30	4	4	4	3	3	3	5	5	5
10	I shared relevant information with other team members as it became available.	PS42	5	5	5	3	3	3	5	5	5

Note. CTCQ = Collective Team Competence Questionnaire; # = Number; PSI = Pilot Study Item; CSWE = Collective Sense of Workplace Events; CKB = Collective Knowledge Base; INT = Interdependency.

Data Collection

Fifteen EDs met this study's inclusion criteria. To be eligible, the ED was located in the province of MB, Canada and used the EDIS as their electronic patient record. Because EDIS data were site specific, approval to access these data from the HIPC was not required. However, requests to conduct research at EDIS sites required organization-specific applications, some defined by regional service delivery organizations and others by specific hospitals. To protect organizational identities, no further details are provided.

A letter of introduction and completed organization-specific applications were submitted during the months of June, July, and August 2020. Upon request from one ED, a virtual presentation occurred with senior organizational representative. A power-point presentation was shared in advance, and information submitted was elaborated on, clarifying the type of data requested and the expected role of managers. From the 15 possible EDs, one declined; there were no responses received from seven; and for two other sites, an expression of interest was received but not the final approval. However, final approval to participate was received from five EDs, whereby four were located in rural communities. Thus, the organizational approval response rate to conduct research at their sites was five out of 15, representing a third of all eligible EDs. Data collection occurred across these five EDs over a 72-hour period of time, starting at 0800 hour on October 15 to 0800 hour on October 18, 2020.

To respect potential participant time and organizational responses to the COVID-19 pandemic, no in-person or virtual presentations were delivered as initially planned for recruitment. However, an “Invitation to Participate” poster and copies of the consent and questionnaire (the survey) were made available at each participating ED during the 2 weeks preceding data collection dates. Within these documents, the purpose of the study and information enabling an informed consent to participate were provided. Walden IRB and my contact information were also provided as the means to address any questions from potential participants. No inquiries were received.

Data collection occurred concurrently as planned. Three sources of data were required to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs: (a) deidentified worked schedules to measure TMS, (b) surveys from ED team members to quantify individual collaborative IP competence and CTC, and (c) EDIS reports as the source of data to measure medical errors.

As can be seen in Table 2, for the October 2020 data collection period, the data received were (a) deidentified worked schedules from ED1, ED2, ED3, and partially from ED4; (b) completed surveys from ED1, ED3, and ED4; and (c) EDIS reports from ED1, ED2, and ED3. Survey response rates did not meet the threshold identified – a minimum sample size of 35 surveys was identified and 14 surveys were completed across sites. Therefore, repeat sampling/data collection for another 72-hour time period was requested. Three of the five participating EDs agreed, and this occurred from November 10 to 13, 2020. Thus, data collection occurred over two 72-hour periods, from October 15 to 18, 2020 and repeated from November 10 to 13, 2020. These 72-hour periods were divided into 4-hour time intervals. For the November sampling period, deidentified worked schedules were received only from ED2.

Table 2

Data Received From Participating Emergency Departments/Urgent Care Centres

		Data sources					
		Deidentified worked schedules		EDIS reports		Survey questionnaires	
	Sampling dates	Oct. 15-18, 2020	Nov. 10-13, 2020	Oct. 15-18, 2020	Nov. 10-13, 2020	Oct. 15-18, 2020	Nov. 10-13, 2020
Participating Eds	ED1	Received	None	Received	Received	7 completed	0 completed
	ED 2	Received	Received	Received	Received	0 completed	1 completed
	ED 3	**Received	None	Received	Received	2 Completed	1 completed
	ED 4	Partial	Did not participate	None	Did not participate	5 completed	Did not participate
	ED 5	None	Did not participate	None	Did not participate	0 completed	Did not participate

Note. ED = Emergency Department/Urgent Care Centre; EDIS = Emergency Department Information System; Oct.= October; Nov. = November.
[a] **Denotes deidentified worked schedules received that contained inconsistencies and were excluded from further analysis.

Data Cleaning and Screening

Deidentified worked schedules, surveys, and EDIS reports were required to analyze the relationship between TMS, individual collaborative IP competence, CTC, and patient outcomes/medical errors. Deidentified worked schedules and EDIS reports were received from ED1, ED2, and ED3. Thus, ED4 and ED5 were excluded from any further inferential data analysis. However, during initial data screening, inconsistencies within the deidentified worked schedules from ED3 were encountered, and ED3 was also excluded from inferential statistical analyses.

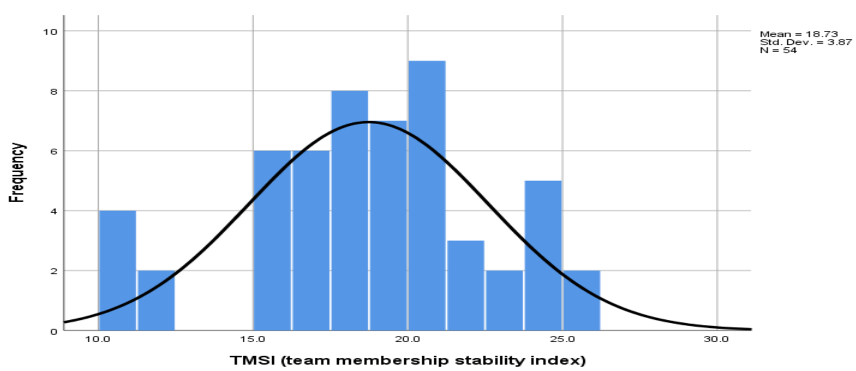
Based on Boreham's (2004) CCT and using deidentified worked schedules to define TMS and individual collaborative IP competence (two predictor variables), temporal order was established. This priori reason was used to define unidirectional influence between these predictors and medical errors. Thus, regression analysis was selected as the most appropriate statistical tool to analyze the relationship between quantitative predictor and outcome variables where a temporal order existed. Assumptions of regression analysis include a univariate normal distribution of predictor and outcome scores, a linear relationship without extreme bivariate outliers, and homogeneity or homogenous variance of outcome values (Warner, 2013). Results of the testing for these assumptions follows.

Tests of Regression Analysis Assumptions

Testing for violation of assumptions related to regression analysis were conducted. Reliable correlational results using regression analysis assumes that the data is normally distributed for both the predictors and the outcome variables (Warner, 2013). Histograms for the team membership stability index (TMSI) and individual collaborative IP competency index (ICICI) for the 54 teams were generated. As can be seen in Figure 1, both TMSI and ICICI scores do approximate a normal distribution. Thus, for the predictive variables, regression analysis assumption of univariate normal distribution existed.

Figure 1

Univariate Distribution for Team Membership Stability Indices for All Teams



Regression analysis assumptions include univariate normal distributions for outcome variables as well (Warner, 2013). For the outcome variables (time to triage, time to physician/alternate, time to diagnostics, and LOS), the distributions were positively skewed.

Since parametric statistics are not robust in the presence of outlier values, these scores can skew the results (see Warner, 2013) However, as can be seen in Figure 2, the first graph for ED1 time to physician/alternate initial assessment (PIA) included all values but when outliers were removed (second graph in Figure 2), the distribution more closely approximated a normal distribution. Thus, outliers were removed from EDIS data prior to conducting regression analysis to uphold univariate normal distribution for outcome variables. P-P plots were also used to confirm bivariate normal distributions and homoscedasticity/homogeneity of variances (see Figure 3 for examples).

Figure 2

Univariate Distribution for Time to Physician/Alternate Initial Assessment at Emergency Department 1 and Team Membership Stability Index at Emergency Department 2

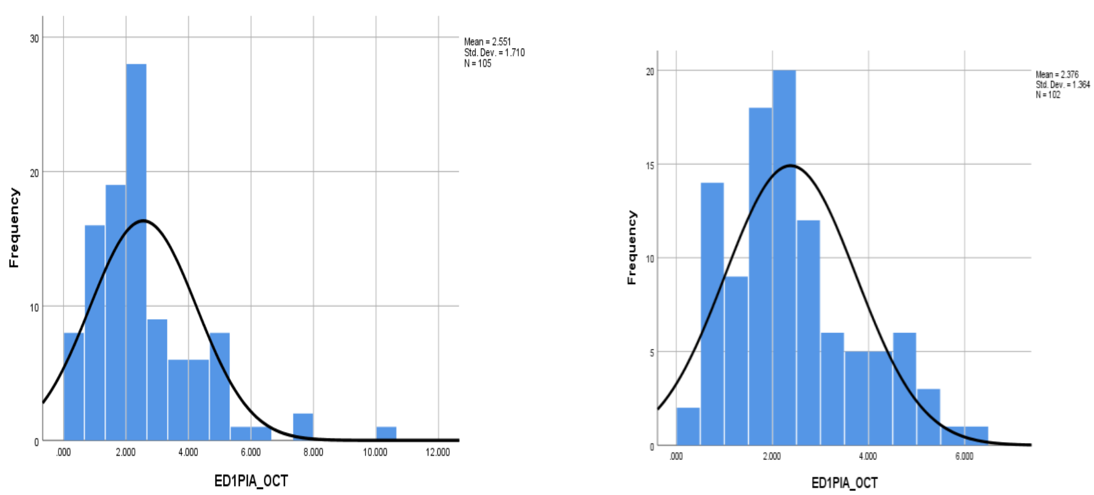
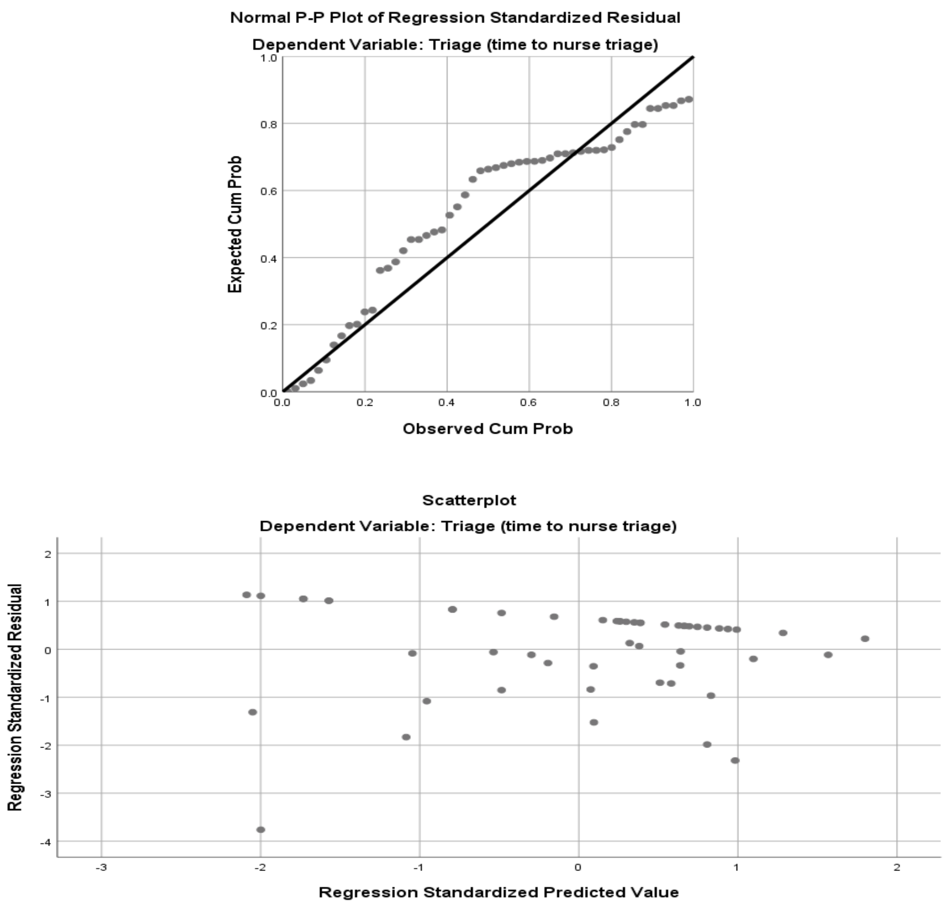


Figure 3

Results of Testing for Regression Analysis Assumptions of Bivariate Normal Distribution and Homoscedasticity Between Team Membership Stability Index (TMSI), Individual Collaborative Interprofessional Competence Index (ICICI), and Time to Triage



When more than one predictor is used, testing for collinearity between predictors is required to maximize reliability of multiple regression analysis. When predictor variables are highly correlated (in excess of .9 absolute value), their predictive contributions cannot be distinguished (Warner, 2013). The correlation analysis between TMSI and ICICI yielded a Pearson's r = .416 (p = .002), only a moderate effect size.

Results

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs located in MB, Canada. TMS was one IV selected; individual collaborative IP competence was the second IV; CTC was a DV of TMS and a third IV of medical errors; and CTC was considered a DV of TMS and a fourth IV medical errors. The volume of patients (see Rice, 2016) and their levels of acuity upon presenting to EDs (see Zhang et al., 2017) were system input factors and potential confounding variables.

Medical Errors

EDIS data were received from ED1, ED2, and ED3. The data captured each patient who presented/registered during the data collection periods that occurred in October and November 2020. The variables of interest were as follows:

- patient volumes
- level of acuity/risk that each patient presented with as defined by CTAS
- DV 1 - time from patient registration to triage by a nurse
- DV2 - time to PIA
- DV3 - time to diagnostics imaging or laboratory
- DV4 - LOS
- DV5 - whether the person was admitted and, if admitted to an inpatient unit, time from registration to admission
- DV6 - number of patients who LWBS by a physician/alternate prescriber.

Medical errors were defined based on the CAEP indicators/benchmarks (see Affleck et al., 2013; Bullard et al., 2017). Time from patient registration to nurse triage is expected to occur within 15 minutes (Bullard et al., 2017). CAEP also defined indicators for (a) time to PIA as a median of one hour, 90th percentile of three hours; (b) ED LOS for discharged patients triaged as CTAS IV/V as a median of 2 hours, 90th percentile of four hours; and for CTAS I-III, a median of 4 hours, 90th percentile of 8 hours; (c) for all admitted patients, irrespective of CTAS levels, median of 8 hours, 90th percentile of 12 hours; and (d) time (to transfer) to an inpatient bed as a median of 2 hours, 90th percentile of 8 hours (Affleck et al., 2013, p. 361). Since the number of patients who LWBS correlated with time to PIA (Affleck et al., 2013), and time to diagnostics/laboratory services was identified as a factor associated with medical errors (IOM/NAM, 2000), these variables were included in the data collection as measures of medical errors. For this analysis, absolute numbers and percentages were used to assess if the targets were met.

As can be seen in Table 3, no ED met the target whereby all patients were triaged within 15 minutes but the degree to which this target was met differed between sites. Patients were triaged consistently within 15 minutes during both data collection periods at ED2 and ED3 (delays at 7% and 31%-36% respectively). In contrast, delays to triage by a nurse at ED1 increased from 24% to 64%. This represented a 40% increase in delays. However, patient volumes and levels of acuity at ED1 were similar during the October and November 2020 data collection periods. That is, in October, 118 patients registered, 60 of which were triaged as CTAS levels I-III and 51 as CTAS IV-V. In November, 120 patients registered, of which 70 were triaged as CTAS levels I-III and 53 as CTAS IV-V.

Time to PIA was met at ED2 in October and November, whereby 50% of patients were seen within 1 hour and 95% and 94% seen within 3 hours. At ED3, in October and November, the 1-hour target was met (54% and 76% of patients were seen respectively), and 86% and 100%

of patients had PIA within 3 hours. In contrast to ED2 and ED3, for the two data collection periods at ED1, 14% and 9% of patients had PIA within 1 hour, and 71% and 46% by 3 hours. Thus, there were differences between the three EDs in how they met the targets for time to PIA.

No specific target was set for the third outcome variable measured – that is, time to diagnostics or laboratory within 2 hours. Irrespectively, as can be seen in Table 3, the greatest number of patients for whom testing was ordered occurred at ED1 for both October and November (68 and 63 respectively), contrasted by 59 and 29 at ED2, and 56 and 49 at ED3. At ED2 and ED3, more patients waited for more than 2 hours when more tests were ordered. In contrast, more tests were ordered at ED1 in October and 58% of testing occurred within the 2 hours; less were ordered in November and 37% occurred within this defined time frame.

The target for patients discharged within 2 hours for CATS IV-V and 4 hours for CTAS I-III (referred to as LOS at 2 and 4 hours) was 50%; and 90% were expected to be discharged within 4 and 12 hours based on the CTAS levels. ED1 did not meet either of these targets for both October and November data collection periods. In contrast, these targets were met at ED2 and ED3.

The LOS targets for patients admitted to inpatient beds irrespective of CTAS levels were 50% within 8 hours and 90% within 12 hours. These targets were only met at ED2. For October, ED1 was comparable to ED3 where 33% of patients were admitted to inpatient beds within 8 hours and 44% and 56% respectively within 12 hours. However, for November, only one patient was admitted within 8 hours at ED1 (LOS was 2.77 hours). The other 10 patients had LOS ranging from 25.94 to 83.91 hours in the ED.

The last outcome variable measured were the number of patients who LWBS by a physician/alternate. The target for LWBS is zero. ED1 in October and ED2 in November had no patients who LWBS (i.e., target was met). ED2 had one patient in October. In contrast, ED3 had seven and four patients who LWBS during these time periods of data collection. However, the number of patients who left LWBS at ED1 went from zero in October to 34 in November 2020.

Table 3

Medical Errors as Delays to Care in Emergency Departments (EDs)

		Triage within 15 minutes			PIA w/in 1 hr	PIA w/in 3 hrs	PIA > 3 hrs		Time to diagnostics or lab within 2 hr.			Length of stay based on CTAS levels				Admitted to inpatient beds			
EDs	vol	yes	no	% not met	yes	yes	no	% not met	yes	no	% not met	2 or 4 hrs	4 or 12 hrs	>4 or 12 hrs	% not met	≤ 8 hrs	≤ 12 hrs	> 12 hrs	LWBS
E1 Oct	118	90	28	24	16	59	30	29	39	29	42	32	43	43	36	3	1	5	0
E1 Nov	120	43	77	64	11	28	40	54	23	40	63	38	37	45	37	1	0	10	34
E2 Oct	120	111	9	7	59	36	5	5	38	21	36	79	35	6	5	14	0	1	1
E2 Nov	90	84	6	7	60	23	5	6	27	8	23	60	25	5	6	10	2	0	0
E3 Oct	151	95	54	36	82	32	19	14	39	17	30	88	45	17	11	3	2	4	7
E3 Nov	117	80	37	31	89	16	0	0	37	12	24	88	19	9	8	4	4	2	4

Note. EDs = Emergency Departments; E = Emergency Department; vol = volume of patients registered; PIA = time to initial physician/alternate assessment; CTAS = Canadian Triage Acuity Scale; LWBS = left without being seen; hr = hour; and hrs = hours.

Team Membership Stability and Medical Errors

Usable deidentified worked schedules were received from ED1for the October data collection period and from ED2 for both October and November 2020 sampling periods. Hence, the relationship between TMS and medical errors was explored using these data. These EDs were both located within rural communities, consisting of two out of nine in MB, Canada, representing 22% of all rural EDs that met the inclusion criteria.

Data collection occurred over a 72-hour period from October 15th to 18th, 2020, and repeated from November 10th to 13th, 2020. These 72-hour periods were divided into 4-hour time intervals. ED core teams were defined as IP team members who worked together during the 4-hour intervals and TMS as the frequency that these IP core team members had previously worked together during the 3 months preceding these sampling times. The process for quantifying TMS began with identifying core team members, summarized in a table (see Table 4 as an example), followed by calculating the frequency that team members had worked together (e.g., Table 5). In October 2020, team sizes at ED1 ranged from 4 to 8 members, with a mode of 5; at ED2, the range was 4 to 11, and the mode were 4 and 6. In November 2020, team sizes at ED2 ranged from 8 to 12 members, and the mode was 8. Core team composition at ED1 and ED2 consisted of MDs and nurses.

Table 4

Core Team Members Who Worked Together During Data Collection Periods as Emergency Department 1

Dates	Time intervals		Core team members								Team size
Oct.15	TI-1	0800 to 1200	N19	N6	N10	N12	N17	N1	MD1		7
	TI-2	1200 to 1600	N19	N6	N10	N12	N17	N1	MD1	MD2	8
	TI-3	1600 to 2000	N11	N6	N10	N12	N13		MD3	MD2	7
	TI-4	2000 to 0000	N11	N7	N21	N22	N13	N20	MD3	MD2	8
Oct.16	TI-5	0000 to 0400		N7	N21	N22		N20	MD3		5
	TI-6	0400 to 0800		N7	N21	N22		N20	MD3		5
	TI-7	0800 to 1200	N4	N12	N15	N14			MD4		5
	TI-8	1200 to 1600	N4	N12	N15	N14			MD4	MD5	6
	TI-9	1600 to 2000	N4	N12	N15	N9			MD6	MD5	6
	TI-10	2000 to 0000		N5	N7	N8	N9		MD6	MD5	6
Oct.17	TI-11	0000 to 0400		N5	N7	N8			MD7		4
	TI-12	0400 to 0800		N5	N7	N8			MD7		4
	TI-13	0800 to 1200	N2	N12	N15	N16	N14	N10	MD4		7
	TI-14	1200 to 1600	N2	N12	N15	N16	N14	N10	MD4	MD6	8
	TI-15	1600 to 2000	N18	N12	N15	N9			MD8	MD6	6
	TI-16	2000 to 0000	N18	N5	N15	N9	N8	N7	MD8	MD6	8
Oct.18	TI-17	0000 to 0400	N18	N5			N8	N7	MD3		5
	TI-18	0400 to 0800	N18	N5			N8	N7	MD3		5

Note. MD = Medical Doctor; N = Nurse; TI = Time interval; Oct. = October.

Table 5

Frequency of Times Worked Together During 3 Months Preceding Data Collection Dates at Emergency Department 1

		Within the cells, frequency of times core team members worked together								
Number team members who worked together		2	3	4	5	6	7	8	Team size	TMSI
Time intervals	1	31	13	4	2	0	0	NA	7	**18.1**
	2	32	13	4	2	1	0	0	8	**16.9**
	3	49	9	2	0	0	0	NA	7	**20.1**
	4	38	12	8	0	0	0	0	8	**18.0**
	5	39	6	4	0	NA	NA	NA	5	**22.4**
	6	39	6	4	0	NA	NA	NA	5	**22.4**
	7	31	9	3	0	NA	NA	NA	5	**20.2**
	8	36	10	4	0	0	NA	NA	6	**19.7**
	9	34	13	1	0	0	NA	NA	6	**18.5**
	10	18	12	5	1	0	NA	NA	6	**16.2**
	11	18	2	0	NA	NA	NA	NA	4	**10.5**
	12	18	2	0	NA	NA	NA	NA	4	**10.5**
	13	34	25	9	0	0	0	NA	7	**25.6**
	14	32	27	11	1	0	0	NA	8	**24.4**
	15	33	6	2	0	0	NA	NA	6	**15.3**
	16	25	16	7	4	1	0	0	8	**19.0**
	17	28	8	3	0	NA	NA	NA	5	**18.4**
	18	28	8	3	0	NA	NA	NA	5	**18.4**

Note. TSMI = Team Membership Stability Index.

As can be seen in Table 5, different numbers of core team members worked together during the 3 months preceding data collection period but at no time did all of the core team members work together at ED1. This was a similar finding at ED2. Furthermore, even within these 4-hour intervals, changes in the team compositions occurred. However, maintaining the 4-hour intervals to define the teams, the frequency of times that different combinations of the number of the IP core team members worked together during the 3 months preceding sampling dates were calculated. For example, when only two members had worked together, when only three members had worked together, etc., and these frequencies were tallied. As can be seen in Table 5, for the Time Interval 1 and for the team size of seven,

- only two team members worked together 33 times during the three months preceding data collection dates;
- only three team members worked together 17 times during the three months preceding data collection dates;
- only four worked together seven times;
- only five worked together twice;
- only six members worked together once; and
- the whole team of seven had not worked together at all.

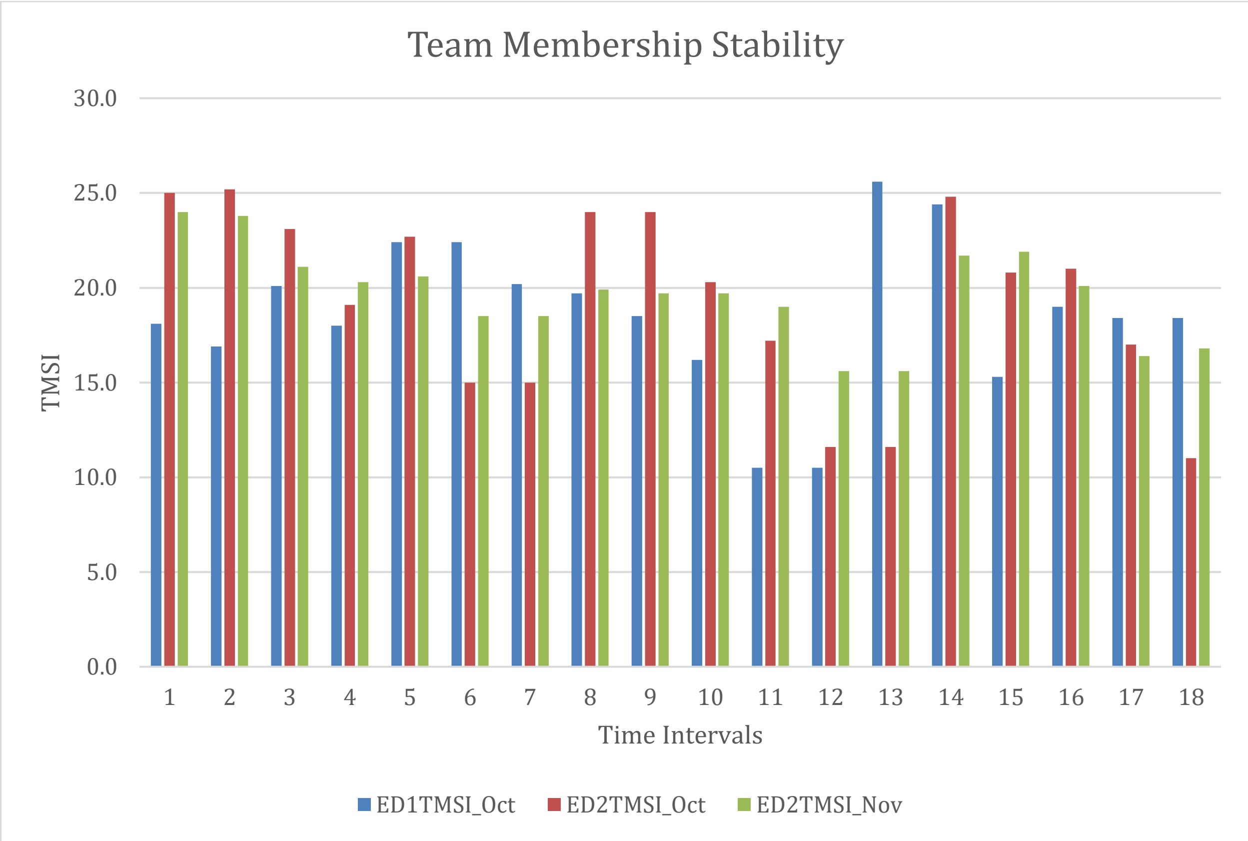
These were the calculated frequencies used to define TMS. To enable statistical regression analyses using SPSS, these frequencies were translated into a new variable, the TMSI. This approach was similar to that used by Hysong et al. (2019) to quantify team network characteristics, how Lee et al. (2015) developed the Team Descriptive Index, and similarly to the method adopted by Scott et al. (2020) to generate their team stability index in relation to turnover. Thus, for this study, the TSMI was calculated using the formula

$n_1(f_1) + n_2(f_2) + n_3(f_3) + \ldots / x$, where "n" represented the minimum number of team members who worked together, "f" represented the frequency that these team members worked together during the 3 months preceding data collection time intervals, and "x" represented the team size during the specific time interval. For example, at ED1, for time interval 1 and a team size of seven, only two team members worked together 31 times in 3 months, etc., yielding the equation 2(31) + 3(13) + 4(4) + 5(2) + 6(0) + 7(0) / 7 = 18.1. Thus, the TMSI for this Time Interval 1 at ED1 is 18.1. Collectively, using the 4-hour intervals to define the teams, these data represented 54 teams. TMSIs were calculated for 54 IP core teams. However, since TMSI was a new index for TMS, no reference points with other research findings were available.

The TMSI scores for ED1 ranged from 10.5 to 25.6, *SD* = 3.98, *M* = 18.6, *Mdn* = 18.4, and mode = 18.4. The TMSI scores for ED2 in October 2020 ranged from 11.0 to 25.2, *SD* = 5.06, *M* = 19.4, *Mdn* = 20.5, and mode of 15.0 and 11.6. As can be seen in Figure 4, there was less variability in the TMSI scores at ED2 during the November data collection period (range = 15.6-23.8, *SD* = 2.30, *M* = 19.2, *Mdn* = 19.7, mode = 15.6 and 18.5) than for ED1 and ED2 in October. For the 54 teams, the TMSI scores ranged from 10.5 to 25.6, a *SD* = 3.87, and *M* = 18.73.

Figure 4

Team Membership Stability Indices at Emergency Department 1 and Emergency Department 2



Patients as the Unit of Analysis

Using the TMSI as the predictor variable with each of five measures of medical errors, separate linear regression analyses were conducted with October 2020 data from ED1, October 2020 data from ED2, and the November 2020 data from ED2 (see Table 6, 7, and 8). The levels of statistical significance ranged from p = .09 to p = .82. None of the relationships were statistically significant.

Table 6

Relationship Between Team Membership Stability Index (TMSI) and Medical Errors at Emergency Department 1 (ED1) in October 2020

Dependent variable		Sum of squares	*df*	Mean Square	*F*	Sig
ED1 Registration to Triage	Regression	.001	1	.001	.050	.823[b]
	Residual	2.729	116	.024		
	Total	2.730	117			
ED1 Registration to Treatment Room	Regression	.318	1	.318	.431	.513[b]
	Residual	82.477	112	.736		
	Total	82.795	113			
ED1 Registration to Physician Initial Assessment	Regression	1.498	1	1.498	.641	.425[b]
	Residual	238.283	102	2.336		
	Total	239.781	103			
ED1 Registration to Diagnostics / Laboratory	Regression	1.024	1	1.024	.523	.472[b]
	Residual	125.413	64	1.960		
	Total	126.437	65			
ED1 Registration to Discharge (Length of Stay)	Regression	6.592	1	6.592	.146	.703[b]
	Residual	5232.486	116	45.108		
	Total	5239.078	117			

Note. [b] is for the predictor (team membership stability index; TMSI) at ED1.

Table 7

Relationship Between Team Membership Stability Index (TMSI) and Medical Errors at Emergency Department 2 (ED2) in October 2020

Dependent variable		Sum of squares	*df*	Mean Square	*F*	Sig
ED2 (October) Registration to Triage	Regression	.001	1	.001	.066	.797[b]
	Residual	1.347	118	.011		
	Total	1.348	119			
ED2 (October) Registration to Treatment Room	Regression	.133	1	.133	.218	.642[b]
	Residual	69.860	114	.613		
	Total	69.994	115			
ED2 (October) Registration to Physician Initial Assessment	Regression	.626	1	.626	.777	.380[b]
	Residual	79.680	99	.805		
	Total	80.306	100			
ED2 (October) Registration to Diagnostics / Laboratory	Regression	33.511	1	33.511	.346	.559[b]
	Residual	5524.822	57	96.927		
	Total	5558.333	58			
ED2 (October) Registration to Discharge (Length of Stay)	Regression	2.020	1	2.020	.207	.650[b]
	Residual	1154.177	118	9.781		
	Total	1156.197	119			

Note. [b] is for the predictor (team membership stability index; TMSI) at ED2 in October 2020.

Table 8

Relationship Between Team Membership Stability Index (TMSI) and Medical Errors at Emergency Department 2 (ED2) in November 2020

Dependent variable		Sum of squares	*df*	Mean Square	*F*	Sig
ED2 (November) Registration to Triage	Regression	.003	1	.003	.82	.597[b]
	Residual	1.078	88	.012		
	Total	1.082	89			
ED2 (November) Registration to Treatment Room	Regression	.646	1	.646	.975	.326[b]
	Residual	56.272	85	.662		
	Total	56.918	86			
ED2 (November) Registration to Physician Initial Assessment	Regression	2.115	1	2.115	2.248	.138[b]
	Residual	66.793	71	.941		
	Total	68.908	72			
ED2 (November) Registration to Diagnostics / Laboratory	Regression	101.477	1	101.477	2.971	.092[b]
	Residual	1501.660	44	34.151		
	Total	1604.136	45			
ED2 (November) Registration to Discharge (Length of Stay)	Regression	2.297	1	2.297	.367	.546[b]
	Residual	550.484	88	6.256		
	Total	552.781	89			

Note. [b] is for the predictor (i.e., team membership stability index; TMSI) at ED2 in November 2020.

A linear regression analysis was also performed combining data from all three sets, with a sample size of 329 patients. With TMSI as the predictor variable, the results were (a) time to triage, $F(1, 326) = 1.51$, $p = .22$, $R = .07$, $R^2 = .005$; (b) time to treatment room, $F(1, 314) = .011$, $p = .92$, $R = .01$, $R^2 = .000$; (c) time to PIA within 1 hour, $F(1, 286) = .461$, $p = .49$, $R = .04$, $R^2 = .002$; (d) time to diagnostics/laboratory within 2 hours, $F(1, 159) = 1.199$, $p = .275$, $R = .087$, $R^2 = .007$; and (e) LOS within 2 or 4 hours based on CTAS levels, $F(1, 326) = 3.792$, $p = .05$, $R = .107$, $R^2 = .011$. Technically, the relationship between TMSI and LOS was the one variable that was statistically significant when rounding the *p* value down to two decimal points but the actual *p* value was $p = .054$.

The Team as the Unit of Analysis and Medical Errors

Deidentified worked schedules were provided by ED1 and ED2. Combining data from these EDs yielded 54 teams. As previously described, a TMSI was generated for each team, a quantitative predictor variable. The DV consisted of multiple medical errors. The frequencies for the number of patients who received care based on national indicators (i.e., when care was not delayed) were changed to percentages. For each time interval/team, the mean of CTAS acuity levels were calculated but patient volumes remained as frequencies. The CTAS and patient volumes were treated as confounding variables.

The relationship between TMSI and patient outcomes was statistically analyzed using the team as the unit of analysis. Similar to when using patients as the unit of analysis, the relationship between TMSI and medical errors was not statistically significant. The results were for (a) TMSI and time to triage, $F(1, 51) = 1.759$, p . = .19; (b) TMSI and time to PIA within 1 hour, $F(1, 51) = 1.736$, p . = .19; (c) TMSI and time to PIA within 3 hours, $F(1, 51) = .372$, p . = .54; (d) TMSI with time to diagnostics or laboratory, $F(1, 47) = 1.343$, p . = .25; and (e) TMSI with LOS less than 2 or 4 hours based on CTAS levels, $F(1, 51) = 2.801$, p . = .10.

RQ_{1a} asks what is the relationship between TMS and medical errors? Based on a p value (or an α level) of .05 and a 95% CI, there were no statistically significant relationships and the first null hypothesis ($H0_{1a}$) was accepted. That is, from using both the patients and the teams as units of analyses, there was no statistically significant relationship between the frequency of IP core team members working together due to shiftwork schedules (i.e., IP TMS) and delays in care (i.e., medical errors).

Individual Collaborative Interprofessional Competence and Medical Errors

Survey data were required to quantify individual collaborative IP competence. From the five participating EDs, a total of 14 survey responses were received in Oct. 2020 and two in Nov. 2020. However, only some surveys were completed during the data collection time intervals, denoted as “relevant” in Table 9. Thus, across sites, there were seven relevant responses. Furthermore, reliable deidentified worked schedules were received only from ED1 and ED2, decreasing the number of relevant surveys to three.

Table 9

Survey Responses From All Participating Emergency Departments (EDs)

	Survey responses from all EDs					
	October. 2020			November.2020		
	Completed	Relevant	Not Relevant	Completed	Relevant	Not Relevant
ED1	7	3	4	0	0	0
ED2	0	0	0	1	0	1
ED3	2	2	0	1	1	0
ED4	5	2	3	0	0	0
ED5	0	0	0	0	0	0
Total	14	7	7	2	1	1

Note. Relevant refers to surveys completed during this study’s data collection periods.

All participants were female, consisting of 13 nurses and three other staff. Self- reported formal education, participation in IPE and professional experience originally defined individual collective IP competence in this study. Their educational background included university, college, and certificate programs (8, 6, and 2 participants respectively). Overall experience since certification ranged from 1 year 2 months to 38 years 3 months; the median was 14 years; and the mean was 15 years (no response from three participants). Their experience working within the ED environment ranged from 4 months to 20 years, with a mean of 7 years (two had not specified). This response rate did not meet the identified sample size required to assess the relationship between individual collaborative IP competence and medical errors. However, the deidentified worked schedules contained the frequency of shifts worked by each core team member during the 3 months preceding data collection periods and professional experience was redefined.

The data collection periods were divided into 4-hour intervals and ED core teams were defined by staff who worked together during these intervals, resulting in a total of 54 teams (the sample size). Similar to TMS, to enable statistical regression analyses using SPSS, the frequencies that each member of the core team worked during the 3-month period preceding the data collection period were translated into a new variable, the ICICI for each 4-hour interval. The ICICI was generated by adding the frequency of shifts worked by each core team member and then divided by the team size (i.e., ICICI was the mean). As can be seen in Table 10, for the 54 teams, ICICI ranged from 26.25 to 42.8, where M = 33.3, Mdn = 32.7; and the mode was 31.6.

RQ1b asks what is the relationship between individual collaborative IP competence and medical errors? Bivariate regression analysis between ICICI and time to triage, PIA within 1 hour, PIA within 3 hours, time to diagnostics/laboratory, LOS at 2 or 4 hours, and LOS at 4 or 8 hours yielded mixed results. Statistically significant relationships existed between ICICI and PIA within 1 hour ($F(1, 51) = 6.103$, p =.02) and with LOS at 2 or 4 hours ($F(1, 51) = 7.005$, p = .01); but no statistically significant relationship was found between ICICI and the other measures of medical errors. However, since there were statistically significant relationships between ICICI and two of the measures of medical errors, $H0_{1b}$ was rejected and HA_{1b} accepted. That is, a statistically significant relationship existed between individual collaborative IP competence and medical errors.

Table 10

Individual Collaborative Interprofessional Competence Index (ICICI) at Emergency Departments

Team #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Team Size	7	8	7	8	5	5	5	6	6
ICICI	32	29.4	36.1	38	42.8	42.8	37	34.2	34
Team #	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Team Size	6	4	4	7	8	6	8	5	5
ICICI	32.5	32.3	32.5	38	38.1	33.9	32	35.4	35.4
Team #	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Team Size	10	11	9	6	4	4	8	9	9
ICICI	33.1	31.3	38.9	35.7	36.25	36.25	34.1	31.9	28.6
Team #	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
Team Size	6	5	5	5	6	8	6	4	4
ICICI	30.3	32.2	32.2	40	35.8	31.9	28.8	32.75	32.75
Team #	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Team Size	9	10	9	8	8	9	9	11	11
ICICI	34.8	33.2	32.7	31.6	31.6	31.6	31.6	31.2	32
Team #	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
Team Size	10	8	8	10	12	10	10	8	8
ICICI	29.6	26.75	26.75	35.5	34.2	33.7	28.1	26.25	26.25

Note. # = number.

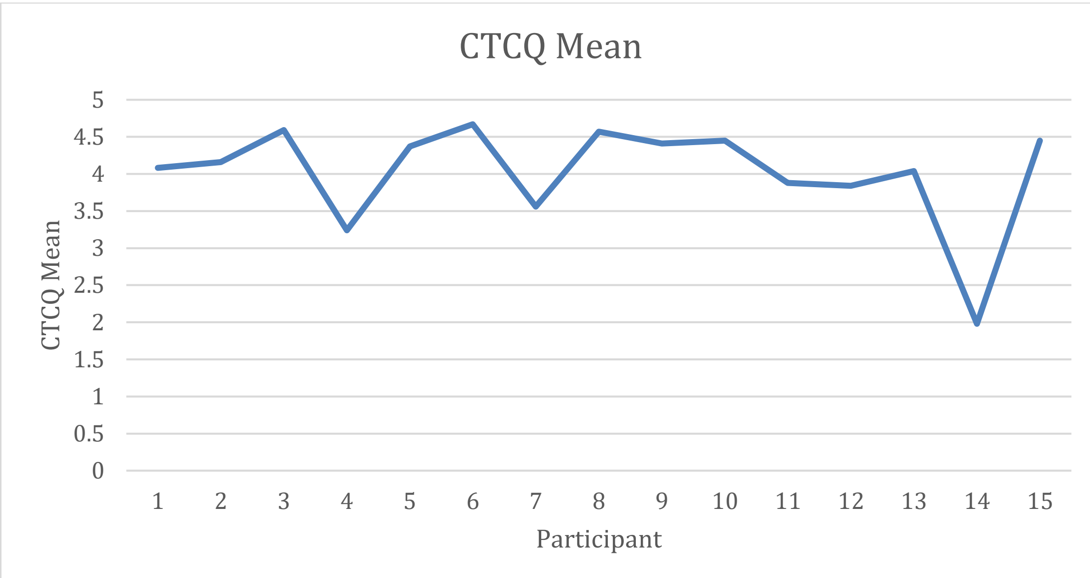
Collective Team Competence

Survey data was required to quantify CTC. The ED staff surveys contained the CTCQ. As a component of the survey, 15 out of 16 participants completed the CTCQ (see previous section for details of the response rate and responder characteristics).

The CTCQ consisted of 49 items, rated on a scale from 0 to 5, ranging from “never” (0%) to “always” (100%). Two items were reversed scored. Except for participant 7, the means of the participants’ 49 ratings were calculated. For participant 7, Item 18 was not rated, and the mean was based on 48 responses. Item 18 read “I used common professional language to communicate with team members". The distribution of CTCQ means for the 15 participants is captured in Figure 5.

Figure 5

Means of the Ratings on the Collective Team Competence Questionnaire



The survey response rate did not meet the minimum sample size of 35 surveys required to reasonably detect if a relationship existed between TMS, CTC, and medical errors in EDs. Furthermore, this sample is minimally representative of the IP core team members who work in rural EDs. For example, from ED1, the nurses who participated were five out of a possible 24 nurses who worked during the three days of data collection in October 2020, representing a 20.8% of the total population at this one ED but no physicians participated. From ED2, 30 nurses worked during the data collection periods in October and November 2020 but only one nurse participated. Additionally, only three of the nurses from ED1 completed the survey during the data collection time intervals and these ratings were for time intervals 15 to 18. However, from all surveys, the ratings ranged from 4.08 to 4.59, a difference of 0.51. This demonstrated that ED care providers perceived that their teams had a high level of collective competence. However, due to the poor survey response rate, no further analyses were conducted using this data and RQ_{1c} was not tested. That is, RQ_{1c} asked what is the relationship between CTC and medical errors and this RQ remained unanswered.

Team Membership Stability, Individual Collaborative Interprofessional Competence, and Medical Errors

The correlation between the TMSI and ICICI was moderate (r = .416), suggestive that these factors may have moderating and/or mediating effects with each other on patient outcomes/medical errors. Thus, their combined relationship to medical errors was explored to answer RQ_{1d} which asks what is the relationship between TMS, individual collaborative IP competence, and medical errors.

Bivariate regression analysis with both TMSI and ICICI as predictor variables was conducted. Results were as follows:

- with time to triage, $F(2, 49) = 2.216$, $p = .12$; $R = .288$, $R^2 = .083$, Adjusted $R^2 = .046$
- with PIA within 1 hour, $F(2, 50) = 3.084$, $p = .055$, $R = .331$, $R^2 = .110$, Adjusted $R^2 = .074$
- with PIA within 3 hours, $F(2, 50) = .269$, $p = .77$, $R = .103$, $R^2 = .011$; Adjusted $R^2 = -.029$
- with time to diagnostics or laboratory, $F(2, 46) = .662$, $p = .52$, $R = .167$, $R^2 = .028$, Adjusted $R^2 = -.014$
- with LOS at 2 or 4 hours, $F(2, 50) = 3.736$, $p = .03$, $R = .361$, $R^2 = .130$, Adjusted $R^2 = .095$
- with LOS at 4 or 8 hours, $F(2, 50) = .242$, $p = .79$, $R = .098$, $R^2 = .010$, Adjusted $R^2 = -.030$

The only statistically significant relationship for the combined effect of TMSI and ICICI was found with LOS at 2 and 4 hours. However, when controlling for patient acuity (i.e., CTAS levels) and patient volumes, ICICI exhibited a mediating effect on TMSI whereby the relationship between TMSI and PIA within 1 hour became statistically significant ($F(8, 52) = 1.618$, $p = .05$, $R^2 = .976$, Adjusted $R^2 = .695$). In contrast, the statistically significant relationship between ICICI as the only predictor and PIA within 1 hour ($F(1, 51) = 6.103$, $p = .02$) became no longer statistically significant ($p = .20$); and the p value of ICICI with LOS at 2 or 4 hours ($F(1, 51) = 7.005$, $p = .01$) decreased ($F(1, 50) = 3.736$, $p = .03$). Thus, there were statistically significant relationships between TMSI and ICICI and medical errors, and the combined predictive usefulness of both TMSI and ICICI increased. Thus, $H0_{1d}$ was rejected and HA_{1d} accepted.

Controlling for Patient Acuity Levels and Patient Volumes

Patient acuity levels were identified as potential confounding variables in the relationship between TMS, individual collaborative IP competence, and medical errors. Their potential effects were analyzed using statistical measures.

RQ_{1e}: Team Membership Stability and Medical Errors While Controlling for Patient Acuity Levels (CTAS) and Patient Volumes

Teams were defined by IP core team members who worked together during 4-hour intervals. Patient acuity levels were measured using CTAS means for each 4-hour time interval and patient volumes as the number of patients who registered during these 4-hour time periods. GLM was used to statistically control for the potential confounding effects from these variables between TMS and patient outcomes.

When controlling for both CTAS levels and patient volumes, the results were as follows:

- TMSI and time to triage, $F(40, 52) = .859$, $p = .66$, $R^2 = .795$, Adjusted $R^2 = .067$
- TMSI and time to PIA within 1 hour, $F(40, 52) = .700$, $p = .80$, $R^2 = .772$, Adjusted $R^2 = -.183$
- TMSI and time to PIA within 3 hours, $F(40, 52) = 1.869$, $p = .15$, $R^2 = .911$, Adjusted $R^2 = .538$
- TMSI and time to diagnostics or laboratory, $F(39, 48) = .765$, $p = .73$, $R^2 = .848$, Adjusted $R^2 = -.042$
- TMSI and LOS at 2 and 4 hours, $F(40, 52) = 1.115$, $p = .46$, $R^2 = .826$, Adjusted $R^2 = .093$
- TMSI and LOS at 4 and 8 hours, $F(40, 52) = 1.894$, $p = .14$, $R^2 = .884$, Adjusted $R^2 = .399$

As can be seen, no statistically significant relationships were found between TMSI and patient outcomes when controlling for CTAS levels and patient volumes. Thus, $H0_{1e}$ was accepted in that there was no statistically significant relationship between TMS and medical errors. However, statistically significant relationships were found between the CTAS means and time to nurse triage ($F(1, 52) = 10.313$, $p = .009$), time to PIA within 1 hour ($F(1, 52) = 5.423$, $p = .04$), and time to PIA within 3 hours ($F(1, 52) = 10.574$, $p = .009$). Therefore, patients' levels of acuity were positively related to the time for patients to be triaged and seen by a physician/alternate.

RQ$_{1f}$: Individual Collaborative IP Competence and Medical Errors While Controlling for Patient Acuity Levels (CTAS) and Patient Volumes

GLM was also used to assess the relationship between individual collaborative IP competence (using ICICI) and medical errors while controlling for possible confounding effects of patient acuity levels (using CTAS) and number of patients who registered (i.e., volume) during each 4-hour interval (which defined the team). The results were as follows:

- ICICI and time to triage, $F(37, 51) = .868$, $p = .65$, $R^2 = .737$, Adjusted $R^2 = .120$
- ICICI and time to PIA within 1 hour, $F(37, 52) = 1.563$, $p = .795$, $R^2 = .841$, Adjusted $R^2 = .365$
- ICICI and time to PIA within 3 hours, $F(37, 52) = 1.240$, $p = .35$, $R^2 = .834$, Adjusted $R^2 = .335$
- ICICI and time to diagnostics or laboratory, $F(36, 48) = .604$, $p = .87$, $R^2 = .748$, Adjusted $R^2 = -.209$
- ICICI and LOS at 2 and 4 hours, $F(37, 52) = 2.059$, $p = .08$, $R^2 = .861$, Adjusted $R^2 = .445$
- ICICI and LOS at 4 and 8 hours, $F(37, 52) = 1.484$, $p = .23$, $R^2 = .810$, Adjusted $R^2 = .240$

As can be seen, no statistically significant relationships were found. Thus, $H0_{1f}$ was accepted whereby there was no statistically significant relationship between individual collaborative IP competence and medical errors when controlling for patients' levels of acuity and patient volumes.

Similarly as reported above in relation to TMSI, statistically significant relationships were found between CTAS levels and time to PIA within 1 hour ($F(1, 52) = 12.340$, $p = .004$) and time to PIA within 3 hours ($F(1, 52) = 10.760$, $p = .006$). In contrast, the relationship between CTAS and time to triage was not statistically significant but a statistically significant relationship was found between patient volume and time to PIA within 3 hours ($F(1, 52) = 7.713$,

p = .02), with LOS at 2 or 4 hours (F(1, 52) = 7.198, p = .02), and with LOS at 4 or 8 hours (F(1, 52) = 5.774, p = .03.).

Team Size

Since team sizes varied (ranged from 4 to 12 members) during each 4-hour interval (which defined the team), and its effect as a confounding variable to TMSI and medical errors was statistically controlled. A GLM was used to assess these relationships and to answer RQ_{1g} which asks what is the relationship between TMS and medical errors when controlling for the confounding variable of team size?

When controlling for team size, the results were as follows:

- TMSI and time to triage, F(40, 51) = .635, p = .85, R^2 = .719, Adjusted R^2 = .435
- TMSI and average time to PIA, F(40, 12) = 3.218, p = .03, R^2 = .929, Adjusted R^2 = .638
- TMSI and time to PIA within 1 hour, F(40, 52) = .584, p = .89, R^2 = .694, Adjusted R^2 = .446
- TMSI and time to PIA within 3 hours, F(40, 52) = 1.124, p = .44, R^2 = .805, Adjusted R^2 = .08
- TMSI and time to diagnostics or lab, F(39, 48) = .819, p = .69, R^2 = .800, Adjusted R^2 = -.201
- TMSI and LOS at 2 and 4 hours, F(40, 52) = 1.927, p = .12, R^2 = .876, Adjusted R^2 = .412
- TMSI and LOS at 4 and 8 hours, F(40, 52) = 2.051, p = .10, R^2 = .883, Adjusted R^2 = .447

As can be seen, a statistically significant relationship was found between TMS and the average times to PIA for each time interval/core team. Thus, $H0_{1g}$ was rejected and HA_{1g}, the alternate hypothesis, accepted. That is, there was a statistically significant relationship between TMS and medical errors when controlling for the effects from team size.

Summary

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. The RQ was: What is the relationship between the frequency of IP core team members working together due to shiftwork schedules (i.e., IP TMS), individual collaborative IP competence, CTC; and medical errors? To explore possible relationships amongst the variables, the RQ was subdivided into seven other RQs. The data source to measure medical errors were EDIS reports. TMS and the experience component of individual collaborative IP competence were quantified from deidentified worked schedules. CTC was based on the ratings on the CTCQ.

Fifteen EDs were eligible to participate. From these eligible EDs, five EDs approved to have their sites participate in this study. This represented a 33% response rate. Data collection occurred concurrently over a 72-hour period in October and November 2020. Survey responses were received from four EDs, EDIS data was received from three, and usable deidentified worked schedules from two.

Medical errors selected related to delays in care. These included assessing time to nurse triage, time to PIA, time to diagnostics/laboratory, LOS, and patients who registered but LWBS by a physician/alternate. Medical errors did occur at the three EDs that provided EDIS data but the degree to which the targets were met varied between sites. For example, all patients presenting to an ED should be triaged within 15 minutes (Bullard et al., 2017). However, 93% of patients were triaged within 15 minutes at one ED, about 2/3 at another, and at the third ED, during October 2020, 76% of patients were triaged within 15 minutes but this decreased to 36% in November 2020. Differences between EDs were also noted for the other measures of medical errors.

ED core teams were defined based on who worked together during 4-hour time interval throughout the data collection periods. TMS was defined by how frequently these IP core team members worked together during 3 months preceding to data collection periods. Different numbers of core team members worked together during these 3months but at no time did all core team members work together. For statistical analysis, a TSMI was calculated. There were no statistically significant relationships between TMS and medical errors/delays to care.

Individual collaborative IP competence was to be assessed based on formal education, participation in IP education, and professional experience reported in the staff surveys. However, insufficient number of surveys were received to enable inferential statistical analyses. Thus, professional experience was defined based on the frequency of shifts worked by each IP core team member during the 3 months preceding data collection, translated into an ICICI for each core team. A statistically significant relationship was found between ICICI and PIA within 1 hour and with LOS for patients discharged within 2 or 4 hours depending on their acuity (i.e., CTAS) levels.

Survey data was also required to quantify CTC, containing the CTCQ. Although the number of completed surveys did not meet the sampling threshold, the mean ratings on the CTCQ from 15 participants ranged from 4.08 to 4.59 out of 5. This indicated that ED care providers perceived their teams to possess a high level of CTC competence. However, what the relationship between CTC and medical errors (RQ_{1C}) remains untested and unanswered.

Moderating and mediating effects between the TMSI and ICICI as predictor variables was also assessed. The only statistically significant relationship for their combined effect was found with LOS at 2 or 4 hours. However, when controlling for patient acuity and volumes, ICICI exhibited a mediating effect on TMSI whereby the relationship between TMSI and PIA within 1 hour became statistically significant (p = .05). In contrast, the statistically significant relationship between ICICI as the only predictor and PIA within 1 hour changed from being statistically significant to no longer being significant; and between ICICI and LOS at 2 or 4 hours, the p level decreased from p = .01 to p = .03. Thus, TMSI and ICICI did have interactive effects on medical errors.

Patient acuity (based on CTAS) levels and volumes were considered confounding variables and their potential effects were statistically controlled. When controlling for CTAS and volumes, no statistically significant relationships were found between TMS and medical errors, nor between professional experience and medical errors. However, with TMSI as the predictor variable, statistically significant relationships were found between CTAS and time to nurse triage and CTAS with time to PIA. Similarly, with ICICI as the predictor, statistically significant relationships were found between CTAS levels and PIA but not between CTAS and time to triage, and between patient volumes with PIA and LOS.

The last relationship that was assessed involved controlling for team size as a possible confounding variable between TMSI and medical errors. The relationship between TMS and time to PIA (the means of the times to PIA for each core team) was the only statistically significant one.

A summary of descriptive and inferential statistical results has been provided explaining findings related to the relationships between TMS, individual collaborative IP competence, CTC, and medical errors. Delays in care did occur at three EDs but to different degrees. The RQ was divided into seven sub-RQs. In answer to these questions, four null hypotheses and two alternate hypotheses were accepted, with one remaining untested and unanswered. The interpretation of these findings follows in Chapter 5.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to explore the relationship between IP TMS, individual collaborative IP competence, CTC, and medical errors as patient outcomes in EDs. A quantitative, cross-sectional, correlational research method was used to explore the relationship between these variables.

This study was conducted because medical errors continue to occur (Makary & Daniel, 2016), and teamwork failures have been identified as causing 70% to 80% of serious medical errors (Mayo & Woolley, 2016). Boreham (2000) asserted that teamwork failures in EDs occur from lack of collective competence but that individual and collective competence are constitutive in mitigating errors. One element identified that undermines effective teamwork is instability in team membership (Ulrich & Crider, 2017) and shiftwork schedules introduce instability in the membership of ED core teams.

Collective competence is work-related competence, developed through group processes (Boreham, 2004). Thus, opportunities to develop CTC also require working with others, sharing ideas, and engaging in collective action in providing a service (D'Amour et al., 2005). Therefore, because IP teamwork failures have continued to cause medical errors, the relationship between IP TMS, individual collaborative IP competence, CTC, and IP team effectiveness required further exploration. This study addressed this gap in the literature.

Because reported medical errors include delays in initiating treatment (Carlson, 2016; IOM/NAM, 2000) and system errors (such as extended LOS; Dolejs et al. 2017; Eriksson et al., 2018), I focused on delays to care while controlling for patients' acuity levels (complexity of patient care needs) and volumes (workload). CAEP indicators (see Affleck et al., 2013; Bullard et al., 2017) set as benchmarks that defined what constituted delays in care. Using deidentified worked schedules that preceded data collection periods to define TMS and individual collaborative IP competence (predictors), temporal order in relation to medical errors (outcomes) was established. This priori reason was used to define unidirectional influence between the predictor and outcome variables. Thus, regression analysis was selected as the most appropriate for inferential data analysis of the relationships between these variables.

Based on indicators set by CAEP, medical errors defined based on delays to care did occur at all three participating EDs, but the number of patients at risk differed. For example, only 7% of patients were not triaged within 15 minutes at ED2, ⅓ at ED3, but for ED1, 24% were not triaged in October and increased to 64% in November 2020. Furthermore, ED2 and ED3 met the time to PIA and LOS targets, but the time to diagnostics/laboratory within 2 hours was unmet at all three EDs.

IP core team members who worked together during 4-hour intervals in eligible EDs throughout the data collection periods defined the IP core teams. Based on deidentified worked schedules provided by the EDs, there were 54 teams. Team sizes ranged from four to 12 members, and the most common were teams of eight, representing 22% of the 54 teams.

The frequency that these IP core team members worked together in participating EDs during 3 months preceding data collection defined the stability of the teams. During these preceding 3-month periods, at no time did all of the IP core team members work together. Furthermore, team compositions also changed within the 4-hour time intervals that defined the IP core team. These findings reflected low temporal stability with frequent changes in membership (see Lee et al., 2015). A calculated TMSI quantified the membership stability of each team. Using TMSI, the relationship between TMS and medical errors was not statistically significant.

That is, low temporal stability based on 3 months of interactions with frequent changes in membership due to shiftwork schedules did not translate to statistically significant delays in patient care within the ED environments.

Individualistic and collectivistic ways of construing competence are mutually constitutive (Boreham, 2004). Individual collaborative IP competence was to be based on formal education, IPE, and worked experience. However, due to poor survey response rates, individual competence was based on individual worked experience – that is, the number of shifts each member of the IP core teams had worked during a 3-month period prior to data collection. This frequency of worked shifts for each team member was translated to a team competence index, the ICICI. The individual worked experience team index was positively related to decreasing medical errors related to PIA and LOS, which rendered individual professional competence based on experience from frequency of working an important element in eliminating medical errors in EDs.

The CTCQ captured Boreham's (2004) descriptions of CCT's three normative principles (i.e., a collective sense of workplace events, a collective knowledge base, and interdependency). As a component of the survey, the CTCQ was made available for ED IP core team members to complete. Survey responses were insufficient to conduct inferential statistical analyses but, based on 15 responses, the participants perceived high levels of CTC in their workplaces.

A statistically significant relationship existed between TMSI and ICICI, and moderating effects between these predictors were tested. In their relationship with medical errors, ICICI's interaction with TMSI was positive while TMSI had a negative moderating effect on ICICI. Based on findings from past researchers, a plausible explanation for the negative moderating effects between TMSI and ICICI was posited. That is, higher TMS probably existed from a long history of consistently working together (see Hollenbeck et al., 2012) that was not captured by the TMSI. Team cohesion is a by-product of a long work history (Kumar, 2009; Mathieu et al., 2015), and highly cohesive teams are also at risk of groupthink and collective failures (Gardiner & Chater, 2013; Kaba et al., 2016; Schmidt, 2021). Thus, if cohesive IP core teams existed in the sampled EDs, the most plausible explanation for why TMS would negatively interact with individual worked experience was the existence of groupthink leading to collective failures.

Variables occurring naturally in social situations are not amenable to classical research but can have the potential to generate plausible alternative hypotheses as confounders (Campbell & Stanley, 1963; Frankfort-Nachmias & Nachmias, 2008; Warner, 2013). Thus, because patient acuity levels and volumes were naturally occurring events subject to ethical constraints, their influences on the relationship between TMSI, ICICI, and patient outcomes were statistically controlled. When controlling for these confounding variables, no statistically significant relationship existed between TMSI and medical errors, nor between ICICI and medical errors. These findings were consistent with those reported by Driesen et al. (2018), Rice (2016), and von Thiele Schwarz et al. (2016) whereby patients' levels of acuity and volumes do contribute to delays in care.

Team size was also considered a confounding variable for TMS and medical errors. When controlling for team size, the relationship between TMSI and the means of the times to PIA for the core teams was statistically significant. That is, as team size increased, so did the means of time to physician/alternate. Thus, smaller teams may perform better (see Thompson et al., 2015).

Limitations to generalizability of the results from this study exist. Sources of limitations were identified as

- the advent of COVID-19 pandemic, believed to impact organizational responses to requests for participation as well as remaining in the study
- new CTCQ
- below sampling survey response rates, which resulted in re-defining measurements of individual collaborative IP competence and excluding CTC from inferential analyses
- core team characteristics
- studying distinct elements of teamwork within a complex adaptive environment
- personal biases and possibly faulty interpretation of results as a novice researcher.

These factors limited the generalizability of the results to rural EDs in MB, Canada, and to IP teams with low temporal stability consisting of nurses and medical doctors.

Researchers identified TMS as a key factor in the effectiveness of teamwork (e.g., Bareil et al., 2015; Joshi et al., 2018; He & Zheng, 2016; Lee et al., 2015). Kaba et al. (2016) challenged researchers to use patient-centered performance measures and not process outcomes to evaluate teamwork interventions. In this study, I used patient outcomes, but only 3 months' data defined TMS, and the teams had low temporal stability. Thus, to further test if promoting TMS is a valid intervention in maximizing patient safety, conducting a prospective study that compares patient outcomes across teams with low, moderate, and high temporal stability would provide further patient-centered evidence specific to this factor. Furthermore, because previous studies informed by CCT were qualitative and the generalizability of their findings were limited, and due to poor survey responses in this study, the validity of CCT as the theoretical underpinning for studying patient safety remains unanswered and further quantitative research is recommended.

The findings from this study are important. The results allude to the importance of individual competence from work experience as more relevant than team stability in decreasing delays to care within rural ED environments. Thus, ED direct care providers can benefit through an increased understanding that working within teams with low temporal stability should not impede their success at promoting patient safety. However, a negative moderating effect of TMS on individual competence based on work experience was noted, attributed to cohesive IP core teams that resulted from a long history of team members consistently working together (see Hollenbeck et al., 2012), and highly cohesive teams are at the greatest risk for groupthink (Kaba et al., 2016; Schmidt, 2021). Thus, ED direct care providers and managers/administrators should be motivated to increase their understanding of the perils associated with groupthink that can lead to collective failures. In addition, identifying the point at which increasing the number of staff no longer results in positive patient and staff outcomes (ceiling effect for team size) may translate into greater efficiencies. Furthermore, evidence from other researchers (e.g. de Beijer et al. 2016; Gauss & Cook, 2017) supported that standardized HCS policies, guidelines, and processes can strengthen collective knowledge at the organizational level, resulting in a more responsive and effective HCS, improving quality of ED patient care, and rendering it safer, more accessible, comprehensive, coordinated, and patient-centered.

Interpretation of the Findings

Medical errors defined based on delays to care did occur at all three participating EDs, but the number of patients at risk differed. For example, CAEP set time to nurse triage at 15 minutes for all patients presenting to EDs, irrespective of their levels of acuity (Affleck et al., 2017). Of the three EDs that provided EDIS data, none met this target for all patients. This finding was consistent with reports across Canada, whereby very few hospitals are able to meet the target of 15 minutes for all patients (Affleck et al., 2017). However, differences existed between EDs as to degree to which they met this time to triage target.

In October and November 2020, 93% of patients at ED2 and 2/3 of patients at ED3 were triaged within 15 minutes. At ED1, 76% of patients were triaged within 15 minutes in October and 36% in November 2020 (a 40% decrease). Dadashzadeh et al. (2011) identified three main causes for delays in time to triage as nursing shortages, large number of patients, and a shortage of medical staff. Similarly, Houston et al. (2015) reported that frequently patients waited more than 10 minutes prior to being triaged and that time to triage increased based on the number of patients who presented within the previous hour (from 12.4% when 0 to 5 new patients presented to 68% when more than 16 arrived). Furthermore, overcapacity situations extended time to initial nurse assessments (Boreham et al., 2000; Chiu et al., 2018; Freund et al., 2015; Källberg et al., 2015). However, patient volumes and triage CTAS levels were similar during the two data collection periods at ED1. That is, in October, 118 patients registered, 68 of whom were triaged as CTAS levels I-III and 50 of whom were triaged as CTAS IV-V; in November, 120 patients registered, of whom 71 were triaged as CTAS levels I-III and 48 of whom were triaged as CTAS IV-V (one patient did not have a CTAS level). Team size data were not available for comparison for November 2020. Thus, what is unknown is if the ED or the rest of the hospital was experiencing nursing and physician shortages or was in overcapacity situation. That is, ED processes are inextricably connected to the rest of the hospital and other external healthcare resources (Nugus et al., 2010). Therefore, system factors may have had negative repercussive effects on time to triage in November 2020. Irrespective of the root cause of the delay, bottlenecks at triage are expected to increase the triage nurse's workload and to create crowding in the waiting room with delays in patients receiving appropriate care (Pryce, 2021).

Delays in care based on CAEP's targets (see Affleck et al., 2013; Bullard et al., 2017) occurred at ED1 in relation to time to PIA, and LOS for patients discharged or admitted to inpatient hospital units. In contrast, patients experienced delays in time-to-diagnostics or laboratory tests beyond the 2 hours at all three EDs but in greater numbers at ED1. Within ED2 and ED3, the length of time increased as the number of tests ordered increased but not for ED1. Irrespectively, although delays to diagnostics/laboratory did occur at all three EDs, ED2 and ED3 met the PIA and LOS targets. This finding is suggestive that time to diagnostics is not a factor in ED patients LOS. Furthermore, over a 3-day period in October and November, seven and four patients respectively LWBS at ED3, and 34 LWBS in November at ED1. WTRTF (2017) linked patients who LWBS to longer wait times to PIA. Extended LOS and LWBS could place these patients at risk for adverse events (Carlson, 2016; Linnebur et al., 2018; WTRTF, 2017).

Team Membership Stability and Medical Errors

Ulrich and Crider (2017) reported that instability in team membership was one element that could undermine effective teamwork. TMS is the extent to which the same team members consistently interact together to achieve shared goals (Ulrich & Crider, 2017) and the "degree to which team members have a history of working together in the past and an expectation of working together in the future" (Hollenbeck et al., 2012, p. 84). For this study, IP core team members who worked together during 4-hour intervals in eligible EDs throughout the data collection periods defined the teams. Based on Finnesgard et al.'s (2018) assertion that increased frequency of working together increased team member familiarity and, from Bandura (1971) and Boreham (2000), that functional relationships develop through repeated interactions, the frequency that these IP core team members worked together in participating EDs during 3 months preceding data collection defined the stability of the teams. Based on the frequency that IP core team members worked together during a 3-month period preceding data collection, a calculated TMSI quantified the membership stability of each team. The process used for calculating the TMSI was informed by that used by Hysong et al. (2019) to quantify team network characteristics, how Lee et al. (2015) developed the TDI, and similarly the method adopted by Scott et al. (2020) to generate their team stability index in relation to turnover. Since teamwork failures were identified as causing serious medical errors (Mayo & Woolley, 2016), TMSI enabled the analyses of the relationships between TMS and medical errors.

Based on usable deidentified worked schedules provided by the EDs, there were 54 teams. Team sizes ranged from four to 12 members, and the most common were teams of eight, representing 22% of the 54 teams. Different combinations and frequencies of the number of core team members who worked together during the preceding 3 months existed (e.g., two members worked together 33 times, three team members worked together 17 times, etc.). However, at no time did all members of the core teams work together during these preceding 3-month periods. Furthermore, team compositions also changed within the 4-hour time intervals. These findings reflected low temporal stability with frequent changes in membership (see Lee et al., 2015). Nonetheless, using TMSI, the relationship between TMS and medical errors was not statistically significant.

Based on past research results, these findings were unexpected. For example, Buljac et al. (2013) identified stable core team memberships as a requirement for effective IP collaborative practice, and Finnesgard et al. (2018) reported that a change of one surgical team member resulted in longer operating room times. New members joining existing teams were hesitant in contributing (O’Leary, 2016) and their acceptance was not automatic, unconditional, or implied

(Coyle & Gill, 2017). However, delays in care beginning as early as during the triage process occurred when a lack of routines existed (Källberg, et al., 2015), and clinical pathways had been linked to improved communication and collaborative problem-solving skills (de Beijer et al. 2016). Thus, these current results possibly reflected the existence of structured processes at the participating EDs, reflective of a collective knowledge base at the organizational level (see Boreham, 2004) that buffered the low TMS.

Collective knowledge is a component of organizational capacity that endures when membership changes (Boreham, 2004). For example, clinical pathways were beneficial for IP teams (de Beijer et al., 2016) and, when a crisis/disaster outstripped resources at Ringerike hospital, the hospital was resilient. Gauss and Cook (2017) attributed this resiliency to repeated collective learning and training, which translated into collective knowledge, competence, and structure. Alternatively, since only 3-months of interactions amongst the core team members informed the TMSI, these results may indicate that the teams had a long history of consistently working together (see Hollenbeck et al., 2012; Ulrich & Crider, 2017) not captured by the TMSI. Furthermore, only two professions composed the IP teams at the participating EDs, providing insufficient variability in team membership composition to generate data for valid regression analyses outputs. Nonetheless, low temporal stability based on 3 months of interactions with frequent changes in membership due to shiftwork schedules did not translate to statistically significant delays in patient care within the ED environment.

Individual Collaborative IP Competence and Medical Errors

According to Boreham (2004), individualistic and collectivistic ways of construing competence are mutually constitutive. Thus, with this study, I attempted to measure both of these competencies with the lens of IP collaboration. Formal education, participation in IPE, and professional experience were to define individual collaborative IP competence. Formal education was necessary to meet professional competence to practice for licensure through respective colleges. IPE was reported to be successful in increasing knowledge at an individual level (Ferrie & Sturrock, 2017; Goolsarran et al., 2018; Tsai et al., 2016) and as shared and distributed across members (He & Zheng, 2016; James et al., 2016). For example, IPE using simulations was reported to promote knowledge retention and to enhance teamwork skills (George, 2018), providing the forum for participants to learn how to work together as a team (Egenberg, Karlson, et al., 2017). IPE also promoted confidence for nurses and doctors (Brewster et al., 2017). However, it was professional experience that increased competency through opportunities to apply and integrate knowledge, and repetition in responding to patient care needs (Bari et al., 2016; Freund et al., 2015). The staff survey included questions to capture formal education, participation in IPE, and professional experience.

The survey response was poor, providing insufficient data for further analysis. However, information about team members' professional designation was captured on the deidentified worked schedules. Because IPE was not always successful in achieving learning and patient outcomes (see Egenberg, Oian, et al., 2017; Ginsburg & Bain, 2017; Goolsarran et al., 2018; Grymore et al., 2016; Lochner et al., 2018), the focus for evaluating the relationship between individual collaborative IP competence and patient outcomes changed and centered only on professional experience. This element was redefined and quantified based on how frequently each IP core team member had worked during the 3 months preceding data collection periods. The data from the deidentified worked schedules was translated into the IP core team's ICICI.

Through regression analysis, statistically significant relationships were found between ICICI and time to PIA within 1 hour, and with LOS for patients who were triaged CTAS levels

IV-V discharged within 2 hours and those who were triaged as CTAS levels I-III and discharged within 4 hours. These times were not indicative of delay but met the CAEP indicators for safe ED care (see Affleck et al., 2013; Bullard et al., 2017). Thus, individual worked experience during a 3-month period positively related to decreasing medical errors related to PIA and LOS, which rendered individual professional competence based on the frequency of working an important element in eliminating medical errors in EDs.

Faulty knowledge is one source of cognitive errors (Okafor et al., 2016). Thus, a minimum set of competencies are required to deliver safe emergency patient care (CAEP, 2017; CWG, 2017; McEwen et al., 2018). Also, licensing organizations hold healthcare professionals accountable to maintain their individual professional competence as a means to protect the public (e.g., College of Registered Nurses of Manitoba, 2019). However, medical errors occur even when care is provided by competent health care providers (IOM/NAM, 2000).

A team approach, where one or more providers were involved in decision making, was associated with decreased incidences of medical errors (Freund et al., 2015; Graber et al., 2017; Thomas & Newman-Toker, 2016). However, Zabar et al. (2016) reported that IP collaboration is not significantly related to core clinical skills. Thus, developing or maintaining core clinical knowledge and skills may benefit from worked experience. That is, because individuals learn from direct experience (Bandura, 1971), the more frequently the ED nurses and doctors worked during the 3 months periods, the more opportunities they would have to learn and maintain clinical knowledge and skills. Thus, these current and past research results lend credence to Boreham (2004) assertion that individualistic and collectivistic ways of construing competence are mutually constitutive, needed to eliminate medical errors.

Collective Team Competence and Medical Errors

No quantitative measuring instrument of CTC was located. Similar to other researchers (e.g., Hysong et al., 2015), a deductive process from theory to scale development was used to identify scale items to measure collective competence. Thus, the CTCQ was developed based on Boreham's (2004) descriptions of collective competence's three normative principles (i.e., a collective sense of workplace events, a collective knowledge base, and interdependency). Since subjective perception (and not objective measures) of workload was found to be significantly related to the incidence of adverse events (Abadi et al., 2017), subjective reports of perceived CTC were viewed as appropriate and valid.

The CTCQ was a component of a survey that ED core team members were invited to complete during the data collection periods. Participants were asked to rate 49 items to reflect their perceived experiences of CTC during their worked shift. Their responses on the CTCQ provided a measure of their perceived CTC.

Sixteen surveys were completed in four EDs but only seven during the actual data collection periods. This response rate was insufficient to test statistically the relationship between CTC and patient outcomes. However, CTCQ means ranged from 4.08 to 4.59 out of 5, reflective of perceived high levels of CTC at these participating EDs.

Hager and Johnsson (2009a, 2009b), Hedjazi (2018), and Arnaud and Mills (2012) provided evidence in support of collective competence normative principles being present in differing work environments. However, Hager and Johnsson (2009a) reported improvement in performance resulted from team-based practice. Furthermore, newly formed teams generated practical solutions and developed relationships between members by working together (Hager &

Johnsson, 2009b). These research findings speak to the need for TMS to develop collective competence.

Within the core participating ED teams (defined as IP core team members who worked together during 4-hour intervals), membership changed at least every 8 hours and even within the 4-hour interval. Although shifting team membership changes the focus of sense making (Fox, 2015) and in spite of low temporal stability, the ratings on the CTCQ suggested high collective competence. Thus, if TMS is the “degree to which team members have a history of working together in the past and an expectation of working together in the future” (Hollenbeck et al. 2012, p. 84), an explanation for the perceived high collective competence may be that sufficient members of the core team shared a long history of working together not captured by the 3 months of worked schedules.

Team Membership Stability, Individual Collaborative IP Competence, and Medical Errors

No statistically significant relationships were found between TMSI as a single predictor and medical errors but the relationship between ICICI (the combined individual worked experience over 3 months) as an individual predictor was statistically significant with PIA within 1 hour and LOS at 2 and 4 hours based on CTAS levels (the CAEP indicators). Since the frequency of working within the 3-month period preceding data collection was used to generate both TMSI and ICICI, a fairly strong correlation between TMS individual worked experience of the team was expected and statistically confirmed. The correlation between the TMSI and ICICI was moderate.

CCT identifies individual and collective competence as constitutive (Boreham, 2004) and in combination with the moderate correlation between TMSI and ICICI, these factors were assessed as possibly having moderating effects with each other on patient outcomes/medical errors. That is, both elements of competence are needed to eliminate medical errors. Since direct interactions among team members is required to increase team familiarity and effectiveness (Finnesgard et al., 2018; Joshi et al., 2018), and for CTC to develop (Boreham, 2004), the expectation was that the predictive strength of TMSI and ICICI on medical errors would increase, decreasing delays to care and LOS. Thus, testing for moderating effects occurred.

A statistically significant relationship existed between TMSI and ICICI with LOS at 2 and 4 hours depending on the CTAS levels. However, the p value for the association of ICICI with LOS at 2 and 4 hours was $p = .02$ and increased to $p = .03$ when combined with TMSI (i.e., the level of statistical significance decreased). Thus, the statistically significant relationship with LOS resided with ICICI and not TMSI. Furthermore, TMSI had a negative moderating effect on the IP core teams' individual competence based on individual worked experience. In contrast, when controlling for patient acuity (CTAS levels) and volumes, ICICI exhibited a positive moderating effect on TMSI. That is, the relationship between TMSI and PIA within 1 hour became statistically significant. Furthermore, the effect size of TMSI as a single predictor of PIA within 1 hour was small but, in combination with ICICI and controlling for CTAS levels and volume, the effect size increased to large, resulting in a statistically significant relationship. Therefore, TMSI had a negative moderating effect on ICICI while ICICI's interaction with TMSI was positive in their relationship with medical errors. That is, TMS decreased the positive effect that individual care provider worked experience had on PIA and on the amount of time patients remained in the EDs prior to discharge. Conversely, when controlling for patient acuity and volume, individual worked experience increased the effect size that TMS had on PIA, which was the time to initial assessment by a physician/alternate. Because CCT identifies individual and collective competence as constitutive (Boreham, 2004), the negative mediating effect between

TMS on the relationship between individual competence from worked experience and medical errors was unexpected and counter-intuitive.

Possible explanations for the negative mediating effect of TMS on individual worked experience were sought from the evidence located within the literature reviewed. For example, Grover et al. (2017) found that teamwork failed with inadequate resources and skills mix and the IP core team membership at the participating EDs consisted of physicians and nurses only, which could indicate an inadequate staff mix. However, TMSI and ICICI were not specific to team membership composition. Similarly, within the context of group consciousness, situational awareness, and shared team goals, Cuvelier and Falzon (2014) reported that in an effort to manage workload, a trade off at the individual level occurs between understanding the situation and acting within it. However, based on the data collected, this possibility could not be confirmed or disconfirmed.

From a different perspective, O'Leary (2016) reported that when psychological safety exists, participants experience trust and mutual respect, freeing them to take emotional risks, such as admitting knowledge deficits. But, when distrust is present, professionals ignore their own knowledge and expertise, and do not speak up (Pype et al., 2018). Thus, increases in temporal stability should have translated into more opportunities to build trust and team cohesion, decreasing the number of individuals ignoring their own knowledge and expertise, improving patient outcomes and system efficiency (see Gordon et al., 2017). However, the TMSI was based only 3-months of interactions amongst the IP core team members and the TMSI as a single independent variable was not predictive of medical errors. Thus, I inferred that TMS existed as a by-product of a long history of consistently working together (see Hollenbeck et al., 2012; Ulrich & Crider, 2017) not captured by the TMSI.

The amount of time in a team was one factor that enhances the development of team cohesion, associated with better team performance and patient outcomes (Kumar, 2009; Mathieu et al., 2015; Thompson et al., 2015). However, highly cohesive teams are also at risk of groupthink (Kaba et al., 2016). Groupthink occurs when individuals in a cohesive group strive for conformity, unanimity and consensus, and fail to consider alternatives (Kaba et al., 2016; Schmidt, 2021). Group conformity is associated with incorrect interpretations of physical findings (Kaba et al., 2016). Groupthink and conformity can lead to collective failures. That is, Gardiner and Chater (2013) posited that collective failures result from denying that a problem exists, through pluralistic ignorance by accepting status quo, and/or through diffusion of responsibility. When groupthink is present, team members perceive themselves as being invulnerable, that they cannot be wrong (Schmidt, 2021). When accepting status quo, it can result in no one taking action and diffuses the responsibility for the outcomes across the team (Gardiner & Chater, 2013). Thus, if cohesive IP core teams existed in the sampled EDs, the most plausible explanation for why TMS would negatively interact with individual worked experience is the existence of groupthink leading to collective failure.

Groupthink and collective failures provide a plausible explanation as to why the effect of individual worked experience decreased as TMS increased. That is, if individuals were striving for conformity, unanimity, and consensus, and irrespective of their competency, they did not offer alternatives for consideration, this could lead to collective failures. If groupthink did occur within this study, it would explain why TMS negatively interacted with worked experience.

Controlling for Patients Levels of Acuity and Volumes

Confounding factors have the potential to generate plausible alternative hypotheses (Campbell & Stanley, 1963; Warner, 2013). However, due to ethical constraints (e.g., denying access to care), the study of variables occurring in social situations are not amenable to classical research designs and eliminating confounding variable may not be possible (Campbell & Stanley, 1963; Frankfort-Nachmias & Nachmias, 2008). Thus, since patient acuity levels and volumes are naturally occurring events subject to ethical constraints, their influences on the relationship between TMSI, individual experience (i.e., ICICI), and patient outcomes were statistically controlled.

Levels of acuity for patients presenting to EDs in MB, Canada were quantified using CTAS levels, ranging from Level I as the most acute to Level V as the least. Patient volumes consisted of the number of patients registered and accessing care. When controlling for CTAS levels and patient volumes, no statistically significant relationship existed between TMSI and medical errors; nor between ICICI and medical errors. Thus, the relationship between TMS captured with the TMSI and medical errors remained unchanged. However, the level of individual worked experience as captured by ICICI had a statistically significant relationship with PIA and LOS. This relationship changed when controlling for patients' level of acuity and volumes. Thus, statistical analyses provided the means to control for the effects of CTAS levels and patient volumes as potential confounding factors, and there was a change in the relationship between one predictor (i.e., ICICI) with two outcome variables. This result indicated that neither TMSI nor ICICI were statistically significant predictors of delays to care in EDs.

Mixed findings were located in the literature in relation to the role that patients' levels of acuity and volumes have on medical errors. For example, Zhang et al. (2017) reported that patients triaged at higher acuity levels experienced fewer medical errors and adverse events. In contrast, Driesen et al. (2018) reported that patients with more complex needs experienced LOS greater than 6 hours. Furthermore, patient volumes were associated with longer LOS (Dolej et al., 2017; Eriksson et al., 2018; Flaaten et al., 2017) and wait times increased as patient volumes rose (Rice, 2016). von Thiele Schwarz et al. (2016) also reported that the volumes of patients are significantly higher on low throughput days. However, Georgio et al. (2017) reported that ED LOS and LWBS rates do not change much in spite of increases in volumes and acuity. Based on the findings from this study, patients' levels of acuity and volume were confounding variables, negating the effect that individual experience had on both PIA and LOS. These findings were consistent with those reported by Driesen et al. (2018), Rice (2016), and Schwarz et al. (2016) whereby patients' levels of acuity and volumes do contribute to delays in care.

Controlling for Team Size

ENA (2018) identified patient volumes, levels of acuity, LOS, boarding/holding, and staff skill mix as factors that should inform the optimal number of core team members in EDs. Additionally, the WTRTF (2017) recommended that EDs should staff for the volume and levels of acuity extremes and not the averages. However, Hallas and Petersen (2018) compared caseload measures and having one extra doctor did not have a statistically significant effect on patient flow. Furthermore, Thompson et al. (2015) found that larger teams have greater collective competence but smaller teams develop group cohesion more quickly, which translates to greater performance. Thus, team size was considered another possible confounding variable in the relationship between TMS and medical errors.

Based on the usable deidentified worked schedules provided by the EDs, there were 54 teams. Team sizes ranged from four to 12 members, and the most common were teams of eight, which represented one quarter of the core teams. When team size was statistically controlled, a statistically significant relationship was found between TMS and the means of times to PIA for each time interval, which defined the core teams. This relationship was positively related and the effect size was large. Thus, as the team size increased so did the means of the times to PIA. This finding supported Thompson et al.'s (2015) report that smaller teams perform better; and Hallas and Petersen's (2018) finding that having an extra doctor on a shift does not affect patient flow. However, a balance is required between the optimal number of staff to respond to workload demands, including surge capacity (see WTRTF, 2017), and maintaining the teams small enough to maximize team cohesiveness (see Thompson et al., 2015). Identifying the point at which increasing the number of staff no longer results in positive patient and staff outcomes (the ceiling effect) requires more data/research.

Limitations of the Study

There are limitations to generalizability of the results from this study. The required data sources consisted of EDIS reports to quantify medical errors, deidentified worked schedules to establish TMS, and ED core team surveys to quantify individual collaborative IP competence and CTC.

Due to the advent of the COVID-19 pandemic, engaging in processes requesting organizational approval to participate was deferred from winter to summer 2020. Five organizations approved having their EDs participate, consisting five out of 15 eligible EDs. However, due to challenges organizations encountered in deidentifying worked schedules, two EDs withdrew. The final three EDs were located in rural Manitoba. The deidentified worked schedules received were for medical doctors and nurses. These factors limit generalizability of the results to rural EDs in MB, Canada and to ED teams made up of physicians and nurses.

Survey responses were below sampling threshold. Thus, individual collaborative IP competence was redefined using individual worked experience, which eliminated the analysis of contributions from formal education and IPE in eradicating medical errors in the EDs.

Furthermore, poor survey response resulted in omitting assessing CTC and its relationship to the prevention of medical errors. No generalizations were made based on these surveys.

Measurements of TMS and individual worked experience were based on indexes generated by the frequencies that core team members worked within the 3 months prior to data collection periods. Since there were no times during the 3 months when all members of the core teams had worked together, 3 months may not be a long enough time period to assess these predictors, also limiting the validity of the results.

Lastly, there were limitations in looking at separate elements within a CAS, such as EDs. Kannampallil et al. (2011) maintained that due to the extensive interrelatedness of components within EDs, and the nonlinear response to internal and external environments, studying teamwork in EDs is difficult. Furthermore, ED processes are inextricably connected to the rest of the hospital and other external healthcare resources (Nugus et al., 2010). Thus, although the primary predictor was TMS and discernable other elements were selected for this study, generalizing from linear to complex is limited.

Recommendations

Researchers identified TMS as a key factor in the effectiveness of teamwork (e.g. Bareil et al., 2015; Joshi et al., 2018; He & Zheng, 2016). Kaba et al. (2016) challenged researchers to use patient-centered performance measures and not process outcomes to evaluate teamwork interventions. In this study, I focused on patient outcomes as a function of TMS, independent collaborative IP competence, and CTC. However, 3 months' worth of data defined TMS and at no time during this time interval did all core team members work together. Furthermore, membership also changed during the 4-hour intervals. Thus, these teams had low temporal stability, limiting the utility of the results from this study. However, to further test if TMS is a valid intervention in maximizing patient safety, conducting a prospective study that compares patient outcomes (see Kaba et al., 2016) across teams with low, moderate and high temporal stability would provide further patient-centered evidence specific to this factor.

Burham (2004) and Lingard (2017) argued that effective collaborative IP practice required CTC. Other researchers used CCT to guide their studies (e.g. Arnaud & Mills, 2012; Fox, 2015; Hager & Johnsson, 2009a, b; Hedjazi, 2018; Kitto et al., 2015). However, previous studies informed by CCT were qualitative in nature and generalizability of their findings were limited. In this study, I attempted to measure CTC in relation to patient outcomes but due to poor survey responses, its validity as the theoretical underpinning for studying patient safety remains unanswered. Thus, further quantitative research is recommended.

Implications

The findings from this study are important. Current interventions aimed at improving teamwork lack good quality data and there is substantive evidence that brings to question the utility of collaborative decision-making. Kaba et al. (2016) challenged researchers to use patient-centered performance measures and not process outcomes to evaluate teamwork interventions. In this study, I focused on patient outcomes as a function of TMS, independent collaborative IP competence, and CTC. Understanding these relationships has the potential to promote a positive social change for ED direct care providers, managers, and administrators; and can inform HCS policies and guidelines that ultimately maximize patient safety for those accessing the HCS through EDs.

The results from this study did not support expectations that maximizing TMS was necessary to meet ED performance measures defined by CAEP as indicators for promoting patient safety in EDs (see Affleck et al., 2013; Bullard et al., 2017). The results alluded to the importance of individual competence from work experience as more relevant than team stability in decreasing delays to care within rural ED environments. Thus, ED direct care providers can benefit through an increased understanding that working within teams with low temporal stability should not impede their success at promoting patient safety. However, a negative moderating effect of TMS on individual competence based on work experience was noted, attributed to cohesive IP core teams that resulted from a long history of team members consistently working together (see Hollenbeck et al., 2012). Because highly cohesive teams are at the greatest risk for groupthink (Kaba et al., 2016; Schmidt, 2021), ED direct care providers, managers, and administrators should be motivated to increase their understanding of the perils associated with groupthink that can lead to collective failures. However, because highly cohesive teams are also associated with better team performance and patient outcomes (Kumar, 2009; Mathieu et al., 2015; Thompson et al., 2015) but are at greatest risk for groupthink (Kaba et al., 2016; Schmidt, 2021), implementing strategies at the team level to promote divergent thinking, consulting and questioning each other within a culture of safety should promote interdependency while maintaining a sense of self (see Boreham, 2004).

Patient levels of acuity and volumes did have a confounding effect on the predictor variables (i.e., TMSI and ICICI) and medical errors. This finding supports WTRTF's (2017) recommendation to staff EDs at the 90th percentile. However, when team size was statistically controlled, a statistically significant relationship was found between TMS and PIA. That is, as team size increased so did time to PIA. Because EDs have no control over ebbs and flows, staffing at 90th percentile can generate down time (when ED team members have no patients to care for). Thus, based on the findings from this study, identifying the point at which increasing the number of staff no longer maximizes positive patient outcomes (ceiling effect for team size) may translate into greater organizational efficiencies but not the elimination of all delays to care. Alternatively, HCS continue to staff EDs at the 50th percentile but develop a human resource model that builds capacity to access direct care providers as needed to respond to these patient-related factors of increases/decreases in patient acuity and volume.

This study's results also suggest that the existence of structured processes at the participating EDs was reflective of a collective knowledge base at the organizational level (see Boreham, 2004) that buffered the low TMS. Collective knowledge is a component of organizational capacity that endures when membership changes (Boreham, 2004). Also, Karam et al. (2016) reported that without integration policies, data and information exchange remains poorly developed. Thus, standardized HCS policies, guidelines, and processes reflective of current best practices that strengthen collective knowledge at the organizational level can result in a more responsive and effective HCS, improving quality of ED patient care, rendering it safer, more accessible, comprehensive, coordinated, and patient-centered.

Conclusion

This study addressed a gap in the literature on the relationship between TMS, individual collaborative IP competence, CTC, and medical errors. Increasing knowledge about these relationships was important because medical errors continue to occur (Makary & Daniel, 2016) and teamwork failures were identified as causing 70% to 80% of serious medical errors (Mayo & Woolley, 2016). Medical errors defined based on delays to care did occur at all three participating EDs but the number of patients at risk differed. For example, time to triage within 15 minutes of arrival was met 93% in one ED while it decreased from 76% to 36% at another.

TMS is the extent to which the same team members consistently interact together to achieve shared goals (Ulrich & Crider, 2017), sharing a history and a future expectation of working together (Hollenbeck et al., 2012). Instability in team membership is one element that can undermine effective teamwork (Buljac et al., 2013; Ulrich & Crider, 2017). In this study, I defined ED core teams based on staff who worked together during 4-hour intervals throughout the data collection periods and TMS was defined based on the frequency that IP core team members worked together during a 3-month period prior to data collection. IP core team members at participating EDs consisted of nurses and MDs. At no time during these preceding 3 months did all of the IP core team members work together. Membership also changed during 4-hour intervals used to define the core teams. Thus, these ED core teams exhibited low temporal stability.

The relationship between TMS and medical errors was not statistically significant. Based on past research results, these findings were unexpected. However, since clinical pathways had been linked to improved communication and collaborative problem-solving skills (de Beijer et al. 2016), these current results possibly reflect the existence of structured processes at the participating EDs, reflective of a collective knowledge base at the organizational level (see Boreham, 2004) that buffered the low TMS. Collective knowledge is a component of organizational capacity that endures when team membership changes (Boreham, 2004). Irrespectively, low temporal stability based on 3 months of interactions with frequent changes in membership due to shiftwork schedules did not translate to statistically significant delays in patient care within the ED environment.

The theoretical underpinning for this study was the CCT. This theory describes how individuals and, collectively, groups construe their work-related competence (Boreham, 2004). According to Boreham (2004), individualistic and collectivistic ways are mutually constitutive in construing competence. Data from surveys were needed to measure individual collaborative IP competence and CTC. However, due to a poor survey response rate, individual worked experience during the 3 months preceding data collection was used to define individual collaborative IP competence.

A statistically significant relationship was found between individual worked experience and PIA and LOS, which rendered individual professional competence based on work experience an important element in eliminating medical errors in EDs. Based on the received surveys, the means on the items on the CTCQ reflected perceived high levels of CTC. Thus, if TMS is the "degree to which team members have a history of working together in the past and an expectation of working together in the future" (Hollenbeck et al. 2012, p. 84), an explanation for the perceived high collective competence may be that sufficient members of the core teams shared a long history of working together not captured by the 3 months of worked schedules. Therefore, these current and past results lend credence to Boreham's (2004) assertion that individualistic and collectivistic ways of construing competence are mutually constitutive and both are essential to eliminate medical errors.

TMS was expected to have a positive effect on collective competence. Because individualistic and collectivistic ways of construing competence are mutually constitutive (Boreham, 2004) and a moderate correlation existed between TMSI and ICICI, moderating effects between these two predictors was expected. Moderating effects were present whereby TMS decreased the effect that individual care provider experience had on PIA and on the amount of time patients remained in the EDs prior to discharge. Conversely, when controlling for patient acuity and volume, individual worked experience increased the effect size that TMS had on PIA, the initial assessment by a physician/alternate.

Past researchers did not provide direct insights as to why TMS would negatively interact with worked experience. However, TMS is associated with greater team cohesion, a key element in team effectiveness and positive patient outcomes (Kumar, 2009; Mathieu et al., 2015; Thompson et al., 2015). But highly cohesive teams are also at risk of groupthink and collective errors (Kaba et al., 2016). Thus, if cohesive IP core teams existed in the sampled EDs, the most plausible explanation for why TMS would negatively interact with individual worked experience was the existence of groupthink leading to collective failure.

Groupthink occurs when individuals in a cohesive group strive for conformity, unanimity, and consensus, and fail to consider alternatives (Kaba et al., 2016; Schmidt, 2021), which can lead to collective failures. Collective failures result from denying that a problem exists, through pluralistic ignorance by accepting status quo, and/or through diffusion of responsibility (Gardiner & Chater, 2013). When accepting status quo, it can result in no one taking action, diffusing the responsibility for the outcomes across the team (Gardiner & Chater, 2013). Groupthink and collective failures provide a plausible explanation as to why TMS decreased the strength of the relationships between individual worked experience and time to PIA and LOS. That is, if individuals were members of a highly cohesive team and were striving for conformity, unanimity, and consensus and, irrespective of their individual competency from work experience, they did not offer alternatives for consideration, collective failures would occur and result in longer times to PIA and longer LOS. If groupthink did occur within this study, it would explain why TMS would negatively interact with worked experience.

Confounding factors have the potential to generate plausible alternative hypotheses (Campbell & Stanley, 1963; Warner, 2013) and patient acuity (based on CTAS) levels and volumes were potential confounding predictors controlled statistically. When controlling for

CTAS levels and patient volumes, no statistically significant relationship existed between TMSI and medical errors; nor between ICICI and medical errors. Thus, based on the findings from this study, patients' levels of acuity and volume were confounding variables, negating the effect that individual experience had on both PIA and LOS. In contrast, when team size was controlled, a statistically significant relationship existed between TMS and the average times to PIA for each time interval/IP core team. This relationship was positively related and the effect size was large. That is, as TMS increased so did times to PIA.

There were limitations to generalizability of the results from this study. The advent of the COVID-19 pandemic and the reallocation of resources to address it resulted in two EDs withdrawing from this study (the managers at the two EDs verbalized that they were too busy). Furthermore, survey results were below sampling threshold, limiting the value of the responses received. In addition, based on 3-months of data, temporal stability of the ED core teams was low, limiting the validity of the associations between TMS and delays to care in the EDs. Due to these limitations, further research to understand the relationship between these variables is recommended.

The findings from this study are important. In this study, I focused on patient outcomes as a function of TMS, independent collaborative IP competence, and CTC. Understanding these relationships has the potential to promote a positive social change for ED direct care providers, managers, and administrators; and can inform HCS policies and guidelines that ultimately maximize patient safety for those accessing the HCS through EDs. ED direct care providers can benefit through an increased understanding that working within teams with short-term low temporal stability should not impede their success at promoting patient safety. Furthermore, ED direct care providers and managers/administrators should be motivated to increase their understanding of the perils associated with groupthink that can lead to collective failures. In addition, evidence existed in support of standardized HCS policies, guidelines, and practices, reflective of current best practices that strengthen collective knowledge at the organizational level can result in a more responsive and effective HCS, improving quality of ED patient care, rendering it safer, more accessible, comprehensive, coordinated, and patient-centered.

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Appendix A: Literature Search Strategies and Results

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
CINAHL & Medline combined search	collective competence AND health	28	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s)	Omitted during 1st screening: 13 Selected 15 out of 28
	collective competence AND health; peer reviewed	13		Omitted during 1st screening: 8 Repeats of selected articles: 5 Selected: 0
	competence AND collective OR team; full text; from Jan.2015; research articles; PDF full text; peer reviewed	622	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews and studies focusing on individual competence; omitted studies with simulation after 160 articles screened and many already selected for referencing; stopped screening after the first 200 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 144 Omitted after abstract reviewed: 16 Selected: 40 out of 200
	team* AND interdisciplinary OR interprofessional; from Jan. 2015; peer reviewed	4,723	Screened using same criteria as with Medline; stopped screening at 150 articles when no new relevant sources were identified during the preceding 100 screened.	Omitted during 1st screening: 135 Omitted after abstract reviewed: 2 Repeats: 12 Selected: 1 out of 150
	team* AND interdisciplinary OR interprofessional; emergency department* OR room*; from Jan. 2015; peer reviewed	365	Screened using same criteria as with Medline; stopped screening at 150 articles when no new relevant sources were identified during the preceding 100 screened.	Omitted during 1st screening: 130 Omitted after abstract reviewed: 2 Repeats: 12 Selected: 6 out of 150
	medical errors AND emergency department* OR room* from Jan. 2015; peer reviewed; full text	115	Screened all 115. Screened summaries for medical errors, collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, studies focusing on individual competence, and disease-specific; stopped screening after the first 240 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 108 Omitted after abstract reviewed: 2 Repeats: 6 Selected: 0 out of 115
	"shift work" AND team* AND healthcare OR health care; peer reviewed; from Jan.2015; English	148,633	Not screened; refined search terms	
	"shift work" AND team* AND "Medical errors"; peer reviewed; from Jan.2015; English	1	Not applicable	
	"shift work" AND team* AND effectiveness AND healthcare OR health care; peer reviewed; from Jan.2015; English	125,606	Screened as described above and for shift work.	Only 1 new resource found in the 1st 100

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
	”shift work” AND healthcare OR health care	741,349	Not screened; refined search terms.	
	“shift work” AND patient*	76	All screened using above criteria.	None found.
	Patient flow* AND emergency department*, from Aug. 2015, full text, human	101 articles	All screened using above criteria and patient flow	24 articles selected
CINAHL Plus with full text	collective competence AND health	10	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s)	Omitted during 1st screening: 6; Repeats of selected articles: 4 Selected: 0 out of 10
	competence AND collective OR team NOT culture*; full text; from Jan.2015; peer reviewed	846	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews; stopped screening after the first 240 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 222 Omitted after abstract reviewed: 3 Repeats of selected articles: 6 Selected: 9 out of 240
	team* AND interdisciplinary OR interprofessional; from Jan. 2015; peer reviewed	3,223	Screened using same criteria as with Medline; stopped screening at 160 articles when no new relevant sources were identified during the preceding 30 screened.	Omitted during 1st screening: 145 Repeats of selected articles: 15 Selected: 0 out of 160 Omitted: 183
	team* AND interdisciplinary OR interprofessional; emergency department* OR room*; from Jan. 2015; peer reviewed	225	All 225 screened. Screened summaries for medical errors, collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews.	Omitted after abstract reviewed: 12 Repeats of selected articles: 13 Selected: 17 out of 225
	medical errors AND emergency department* OR room* from Jan. 2015; peer reviewed	63	All 63 screened. Screened summaries for medical errors, collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews.	Omitted: 60 Omitted after abstract reviewed: 2 Repeats of selected articles: 4 Selected: 17 out of 63 + 2 more from pop-up links
	shift work AND team*; from Jan. 2015; peer reviewed	21	Used criteria defined for shift work in above database	Selected 1 out of 21
Medline with full text:	collective competence AND health	12	All captured from other databases Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s)	Omitted during 1st screening: 4; Repeats of selected articles: 7 Selected: 1 out of 12
	competence AND collective OR team NOT cultur*; full text; from Jan.2015; peer reviewed	448	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on indvidual competence;	Omitted during 1st screening: 171 Omitted after abstract reviewed: 3 Repeats of selected articles: 25 Selected: l out of 200

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
Medline with full text: continued			stopped screening after the first 200 since no relevant articles identified during the preceding 30 screened.	
	team* AND interdisciplinary OR interprofessional; from Jan. 2015; peer reviewed	1500	Screened summaries for collective competence, intelligence, collaborative, Interprofessional, interdisciplinary, patient safety; reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence or on specific diagnoses; stopped screening after the first 550 since no new relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 462 Omitted after abstract reviewed: 19 Repeats of selected articles: 16 Selected: 53 out of 550
	team* AND interdisciplinary OR interprofessional; emergency department* OR room*; from Jan. 2015; peer reviewed	144	Screened summaries for collective competence, intelligence, collaborative, Interprofessional, interdisciplinary, patient safety; reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence or on specific diagnoses.	Omitted during 1st screening: 115 Omitted after abstract reviewed: 2 Repeats of selected articles: 11 Selected: 16 out of 144
	medical errors AND emergency department* OR room* from Jan. 2015; peer reviewed	68	All 68 screened using criteria defined in data bases above.	Omitted during 1st screening: 64; Omitted after abstract/article reviewed: 1; Repeats of selected articles: 3; Selected: 0 out of 68
	"shift work" AND team*; full text; peer reviewed; from Jan.2015	4	All screened using above criteria	None selected
ProQuest Health & Medical Collection	"Collective competence*" AND healthcare*, NOT "cultural competence"; peer reviewed, all dates	33	Scanned titles/descriptions for team and collective competencies in EDs or health care system	4 repeats; No new sources identified
	Collective competence* AND healthcare*, NOT "cultural competence"; peer reviewed, all dates	2,834	Screened titles/summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded studies focusing on individual competence; stopped screening after the first 200 when no new relevant articles identified during the preceding 30 screened	Omitted during 1st screening:181 Omitted after abstract reviewed: 5 Repeats of selected articles: 6 Selected: 6 out of 200
	Collective competence* AND healthcare*, NOT "cultural competence"; humans; peer reviewed, all dates	845	Screened as above.	Omitted during 1st screening:195 Omitted after abstract reviewed: 1 Repeats of selected articles: 2 Selected: 2 out of 2

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
ProQuest Health & Medical Collection continued	competenc* AND collective OR team; AND healthcare OR health care NOT "cultural competence"; peer reviewed; 3 years	17,260	Not screened; Refocused the search.	
	competenc* AND collective OR team; NOT "cultural competence"; peer reviewed; 3 years	13,651	Not screened; Refocused the search.	
	competenc* AND collective OR team; NOT "cultural competence AND emergency department OR emergency room; peer reviewed; 3 years	14,139	Not screened; Refocused the search.	
	competence AND collective OR team NOT cultur*; full text; 3years; peer reviewed	3,895	Screened titles/summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence; stopped screening after the first 500 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 496 Omitted after abstract reviewed: 0 Repeats of selected articles: 2 Selected: 2 out of 500
	collective competenc* AND healthcare OR health care; peer reviewed; 3 years	2,094	Not screened for relevance	
	collective competence AND emergency; peer reviewed; 3 years = 438 results; NOT "cultural competence"	370	Screened titles for team, collective competencies collective competence, intelligence, collaborative, interprofessional team(s); in EDs or health care system(s); screened abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence. Stopped screening after the first 280 since no relevant articles identified during the preceding 30 screened	Omitted during 1st screening: 270 Omitted after abstract reviewed: 2 Repeats of selected articles: 3 Selected: 5 out of 280
	team* AND interdisciplinary OR interprofessional; emergency department* OR room*; 3 years; peer reviewed	7,771	Screened using criteria defined above. Stopped screening after the first 500 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 474; Omitted after abstract reviewed: 9; Repeats of selected articles: 5 Selected: 12 out of 500
	medical errors AND emergency department* OR emergency room* last 3 years; peer reviewed	10,840	Not screened; modified search	
	medical errors AND emergency AND team* last 3 years; peer reviewed	5,178	Screened titles for medical errors, emergency, team(s); screened abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews and commentaries. Stopped screening after the first 500 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 476; Omitted after abstract reviewed: 7; Repeats of selected articles: 5; Selected: 12 out of 500

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
ProQuest Health & Medical Collection continued	shift work AND team* AND effectiveness OR development AND healthcare OR health care; peer reviewed; 3 years	10,682	Not screened	
	shift work AND team* AND effectiveness AND healthcare OR health care; peer reviewed; 3 years	4,754	Screened titles for shift work, medical errors, emergency, team(s), membership, effectiveness; screened abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews and commentaries. Stopped screening after the first 60 since no relevant articles identified.	
	shift work AND team* AND membership AND healthcare OR health care; peer reviewed; 3 years	850	None found within 100 results	
	shift work AND team* AND "medical errors"; peer reviewed; 3 years	39	1 commentary considered 1 systematic review selected	4 repeats None selected
	"shift work" AND team*; peer reviewed; 3 years	472	Screened as per criteria defined above. Stopped screening after the first 160 since no relevant articles identified within the previous 30 results.	2 selected
ProQuest Nursing and Allied Health Collection	collective competenc* AND healthcare OR health care NOT cultural competenc* OR emotional; peer reviewed; full text; 3 years	458	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence; stopped after 300 screened since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 296 Omitted after abstract reviewed: 2 Repeats of selected articles: 3 Selected: l out of 300
	competence AND collective OR team NOT cultur* OR emotion*; full text; 3years; peer reviewed	1,419	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence; stopped screening after the first 500 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 489 Omitted after abstract reviewed: 5 Repeats of selected articles: 2 Selected: 4 out of 500 There were many duplicate articles within the 500 results.
	medical errors AND emergency department* OR room*; 3 years; peer reviewed	5,358	Screened using criteria defined above + for medical errors. Also excluded studies focusing on disease-specific	2 abstracts screened and omitted; no new results found.
	medical errors AND teamwork; full text; peer reviewed; 3 years	814	Screened as per above criteria.	Omitted during 1st screening: 273 Omitted after abstract reviewed: 3 Repeats of selected articles: 8 Selected: 16 out of 300

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
ProQuest Nursing and Allied Health Collection continued	shift work AND team effectiveness OR development AND healthcare OR health care; peer reviewed; all dates	55,638	Did not screen; refocused the search.	
	shift work AND team effectiveness OR development AND healthcare OR health care; peer reviewed; 3 years	11,194	Did not screen; refocused the search.	
	"shift work" AND teamwork; peer reviewed; 3 years	35	Screened as per criteria defined in databases above.	1 repeat; no new articles selected
PubMed	competence AND collective OR team NOT cultur* OR emotion*; full text; from Jan 2015; sorted by most relevant in PubMed	1652	Screened summaries for collective competence, intelligence, collaborative, interprofessional team(s); reviewed abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews, commentaries, and studies focusing on individual competence; stopped screening after the first 500 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 464 Omitted after abstract/article reviewed: 1 Repeats of selected articles: 16 Selected: 19 out of 500
	medical errors AND teamwork; full text; peer reviewed; all dates	509	Screened titles for medical errors, emergency, team(s); screened abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews and commentaries. Stopped screening after the first 340 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 464 Omitted after abstract/article reviewed: 4 Repeats of selected articles: 10 Selected: 10 out of 340
	"shift work" AND teamwork OR team work AND patient safety; full text; 5 years	619	Screened titles for shiftwork, team(s), patient safety; screened abstracts of articles when initial screening did not provide a clear picture; excluded systematic reviews and commentaries. Stopped screening after the first 200 since no relevant articles identified during the preceding 30 screened.	Omitted during 1st screening: 193 Omitted after abstract/article reviewed: 4 Repeats of selected articles: 0 Selected: 3 out of 200
General search in Walden library	Wait times AND emergency; full article	2910	selected ones that appeared relevant to impaired emergency department flow; excluded disease-specific	Selected 22
Theories and Theorists: Sage Knowledge	Collective competenc* theory	867	Screened for the presence of both words collective and competence None within the 1st 180 documents Located1 within the Encyclopedia of Social Theory	None selected
	Team collective competenc*	453		
	Distributed cognition	393		
	Social learning theory		Searched for social learning; Bandura was identified as the theory founder	Selected 3 references
	Social Constructionism		Searched for social constructionism; identified Berger and Luckmann were the founders.	Selected 4 references

Source	Search term(s) and delineators	Results	Screening criteria/comments	Number of articles screened and selected
Google Scholar	Lingard		Lingard has advocated for collective competence as necessary for effective interprofessional teamwork. Screened her articles for those related to collective competence. Lingard identified Boreham as one who contributed to collective competence. Search for Boreham's work resulted in finding his article that combined other theories and proposed a collective competence theory.	Selected Boreham's theory of collective competence
	Theories: Collective competence Collective competence theory	 1,310,000 1,220,000	For foundational theories, identified original theory proponent and at a minimum of another reliable source that provided an explanation of key concepts and assumptions related to each theory.	Selected 2 from Bandura and 1 SAGE source; selected Hutchins' work; selected 2 articles by Berger & Luckman and 1 by SAGE
	Social learning theory	3,220,000		
	Social cognitive theory AND Bandura	73		
	Distributed cognition	2,770,000		
	Distributed cognition AND Hutchins	26,100		
ProQuest Dissertations and Theses Global	Collective competenc*; full text	226,414	Refocused the search.	
	Collective competenc* AND healthcare OR health care; full text	176,124	Refocused the search.	
	Collective competenc* AND healthcare OR health care; NOT cultural competenc*; full text; 5 years;	3,498	Looked for both collective and competence in summaries; Scanned 1st 600	Selected 3 as relevant: Blair, V. W. (1996). Thompson, J. L. (2007). McEwen, L. (2017). Carmouche, M. F. (2017).
	Collective efficacy		Scanned 1st 400; reviewed 6 papers	
Professional; miscellaneous sources	Institute of Medicine site – medical errors		Located: Institute of Medicine (1999); Institute of Medicine. (2001).	2 documents
	Interprofessional collaborative sites – interprofessional team work		Located: Canadian Interprofessional Health Collaborative; Interprofessional Education Collaborative (IPEC)	2 sites 2 documents 1 document
	RNAO best practice guidelines site - interprofessional		Developing and sustaining interprofessional health care: Optimizing patients/clients, organizational, and system outcomes	2 documents
	Work-related sources		Wait Times Task Force, Man.	
	WHO site - interprofessional		Framework for action on interprofessional education and collaborative practice	1 document
Reference from other articles	Makary & Daniel's article pop-ups	4		Selected all 4

Appendix B: Participant Survey

Team Membership, Inter-Professional Collective Teamwork, and Emergency Department (ED) Outcomes Survey

Please read the consent form before completing this survey. Your informed consent is required. By completing this survey, you are consenting to participating in this study. You may stop at any time. When completed, please place in the secure box provided.

A. General Information

Please Note: The name of the hospital will be kept confidential. It is requested to link your responses with team membership and patient outcomes.

Hospital: Date:
Time shift started: Time shift ended:

Your **occupational designation** □ Physician □ Nurse
□ Other professional discipline (e.g. respiratory therapist - enter):
□ Other Staff (e.g. unit clerk; health care aide - enter):

Personal Information:

Gender: □ Male
□ Female
□ Other

Your **experience** since:	Years	Months
Licensure or practice designation (e.g. MD, RN)	_______	______
Working in an ED setting	_______	______
Working within this ED	_______	______

Your **formal educational background** (e.g. college, university, certificates): please list

Number of courses that included 2 or more professions if known:

	Number
Your **informal educational background** (e.g. mocks; inservices; conferences)	
Number of **learning session(s)** attended within the past two (2) year where a minimum of 2 professions participated.	________
How many of these were within the previous 12 months?	________
How many of these were within the previous 6 months?	________
How many of these were within the previous 3 months?	________

Please place a **check mark** and enter a **number** next to the **members of the team** (by profession) with whom you interacted while providing patient care during this one shift.

□ ED Physician(s) □ ED Nurses □ Respiratory Therapist
□ Laboratory □ Diagnostic Imaging □ Pharmacist
□ Physiotherapist □ Occupational Therapist □ Social Worker
□ Physician specialist(s) □ Inpatient Physician(s) □ Inpatient Nurse(s)
□ Mental Health Services Other (list):

Number of patients by Canadian Triage Assessment Score (CTAS) level that you participated in their care delivery during this shift.

CTAS level	I	II	III	IV	V
Number	_____	_____	_____	_____	_____

B. Self-Rating of Your Perception of Collective Teamwork

Please circle the number on the rating scale that best describes your experience during this shift. As a guide to what each level on the scale means, a percentage has been provided. That is, please select "never" if what is described occurred 0% of the time during the shift, and so on.

0	1	2	3	4	5
Never	Infrequently	Sometimes	Most Times	Frequently	Always
(O%)	(20%)	(40%)	(60%)	(80%)	(100%)

1.	I had a clear understanding of what our team goal(s) was/were.	0 1 2 3 4 5
2.	I knew what needed to be done to achieve our team goal(s).	0 1 2 3 4 5
3.	I knew how to get the work done to achieve our team goal(s).	0 1 2 3 4 5
4.	I knew what was expected of me in relation to other team members' roles and responsibilities.	0 1 2 3 4 5
5.	I had tools available to guide my actions (e.g. ground rules; job aids; defined procedures).	0 1 2 3 4 5
6.	I was able to anticipate the needs of team members.	0 1 2 3 4 5
7.	I was aware of what the other team members were doing.	0 1 2 3 4 5
8.	I understood how my role and responsibilities contributed to (and were shaped by) team dynamics and/or events in the workplace.	0 1 2 3 4 5
9.	I was aware in a timely manner of changes within and beyond the team environment that impacted the team's ability to achieve its goal.	0 1 2 3 4 5
10.	I shared relevant information with other team members as it became available.	0 1 2 3 4 5
11.	**When we encountered problems or conflicting priorities, I experienced doubt and uncertainty.	0 1 2 3 4 5
12.	We shared our feelings about the situation(s).	0 1 2 3 4 5
13.	I responded to changes by adjusting my actions.	0 1 2 3 4 5
14.	I was involved in discussions to re-evaluate situational changes.	0 1 2 3 4 5
15.	I sought out other team members to address issues/problems.	0 1 2 3 4 5
16.	I negotiated responsibilities with other team members whose roles overlapped with mine.	0 1 2 3 4 5
17.	I was aware of changes in roles and responsibilities.	0 1 2 3 4 5
18.	I used common professional language to communicate with team members.	0 1 2 3 4 5
19.	I used organizational standardized processes to guide my actions.	0 1 2 3 4 5
20.	We encouraged each other to use our knowledge and skills.	0 1 2 3 4 5
21.	I used more than one (1) resource to find information needed to inform my actions (e.g. another team member; written materials).	0 1 2 3 4 5
22.	I purposefully created opportunities to communicate with others.	0 1 2 3 4 5
23.	I contributed to the effectiveness of the team.	0 1 2 3 4 5
24.	I was able to coordinate my perceptions of what was occurring with perceptions of other team members to guide my actions.	0 1 2 3 4 5
25.	I learned through sharing of my knowledge and expertise with team members.	0 1 2 3 4 5

26. I learned by watching how other team members performed their duties and fulfilled their roles and responsibilities.	0	1	2	3	4	5
27. I was able to apply what I had learned from others.	0	1	2	3	4	5
28. When we encountered a problem, as a team we examined it carefully to understand what the problem was about and why it had occurred.	0	1	2	3	4	5
29. I contributed to shared team decision making.	0	1	2	3	4	5
30. I participated in re-setting team goal(s) and activities as needed.	0	1	2	3	4	5
31. My actions were consistent with those that we had practiced using a team approach.	0	1	2	3	4	5
32. We used a team approach to fulfill our professional responsibilities.	0	1	2	3	4	5
33. I worked closely with other team members to meet our goal(s).	0	1	2	3	4	5
34. I was aware of (or engaged in) communications between our team and other teams (or individuals) within or external to the organization.	0	1	2	3	4	5
35. Through team interaction(s), I understood our responses to problematic situations.	0	1	2	3	4	5
36. I was accountable for my contributions to the team.	0	1	2	3	4	5
37. I felt safe to speak up.	0	1	2	3	4	5
38. I actively listened to other team members' ideas and concerns.	0	1	2	3	4	5
39. I actively listened to other team members' ideas and concerns.	0	1	2	3	4	5
40. I took into account the ideas of other team members.	0	1	2	3	4	5
41. I respected the team members I worked with.	0	1	2	3	4	5
42. I trusted the team members I worked with.	0	1	2	3	4	5
43. **I experienced power struggles.	0	1	2	3	4	5
44. Leadership role was shared based on team members' expertise with what was happening.	0	1	2	3	4	5
45. I used constructive feedback that promoted positive interactions.	0	1	2	3	4	5
46. I addressed team conflict in a respectful manner.	0	1	2	3	4	5
47. I provided assistance to team members as needed.	0	1	2	3	4	5
48. I received assistance from team members as needed.	0	1	2	3	4	5
49. I felt that I belonged on the team.	0	1	2	3	4	5

Note. ** Reversed scored items.

Appendix C: Collective Competence Theory Elements, Indicators, and Scale Items for the Collective team competence questionnaire (CTCQ)

CSWE defining factors	Indicators of defining factors	CTCQ Scale Items
○ Clearly defined and shared object of their activity = goal ○ member consciousness: co-knowing what the object of their activity is ○ group consciousness: knowing what needs to be done in relation to what others are doing ○ working as a single unit; ○ collective mind = distributed cognition: ○ members attend to system-level consequences of their actions ○ team acts as a single unit; ○ interactive consciousness: members socialized into a collective way of thinking ○ making sense of workplace contradictions, predicaments, uncertainties, problems; conflicting priorities ○ result in feelings of doubt and uncertainty ○ do not know how to act; ○ feelings of anxiety; require self-organizing collective behaviors and adaptability	• Shared goal; (scale Item 1) • knowing what needs to done and the processes for getting it done; (scale Item 2) • know and understand the plan; (scale Item 3) • set of rules for ordering interactions (scale Items 4, 5) • division of labor (scale Items 4, 5); • rules for everyday interactions (scale Item 5) • able to anticipate what needs to be done in relation to other team members (scale Item 6) • coordinated actions (scale Items 6, 7) • situational awareness: understand functional relationships between all system elements and interactions between the individual and environment through monitoring the environment; (scale Items 6, 7, 8, 9, 10, 12) • shared representation of functional relationships /work processes (scale Item 5) • presence of and communication through language and artifacts (scale Item 5) • coordinated responses/actions (scale Items 4, 6, 7) • feelings of doubt/uncertainty (scale Item 11) • exchange of feelings about the situation (scale Item 12); • spontaneous discussions (scale Items 13, 14, 15) • collective reinterpretation of verbal exchanges (scale Items 16, 17) • redefining boundaries of professional roles/changes in roles and responsibilities (scale Item s 15, 16) • shared mental models of tactical reasoning (scale Item 17) • team members aware when the plan has changed (scale Item 16)	1. I had a clear understanding of what our team goal(s) was/were. 2. I knew what needed to be done to achieve our goal(s). 3. I knew how to get the work done to achieve our goal(s). 4. I knew what was expected of me in relation to other team members' roles and responsibilities. 5. I had tools available to guide our actions (e.g. ground rules; job aids; defined procedures). 6. I was able to anticipate the needs of team members. 7. I was aware of what the other team members were doing 8. I understood how my role and responsibilities contributed to and were shaped by team dynamics and/or events in the workplace. 9. I was aware in a timely manner of changes within and beyond the team environment that impacted the team's ability to achieve its goal(s). 10. I shared relevant information with other team members as it became available. 11. **When encountering problems, I experienced doubt and uncertainty. 12. We shared our feelings about the situation(s). 13. I responded to changes in the work environment by adjusting my actions. 14. I was involved in discussions to re-evaluate situational changes. 15. I sought out other team members to address issues/problems. 16. I negotiated responsibilities with other team members whose roles overlapped with mine. 17. I was aware of changes in roles and responsibilities.

CKB defining factors	Indicators of defining factors	CTCQ Scale Items
○ sub-language tailored to specific event ○ group processes maintained over time ○ group processes used to guide conversation and thinking ○ integration of specialized knowledge ○ knowledge resources ○ collective knowledge becomes embedded in patterns of heedful inter-relating ○ members contribute to the team ○ subordinate individual actions to fit with actions of others, and able to see the system as a whole ○ weave together thinking, feeling, and willing ○ interpretation of common experiences ○ developed naturally within each team as a result of experience but can be made explicit, codified and used ○ use of language for developing, transmitting, and maintaining knowledge ○ responses to system changes result in self-organization behaviors that lead to emergence of new non-decomposable state of collective action	• communication through language and artifacts (scale Items 8, 18) • standardized processes (scale Item 19) • specialized knowledge brought together to inform team actions (scale Item 20) • available sources for different types of information (scale item 21) heedful interrelating: acting carefully, critically, consistently, purposefully, attentively, vigilantly, conscientiously, pertinaciously (scale Item 22) • cooperation and coordination (scale Item 23) • integrated existing realities to produce new meanings from social interactions (scale Item 24) • shared mental model of reasoning = game plan (scale Item 24) • communication (scale Item 25) • experience (scale Item 25) • modeling of expected performance (scale it Item 26) • learning through mental and performance rehearsal as memory aids (scale Item 27) • new processes defined after encountering workplace contradictions, predicaments, uncertainties, problems; conflicting priorities (scale Item 28) • functional reconfigurations to achieve coordinated actions (scale Item 29, 30) • collective reinterpretation of communication and events (scale Item 29, 30) • shared reality habituated through repetition (scale Item 31)	18. I used common professional language to communicate with team members. 19. I used organizational standardized processes to guide my actions (e.g. protocols). 20. We encouraged each other to use our knowledge and skills. 21. I used more than one (1) resource to find information needed to inform my actions (e.g. another team member; written materials). 22. I purposefully created opportunities to communicate with others. 23. I contributed to the effectiveness of the team. 24. I was able to coordinate my perceptions of what was occurring with perceptions of other team members to guide our actions 25. I learned through sharing of my knowledge and expertise with team members. 26. I learned by watching how other team members performed their duties and fulfilled their roles and responsibilities. 27. I was able to apply what I had learned from others. 28. When we encountered a problem, as a team we examined it carefully to understand what the problem was about and why it had occurred. 29. I contributed to shared team decision making. 30. I participated in re-setting team goal(s) and activities as needed. 31. My actions were consistent with those that we had practiced using a team approach.

Interdependency defining factors	Indicators of defining factors	CTCQ Scale Items
○ non-decomposability: team behaviors within the system ○ coordinating collective responses to problematic situations ○ non-hierarchical interactions ○ empowerment, valuing all contributions equally ○ identify and acknowledge any existing internal division ○ group needs to prevent and overcome the fragmenting tendencies of different perceptions of subsystems (can be individuals or subgroups) ○ negotiations and joint activity to transcend differences ○ emotions that members are experiencing is a transient state ○ non-linear responses to internal and external stimuli ○ self-organizing and adaptability of the team as a whole ○ inter-nodal networks represent and guide collective action	• team acts as a single unit (scale Item 32) • coordinated actions/responses (scale Items 23, 29, 30, 33) • communication and cooperation between subsystems to align goals systematically (scale Item 34) • shared mental models of problematic situations (scale Item 35) • mutual understanding established (scale Item 35) • all contribute to the overall task of the team (scale Items 36); • psychologically safe place that supports speaking up (scale Items 37, 38, 39) • all contributions equally valued (scale Items 40, 41, 42) • leadership (scale Items 43, 44) • existing internal divisions (conflicts) identified and addressed (scale Items 44, 45) • conflict resolution strategies used to overcome fragmenting tendencies of different perceptions (scale Items 45, 46) • here-and-now awareness of being dependent upon one another (scale Items 47, 48) • positive inter-personal relationships (scale Items 45, 49)	32. We used a team approach to fulfill our professional responsibilities. 33. I worked closely with other team members to meet our goal(s). 34. I was aware of (or engaged in) communications between our team and other teams (or individuals) within or external to the organization. 35. Through team interaction(s), I understood our responses to problematic situations. 36. I was accountable for my contributions to the team. 37. I felt safe to speak up. 38. I actively listened to other team members' ideas and concerns. 39. I expressed my ideas without being judgemental. 40. I took into account the ideas of other team members. 41. I respected the team members I worked with. 42. I trusted the team members I worked with. 43. **I experienced power struggles. 44. Leadership role was shared based on team members' expertise with what was happening. 45. I used constructive feedback that promoted positive interactions. 46. I addressed team conflict in a respectful manner. 47. I provided assistance to team members as needed. 48. I received assistance from team members as needed. 49. I felt that I belonged on the team.

Note. Collective team competence questionnaire (CTCQ) scale items were deduced from the Boreham's (2004) descriptions of the collective competence theory's (CCT) three normative principles, which are a collective sense of workplace events (CSWE), a collective knowledge base (CKB), and a sense of interdependency. Indicators were generated and informed the scale items.

Appendix D: Pilot Study Participant Survey

Your Demographic Information

Gender: □ Male □ Female □ Other   Age:_______________

Please select one or more of the boxes within each section below.

Professional/Occupational Category or Role:

□ Audiology	□ Dentistry	□ Diagnostic Imaging
□ Kinesiology	□ Laboratory	□ Management/Leadership
□ Medicine	□ Nursing	□ Nutrition (e.g. Dietitian)
□ Occupational Therapy	□ Pharmacy	□ Physiotherapy
□ Psychiatry	□ Psychology	□ Public Health
□ Respiratory Therapy	□ Social Work	□ Speech Language Pathology

□ Support Services (e.g. administration; specify):

□ Other (specify):

Comment(s):

Employment/professional experience history:
Number of Years ____________ Months_______________

Length of time on current team:
Number of Years ____________ Months_______________

Amount of work time engaged in teamwork in current position (Please select only one):

0	1	2	3	4	5
Never (O%)	Infrequently (20%)	Sometimes (40%)	Most Times (60%)	Frequently (80%)	Always (100%)

Your **Formal Educational Background** (e.g. college, university, certificates): please list

____

____

____

Number of courses that included 2 or more professions if known:

Your **Informal Educational Background** (e.g. intra-organizational inservices; professional conferences) where a minimum of 2 professions participated. Number

Number of **learning session(s)** attended within the past two (2) year

How many of these were within the previous 12 months? ______

How many of these were within the previous 6 months? ______

How many of these were within the previous 3 months? ______

Descriptions of Collective Competence Theory Normative Principles

1. Collective sense of workplace events:
   - Requires situational awareness of and responses to workplace events by the activity system within a complex adaptive system. The activity system is the core team; complex inter-relationships between people and their environment define complex adaptive systems.
   - Characterized by shared goal(s) or the objective(s) of the team's activities.
   - Requires understanding system-level consequences of individual and collective actions.
   - Involves group consciousness (knowing what needs to be done in relation to what others are doing in the organization); and collective responses in addressing problems or uncertainties that arise through self-organizing collective behaviors and adaptability (Birdsey et al., 2017; Boreham, 2004).

2. Collective knowledge base:
   - Requires learning. Learning occurs through direct and vicarious observations observation of others, and with the use of symbols (e.g. written materials); reinforced through repeated observances, and with mental and/or performance rehearsal.
   - Uses language to develop, transmit, and maintain knowledge within social-cultural situations, used to guide everyday life.
   - Places individual knowledge within the context of learning how to learn.
   - Requires knowing how to access situated and context-linked distributed knowledge (e.g. organizational resources, such as communication tools and policies).
   - Emerges through social interactions, shared experiences, and tacit knowledge.
   - Becomes embedded through heedful interrelating, involving purposeful and conscientious actions.
   - Requires division of labor and rules for interactions (Berger & Luckman, 1966; Boreham, 2004; Lingard, 2009).

3. Interdependency:
   - Characterized by the team acting as a single unit.
   - Involves identifying and acknowledging internal divisions, negotiations, and joint activity for coordinated responses, overcoming problematic situations.
   - Use conflict resolution to overcome fragmenting tendencies from different perspectives and to foster positive interrelationships.
   - Defined by non-hierarchic al interactions, empowerment, and valuing all contributions equally.
   - Involves creating a psychologically safe place that supports speaking up.
   - Involves creating a here-and-now awareness of being dependent upon one another (Boreham, 2004).

Rating Collective Team Competence Questionnaire (CTCQ) Items

Please indicate your level of agreement with each of the scale items with the descriptions of the collective competence theory's three normative principles where:

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Collective team competence scale items	Collective sense of workplace events	Collective knowledge base	Interdependency
1. I had a clear understanding of what our team goal(s) was/were.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. I knew <u>how</u> to get the work done to achieve our team goal(s).	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. I used common professional language to communicate with team members.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4. I felt that I belonged on the team.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5. We shared our feelings about the situation(s).	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6. I respected the team members I worked with.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7. We encouraged each other to use our knowledge and skills.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
8. I learned through sharing of my knowledge and expertise with team members.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
9. We used constructive feedback that promoted positive interactions.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
10. I participated in re-setting team goals and activities as needed.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
11. My actions were consistent with those that we had practiced using a team approach.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
12. I was accountable for my contributions to the team.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
13. I knew <u>what</u> needed to be done to achieve our goal.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
14. I knew what was expected of me in relation to other team members' roles and responsibilities.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
15. I addressed team conflict in a respectful manner.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
16. I received assistance from team members as needed.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
17. We had tools available to guide our actions (e.g. ground rules; job aids; defined procedures).	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Collective team competence scale items	Collective sense of workplace events	Collective knowledge base	Interdependency
18. I was able to anticipate the needs of team members.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
19. I understood how my role and responsibilities contributed to (and were shaped by) team dynamics and/or events in the workplace.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
20. I used standardized processes to guide my actions.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
21. I used more than one (1) resource to find information needed to inform my actions (e.g. another team member; written materials).	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
22. I was aware of changes in roles and responsibilities.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
23. **I experienced power struggles.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
24. I contributed to the effectiveness of the team.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
25. I was able to coordinate my perceptions of what was occurring with perceptions of other team members to guide my actions.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
26. I worked closely with other team members to meet our goal(s).	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
27. I felt safe to speak up.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
28. I contributed to shared team decision making.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
29. I took into account the ideas of other team members	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
30. I was aware in a timely manner of changes within and beyond the team environment that impacted the team's ability to achieve its goal.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
31. I purposefully created opportunities to communicate with others.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
32. When we encountered a problem, as a team we examined it carefully to understand what the problem was about and why it had occurred.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
33. We used a team approach to fulfill our professional responsibilities.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
34. I was aware of what the other team members were doing.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
35. I responded to changes by adjusting my actions.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Collective team competence scale items	**Collective sense of workplace events**	Collective knowledge base	Interdependency
36. I was aware of (or engaged in) communications between out team and other teams (or individuals) within or external to the organization.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
37. I sought out other team members to address issues/problems.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
38. I provided assistance to team members as needed.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
39. Leadership role was shared based team members' expertise with what was happening.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
40. I was able to apply what I had learned from others.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
41. I was involved in discussions to re-evaluate situational changes.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
42. I shared relevant information with other team members as it became available.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
43. I learned by watching how other team members performed their duties and fulfilled their roles and responsibilities.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
44. I actively listened to other team members' ideas and concerns.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
45. I expressed my ideas without being judgmental towards others.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
46. I negotiated responsibilities with other team members whose roles overlapped with mine.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
47. I trusted the team members I worked with.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
48. Through team interaction(s), I understood our responses to problematic situations.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
49 **When we encountered a problem, as a team we examined it carefully to understand what the problem was about and why it had occurred.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Appendix E: Team Membership Stability Based on Frequency of Shifts Worked Together Over a 3 Month Time Period

	RN1	MD1	RT1	RN2	RN3	RN4	MD2	MD3	RT2	RT3
RN1	X									
MD1		X								
RT1			X							
RN2				X						
RN3					X					
RN4						X				
MD2							X			
MD3								X		
RT2									X	
RT3										X

Note. An excel worksheet was used to calculate the frequency that ED core team members worked together during the 3 months preceding sampling dates, each captured by professional designation and assigned number (e.g. RN1; MD1; RT1).

Appendix F: A Comparison of Existing Validated Instruments to Establish Convergent Validity for the Collective Team Competence Scales

CTCQ Items	T-TPQ	AITCS-II	TEAM	Reciprocal Learning	ISVS	ICCAS
1. I had a clear understanding of what our team goal(s) was/were.	"My unit has clearly articulated goals".		"The team leader let the team know what was expected of them through direction and command".			
2. I knew what needed to be done to achieve our team goal(s).		"Equally divide agreed upon goals amongst the team".				
3. I knew how to get the work done to achieve our team goal(s).						
4. I knew what was expected of me in relation to other team members' roles and responsibilities	"Staff understand their roles and responsibilities".	"Understand the boundaries of what each other can do".	"The team worked together to complete tasks in a timely manner".		"I feel able to act as a fully collaborative member of the team".	"Understand the abilities and contributions of [interprofessional] IP team members".
5. I had tools available to guide my actions (e.g. ground rules; job aids; defined procedures).		"Equally divide agreed upon goals amongst the team".	"The team followed standards/ guidelines".			
6. I was able to anticipate the needs of team members.	"Staff effectively anticipate each other's needs".		"The team anticipated potential situations".			
7. I was aware of what the other team members were doing.	"Staff monitor each other's performance".					
8. I understood how my role and responsibilities contributed to (and were shaped by) team dynamics and/or events in the workplace.			"The team monitored and reassessed the situation".		"I feel comfortable in accepting responsibility delegated to me within the team".	
9. I was aware in a timely manner of changes within and beyond the team environment	"Staff within my unit share information that enables timely decisions making…"	"The team maintained a global perspective".	"The team adapted to changing situations".			

CTCQ Items	T-TPQ	AITCS-II	TEAM	Reciprocal Learning	ISVS	ICCAS
that impacted the team's ability to achieve its goal.						
10. I shared relevant information with other team members as it became available.	"Staff exchange relevant information as it becomes available".					
11. **When we encountered problems or conflicting priorities, I experienced doubt and uncertainty.						
12. We shared our feelings about the situation(s).	"Staff resolve their conflicts, even when the conflicts have become personal".					
13. I responded to changes by adjusting my actions.						
14. I was involved in discussions to re-evaluate situational changes.	"Staff share information regarding potential complications".		"The team monitored and reassessed the situation".			
15. I sought out other team members to address issues /problems.						"Seek out IP team members to address issues".
16. I negotiated responsibilities with other team members whose roles overlapped with mine.					"I feel comfortable clarifying misconceptions with other team members of the team about the role of someone in my profession".	"I negotiated responsibilities within overlapping scopes of practice".
17. I was aware of changes in roles and responsibilities			"The team adapted to changing situations".			
18. I used common professional language to communicate with team members.		"Use consistent communication with all team members".	"The team communicated effectively".			"Promote effective communication among IP members".
19. I used organizational standardized		"Use an agreed upon process	"The team followed			

CTCQ Items	T-TPQ	AITCS-II	TEAM	Reciprocal Learning	ISVS	ICCAS
processes to guide my actions.		to resolve conflict".	standards/ guidelines".			
20. We encouraged each other to use our knowledge and skills.		"Encourage each other and patients and their families to use knowledge and skills that each of us can bring in developing plans of care".				
21. I used more than one (1) resource to find information needed to inform my actions (e.g. another team member; written materials).	"My unit makes efficient uses of resources".		"The team followed standards/ guidelines".			
22. I purposefully created opportunities to communicate with others.		"Encourage and support open communicatio n …"			"I more highly value open and honest communicatio n with team members".	
23. I contributed to the effectiveness of the team.						"Identify and describe my abilities and contributions to the IP team".
24. I was able to coordinate my perceptions of what was occurring with perceptions of other team members to guide my actions.				"I learned a lot about how to do my job by talking with people in the clinic".	"I have gained a better understanding of my own approach within an interprofession al team".	
25. I learned through sharing of my knowledge and expertise with team members.				"In this clinic, we frequently learn about new things together as a group. I learn how to do things in this clinic by sharing knowledge with team members".	"I am able to share and exchange ideas in a team discussion".	"Learn from IP team members to enhance care".
26. I learned by watching how other team members performed their duties				"I am frequently taught new things by other people in the clinic".		"Learn from IP team members to enhance care".

CTCQ Items	T-TPQ	AITCS-II	TEAM	Reciprocal Learning	ISVS	ICCAS
and fulfilled their roles and responsibilities						
27. I was able to apply what I had learned from others.						
28. When we encountered a problem, as a team we examined it carefully to understand what the problem was about and why it had occurred.	"Staff meet to re-evaluate patient care goals when aspects of the situation have changed".	"Meet to discuss patient care needs".	"The team prioritized tasks".	"When we have a problem in this clinic, we tend to examine it carefully so that we can come to an understanding of the problem and why it occurred".		"Work closely with IP team members to enhance care".
29. I contributed to shared team decision making.	"Staff are held accountable for their actions".				"I am comfortable in shared decisions making with clients".	
30. I participated in re-setting team goals and activities as needed.						"Work closely with IP team members to enhance care".
31. My actions were consistent with those that we had practiced using a team approach.						
32. We used a team approach to fulfill our professional responsibilities.			"The team acted with composure and control".			"Recognize how other's skills and knowledge complement my own".
33. I worked closely with other team members to meet our goal(s).		"Work with patient and his/her relatives in adjusting care plans".				"Develop an effective care plan with IP team members".
34. I was aware of (or engaged in) communications between our team and other teams (or individuals) within or external to the organization.		"Coordinate health and social services (e.g. financial, occupation, housing, connections with the community, spiritual) based upon patient care needs".				
35. Through team interaction(s), I understood our responses						

CTCQ Items	T-TPQ	AITCS-II	TEAM	Reciprocal Learning	ISVS	ICCAS
to problematic situations.						
36. I was accountable for my contributions to the team.					"I feel comfortable in being accountable for responsibilities I have taken on".	"Be accountable for my contributions to the IP team".
37. I felt safe to speak up.	"Staff advocate for patients even when their opinion conflicts with that of a senior member of the unit".				"I feel comfortable debating issues in a team". "I feel comfortable speaking out within the team when otherwise are not keeping the best interest of the client in mind".	
38. I actively listened to other team members' ideas and concerns.					"I am able to listen to other members of the team".	"Actively listen to the perspectives of IP team members".
39. I expressed my ideas without being judgmental.						"Express ideas and concerns without being judgmental".
40. I took into account the ideas of other team members.						"Take into account the ideas of IP team members".
41. I respected the team members I worked with.		"Respect and trust each other".				
42. I trusted the team members I worked with.		"Respect and trust each other". "Establish a sense of trust among team members".				
43. **I experienced power struggles.		"Share power with each other".				
44. Leadership role was shared based team members' expertise with what was happening.		"Support the leader for team varying depending on the needs of our patients". "Together select a leader".			"I am comfortable being the leader in a team situation. I feel comfortable in taking different roles in a team (e.g. leader, participant)".	

CTCQ Items	T-TPQ	AITCS-II	TEAM	Reciprocal Learning	ISVS	ICCAS
45. I used constructive feedback that promoted positive interactions.	“Staff correct each other’s mistakes to ensure that procedures are followed properly”. “Feedback between staff is delivered in a way that promotes positive interactions and future change”.	“Are open and honest with each other”.				“Provide constructive feedback to IP team members”.
46. I addressed team conflict in a respectful manner.	“Staff resolve their conflicts, even when the conflicts become personal”.	“Strive to achieve mutually satisfying resolution for differences in opinion”.	“The team morale was positive”.			“Address team conflict in a respectful manner”.
47. I provided assistance to team members as needed.	“Staff assist fellow staff during heavy workload”.					
48. I received assistance from team members as needed.	“Staff request assistance from fellow staff when they feel overwhelmed”.					
49. I felt that I belonged on the team.						

Note. Convergent validity for collective team competence questionnaire (CTCQ) was established through a comparison of scale items from existing validated instruments. The instruments selected for comparison are (a) Teamwork Perceptions Questionnaire (T-TPQ; Agency for Healthcare Research and Quality, 2014), (b) Assessment of Interprofessional Team Collaboration Scale (AITCS-II; Orchard et al., 2018), (c) Team Emergency Assessment (TEAM; Cooper et al., 2016), (d) Reciprocal Learning (Leykum et al., 2011), (e) Interprofessional Socialization and Valuing Scale (ISVS; King et al., 2010), and (f) the Interprofessional Collaborative Competency Attainment Survey (ICCAS; Schmitz et al., 2017).