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The Impact of a Dedicated Pediatric Ambulance on Interfacility Transport Dispatch Times: Findings from the Canadian Pediatric Transport Network Database

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Abstract

Introduction: This retrospective cohort study evaluates the impact of a dedicated ambulance on dispatch times of pediatric transports to the London Health Sciences Centre using the Canadian Pediatric Transport Network (CPTN) database.

Methods: After assessing the data quality of the CPTN database, we used multiple linear regressions to examine differences in dispatch times before and after June 2019, when a dedicated ambulance was introduced.

Results: We found that additional measures are needed to improve data quality in the CPTN database. A dedicated ambulance improved ambulance return times but not dispatch times.

Conclusion: Ongoing quality assessment is necessary to improve the CTPN. Additional research is needed to investigate the cause of dispatch time delays.

Keywords

Pediatric transport, critically ill children, interfacility transport, dedicated ambulance, emergency medical services, Canadian Pediatric Transport Network

Summary for Lay Audience

Critically ill children often receive basic medical care and stabilization in their local hospitals but require transfer to a tertiary pediatric facility for specialized medical or surgical care. The goal of interfacility transport is to transport patients from referring local hospitals to specialized pediatric care centres at a standard as similar as possible to the care provided in pediatric critical care units. In Ontario, children under the age of 18 are transported by Ornge Transport Medicine, a nonhospital affiliated air medical transport agency, or by hospital-based teams, such as the transport team at the London Health Sciences Centre (LHSC). Interfacility transports are dangerous procedures because patient monitoring while in transit is difficult in addition to having limited medical resources. Thus, patient transports are ideally carried out in the shortest amount of time possible. One method that has shown to allow for shorter ambulance dispatch times is by having a dedicated pediatric ambulance, as it limits the need to rely on or coordinate transport with third parties. Since June 2019, transports by the London Pediatric-Neonatal Transport Team at the LHSC have been completed with a dedicated and specially equipped pediatric ambulance. We used the Canadian Pediatric Transport Network, a health administrative database, to assess whether having a dedicated ambulance was associated with shorter dispatch times. We found that having a dedicated ambulance improved ambulance return times to the LHSC but not dispatch times. Although a dedicated ambulance is a necessary resource, additional research is needed to investigate the cause of dispatch time delays to enhance the transport program at the LHSC.

Co-Authorship Statement

The study presented was conceived, designed, and executed by Tiffany Liu. Dr. Maria Mathews and Dr. Anna Gunz were primary supervisors and were involved in all aspects of this work. Dr. Kathy Nixon Speechley was a thesis committee supervisor and provided comprehensive feedback. All authors participated in critical revision of the thesis.

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List of Abbreviations

CI (*ll, ul*)	Confidence interval (*lower limit, upper limit*)
CIHI	Canadian Institute of Health Information
CPTN	Canadian Pediatric Transport Network
EHR	Electronic Health Records
EHS	Emergency Health Services
EMS	Emergency Medical Services
GTA	Greater Toronto Area
LHSC	London Health Sciences Centre
NICU	Neonatal Intensive Care Unit
PCCU	Pediatric Critical Care Unit
PELOD	Pediatric Logistic Organ Dysfunction
PIM III	Pediatric Index of Mortality III
REDCap	Research Electronic Data Capture
SD	Standard deviation

Chapter 1

1 Introduction

Due to the regionalization of healthcare, critically ill children often receive basic medical care and stabilization in their local hospitals but require transfer to a tertiary pediatric facility for specialized medical or surgical care (Gunz et al., 2014). In Canada, these facilities may be located a considerable distance from the referring hospitals (Gunz et al., 2014). The goal of interhospital critical care transport is to transport patients from referring hospitals to specialized pediatric care centres at a standard as similar as possible to the care provided in pediatric critical care units (PCCUs) (Kawaguchi et al., 2019). Acting as a mobile PCCU, critical care transport is necessary for patients requiring ongoing administration of medications and blood products, requiring specialized equipment or monitoring devices in appropriate pediatric size, and/or at high risk of deterioration during transport (Ornge Transport Medicine, 2020).

In Ontario, children under the age of 18 are transported by Ornge Transport Medicine or by hospital-based teams, such as the Neonatal-Pediatric Transport Team at the London Health Sciences Centre (LHSC), from referring hospitals to any of the four PCCUs in the province located in London, Toronto, Hamilton, and/or Ottawa (Kawaguchi et al., 2019). Hospital-based teams are dedicated pediatric transport teams, mostly consisting of registered nurses and respiratory therapists with specialized skills, that provide high quality care to critically ill children. Depending on the geography, weather, and distance between referring and accepting facilities, interfacility transports are carried out using land ambulances, air medical transport vehicles, or a combination of both (Whyte & Jefferies, 2015). Transports aim to be conducted as fast as possible as minimizing the entire out-of-hospital time is beneficial for patient outcomes (Blackwell & Kaufman, 2002). However, response time delays can occur at any point during the transport, whether from transport staff scheduling, patient conditions, weather, local emergency medical services (EMS) vehicle availability, or transport service coordination (Blackwell & Kaufman, 2002; Whyte & Jefferies, 2015).

In 2019, the Ministry of Health announced a $6.8 million investment into safer and faster transport for critically ill newborns and children across the province. The funding supported five specially equipped ambulances to support hospital-based neonatal and neonatal-pediatric teams in providing transport to the four children's hospitals in Ontario (Ministry of Health and Long-Term Care, 2019). While the LHSC team transports on average 300 critically ill infants and children annually, the team did not have its own ambulance prior to 2019, but instead relied on non-emergency private patient transfer vehicles such as Voyago (Voyageur Medical Transportation) vehicles or taxis to transport the team between referring facilities and the LHSC (London Health Sciences Centre, 2020a; Southwest Healthline, 2020). With the new funding, a dedicated ambulance was assigned to the LHSC for pediatric transports. This study evaluates the impact of a dedicated ambulance on transport times of pediatric transports to the LHSC using the Canadian Pediatric Transport Network (CPTN) database.

The CPTN database captures data of all pediatric patients (less than 18 years old) who are transported by the LHSC transport team between healthcare facilities in Ontario. It is a new database that provides an opportunity to describe the characteristics of interfacility transports of pediatric patients. The existing database is a pilot project at the LHSC, aiming to expand the CPTN to include all Canadian pediatric transport teams in the future. Accordingly, this study assesses the quality of the CPTN database through data validation.

1.1 Research Question and Objectives

What is the quality of the CPTN database, and can it be used to assess the impact of a dedicated ambulance on transport times of critically ill children to the LHSC?

This study has three objectives:

1. To assess the validity of the CPTN Database.
2. To describe the characteristics of transports completed by the LHSC transport team over a two-year period, from May 2018 to April 2020.
3. To evaluate the impact of a dedicated ambulance on transport times of critically ill children to the Children's Hospital at the LHSC in London, Ontario.

We hypothesize that having a dedicated ambulance at the LHSC reduces the total dispatch time, compared to not having a dedicated ambulance.

1.2 Rationale

The CPTN is a newly formed national pediatric transport collaborative database aiming to provide evidence required to inform decisions and improve transport practices and patient safety. This study provides an opportunity to support research in critical care pediatrics by validating the new CPTN database and its attributes. Advances in knowledge in pediatric transport rely on the availability, quality, and comprehensiveness of data from cohort studies with large population-based samples (van Hoeven et al., 2017). It is important to conduct data quality assessments to ensure that the CPTN database is suitable for research purposes since it was created with information collected for the purpose of clinical care (Khare et al., 2017; Weiskopf & Weng, 2013). Data quality analyses allow for a description of the current data, advises on future data entry submissions to minimize errors, as well as provide clarity on variables that are suitable for research (Khare et al., 2017).

The study also provides information about the pediatric transport program at the LHSC. Since the CPTN database has not yet been used in research, the first step of data analysis is usually of a descriptive nature. A descriptive analysis provides an understanding of transports completed by the LHSC transport team over the 2-year period such as the patient population going to the LHSC, the frequency of interfacility transports, emergency vehicle transport times, transport team characteristics, and complications during transports. With basic information about the nature of transports, the LHSC can create a benchmark for assessing quality of care during pediatric transport. Descriptive data about the program is essential for future planning and justifying resource needs to improve the program. As well, descriptive analyses can identify where revisions of the data collection tools are needed. A better understanding of the program can highlight potential relationships between variables, generate hypotheses, and ultimately allow for the development of new research questions.

Lastly, understanding the impact of a dedicated ambulance on transport time can help improve the program by identifying how additional resources have affected the provision of care during transport. The analyses can provide detailed information about overall transport times and identify where improvements could be made. This study provides an example of how the CPTN database can be used for research and ongoing quality improvement within the pediatric transport program. The findings can inform on the development of national standards for pediatric transport teams to maximize patient safety and system efficiency during the interfacility transport of critically ill and injured Canadian children.

Chapter 2

2 Background & Literature Review

The following background first describes healthcare facilities in Southwestern Ontario and ambulance services in Ontario. It continues by providing an overview of the literature available on pediatric transport and describes the interfacility transport process at the LHSC. The chapter concludes by discussing factors associated with transport times.

2.1 Healthcare Facilities in Southwestern Ontario

Southwestern Ontario has a population of 1.68 million, accounting for 11.7% of Ontario's population. It encompasses ten municipalities including the Bruce, Elgin, Essex, Grey, Huron, Chatham-Kent, Lambton, Middlesex, Oxford, and Perth municipalities (Ministry of Finance, 2018). The region has roughly 30 healthcare facilities, including one of the four pediatric hospitals in Ontario (Ministry of Health and Long-Term Care, n.d.). As a regional referral centre, the Children's Hospital at the LHSC provides specialized pediatric inpatient and outpatient services, including trauma and intensive care to the region's 400,000 children from birth through age 18 (London Health Sciences Centre, 2020a).

2.2 Ambulance Services in Ontario

2.2.1 Organization of Ambulance Services in Ontario

The Ministry of Health and Long-Term Care (Ministry) oversees land ambulance services in Ontario based on requirements set out in the Ambulance Act (Ministry of Health and Long-term Care [MOHLTC], 2008). The Act ensures a balanced and integrated system of ambulance services and communication services used in dispatching ambulances (MOHLTC, 2008). The Ministry's emergency health services (EHS) system is a series of interrelated land and air emergency medical services and programs designed to provide timely medical response and pre-hospital care (Ministry of Health and Long-term Care [MOHLTC], 2018a). Ontario's dispatch and emergency response system is jointly managed by the Ministry, municipalities, and Ornge Transport Medicine (MOHLTC, 2018a).

The Ministry is responsible for the land ambulance system by regulating ambulance operations, monitoring, and certifying ambulance services, and ensuring paramedics have proper qualifications (MOHLTC, 2018a). Under the Act, every municipality is responsible for ensuring proper provision of land ambulance services in accordance with the needs of persons (MOHLTC, 2008). Municipalities have the option to provide ambulance services directly or contract a third-party provider as 15% of municipalities do, whether it be a neighbouring service or a private operator (MOHLTC, 2008). Accordingly, 42 municipalities and eight other designated delivery agents, that are primarily in remote areas, are responsible for operating and maintaining land ambulance services (MOHLTC, 2008). Of 22 dispatch centres that serve as communication hubs for receiving emergency calls and dispatching land ambulances, 11 are run by the Ministry, six by hospitals, four by municipalities and one by a private operator (MOHLTC, 2008). Ornge is a nonhospital affiliated air medical transport agency in Ontario involved in all air ambulance services, air dispatch, and authorizing air and land ambulance transfers (MOHLTC, 2018). Ornge conducts more than 18,000 patient transports annually using a fleet of rotor wing aircrafts (helicopter), fixed wing aircrafts, and land ambulances (Kawaguchi et al., 2019).

2.2.2 Ambulance Services

Ambulances serve to respond only to emergency situations, which is when a person's safety or health is at risk and they require immediate help (Region of Peel, n.d.). Medical emergencies can include chest pain, fractured or broken bone, wounds that need stitches, severe pain or shortness of breath, choking or difficulty breathing, and signs of a stroke (Region of Peel, n.d.). Children experiencing diarrhea and vomiting who refuse to eat or drink, babies younger than six months with a fever above 37.9°C, or babies six months or older with a fever above 38.5°C are also deemed as emergency situations (Region of Peel, n.d.). Medical care that does not require immediate action may not require ambulance services. Ambulance responses include interfacility transport (when patients require medical attention during transport between hospitals), scene calls (where medical personnel provide first response or initial care at the scene), and modified scene calls

(where medical personnel is dispatched to the scene and then redirected to the nearest hospital because another provider arrived at the scene first) (Singh et al., 2016).

2.2.2.1 Pre-hospital Care

Pre-hospital care, which includes scene calls and modified scene calls, is the assessment, stabilization and care patients receive before arriving at the hospital. Care is provided by EMS responders, who are the initial health care providers at the scene of a disaster (Hanfling et al., 2012). Emergency scenes are often chaotic, challenging for emergent or urgent healthcare interventions, and unfamiliar places to pre-hospital care providers (Bigham, 2012). EMS personnel, such as emergency medical technicians and paramedics, are first to recognize the nature of the disaster and must make quick on-scene assessments (Hanfling et al., 2012). They transport patients to the nearest emergency department and return to service in their community (Bigham, 2012).

2.2.2.2 Interfacility Care

Interfacility transport is needed if patients require additional technical or medical care that is not available at the patient's location (Kawaguchi et al., 2019). It is necessary to improve upon the existing management of the patient through transfer to another facility with more advanced care. Patients are usually transported by the local EMS or by hospital-based teams (Kawaguchi et al., 2019). Interfacility transport personnel are responsible for pre-transfer stabilization and preparation, providing continued medical care during transport, and documentation and handover of the patient at the receiving facility (Kulshrestha & Singh, 2016). Compared to pre-hospital care, interhospital transport usually admits the patient directly to an inpatient bed instead of the emergency department.

2.2.3 Air and Land Paramedic Vehicles

Various land vehicles are available for patient transport in the EHS system, depending on the emergency (MOHLTC, 2018a). Ambulances are used to transport patients suffering from acute illness with risk to their life and patients who require a stretcher or medical attention during transport, whether to a hospital or interhospital (MOHLTC, 2018a). As

per provincial standards, they are equipped with adult and pediatric equipment (Ministry of Health and Long-Term Care [MOLTHC], 2018b). An emergency response vehicle is a vehicle other than an ambulance that can respond to a medical emergency and address patients on site (MOHLTC, 2018a). Special purpose ambulances are equipped with specific functionality, such as more equipment and medication, to address specific non-standard medical emergencies (MOHLTC, 2018a; MOHLTC, 2018b). In terms of air medical transport vehicles, Ornge is involved in all air transport in Ontario, with aircrafts positioned to deliver services based on operational requirements. Many air transports conducted by Ornge originate in rural areas where road access is limited, and remote locations are too far for land ambulances to be a feasible option (Singh et al., 2016). Despite air transport being advantageous in terms of speed, they are more susceptible to weather conditions such as thunderstorms, snowstorms, or high wind velocities, and are inherently more dangerous than ground transport as they result in more fatal accidents (Steenhoff & Zohn, 2020). Mode of transport is dependent on distance, which can be up to 1500 kilometers in Ontario.

The province of Ontario funds the land ambulance dispatch system, service provision to First Nations, and service provisions to territories without municipal organization (MOHLTC, 2018a). All EHS are publicly funded, which includes land ambulances services and Ornge's air ambulance and critical care land ambulances (MOHLTC, 2018a). There are also private land and air transport services in Ontario, such as Voyago or MedEvac Canada, responsible for transporting non-emergency patients to and from hospitals, medical facilities, retirement homes, long-term care homes, airports, and private homes (MedEvac Canada, 2018).

2.3 Pediatric Transport

Of the 140,000 newborns in Ontario annually, more than 2,000 require transport to a specialized care centre. In 2016-2017, there were 27.8 per 1,000 patients aged 0-4 years old and 22.5 per 1,000 patients aged 5 to 18 years old who arrived by ambulance seeking higher level emergency medical care (MOHLTC, 2018a). Reasons for emergency medical care for patients aged 0 to 4 years were seizure, fever, shortness of breath, head

injury, and cough or congestion, and reasons for patients aged 5 to 18 years old were seizure, head injury, lower extremity injury, abdominal pain, and depression, suicidal or self-harm (MOHLTC, 2018a).

Ontario's critically ill pediatric population is served by four PCCUs located in Ottawa, Hamilton, London, and Toronto. Transport is necessary for critically ill patients who require in-transit management of critical illness and/or injury such as ongoing administration of medications and/or blood products during transport, specialized equipment (ventilators, multi-channel infusion pumps) or monitoring devices, specialized procedures (special peripheral or central access, intubation, chest tubes), and/or at high risk of deterioration (Kawaguchi et al., 2019; Ornge Transport Medicine, 2020)

Previously, Ornge had a designated pediatric transport team which consisted of a nurse with pediatric experience and a paramedic with critical care paramedic designation. However, the designated team was disbanded before 2020 (MOHLTC, 2018a). Currently, children under the age of 18 who require specialized medical care are transported by either Ornge general transport teams or hospital-based pediatric critical care teams. Ornge services patients under 5 kg who are non-ventilated and patients under the age of 18 from any location in Ontario to a PCCU (Ornge Transport Medicine, 2020). All four children's hospitals in Ontario have dedicated hospital-based transport teams. Pediatric critical care physicians are most often responsible for deciding the hospital-based team composition and mode of transport (Kawaguchi et al., 2019). The LHSC transport team transports children up to 18 years of age to the Children's Hospital at the LHSC, while the team at The Hospital for Sick Children in Toronto provides transport for children up to 12 years of age. Both the McMaster Children's Hospital in Hamilton and the Children's Hospital of Eastern Ontario located in Ottawa provide transport for children up to 28 days of age and 5 kg.

2.3.1 LHSC Neonatal-Pediatric Transport Team

The LHSC Neonatal-Pediatric Transport Team consists of around 25 highly skilled and experienced registered nurses and respiratory therapists who have received

comprehensive advanced training in neonatal and pediatric transport (London Health Sciences Centre [LHSC], 2020b). The LHSC's transport team is unique as it is the only hospital-based team in the province that services transport for the entire pediatric age range, from neonates to 18 years old. They transport on average 300 critically ill infants and children annually (LHSC, 2020b). Compared to ad hoc team members, transport team members work regular shifts in the PCCU and the Neonatal Intensive Care Unit (NICU) during and after their training to keep their skills honed and are ready to leave for patient transports immediately when called upon.

2.4 Transfer Process (LHSC)

The process for interfacility transport of a pediatric patient to a centre with a higher level of care begins with a call from a referring facility to the accepting facility, like the LHSC. There are multiple outcomes of a call which include requesting advice for the care of a patient (no resulting transport), referral to another transport team or to another hospital, telemedicine, transport by the referral site, deferred to the NICU for neonatal advice/care, deferred transport as no team is available for transport and lastly, transport by the accepting facility. If the accepting physician accepts the transfer, the LHSC transport team is dispatched. Another call is made to Voyago or to a taxi company to dispatch a vehicle to pick up and take the transport team to the referring facility. The roles and responsibilities of the referring and accepting physician are well defined, where the referring physician reports the acuity of the patient, and the accepting physician selects the type and urgency of transport. If multiple patients require transport, the transport team is triaged based on patient acuity and the remaining patients are assigned to a team ad hoc with varying skill levels. Transport to and from the referring facility can involve multiple legs if more than one mode of transportation is used and can take hours depending on distance between facilities. Upon arrival to the patient's bedside, the transport team stabilizes and resuscitates the patient as much as possible, and performs interventions deemed necessary (for e.g., endotracheal intubation) as any interventions are more difficult during transit. Stabilization can take several hours. Finally, once appropriately stable for transport, the patient is transported to the LHSC for admission.

Until 2019, the LHSC team did not have its own ambulance. Previously upon dispatch, Voyago vehicles or taxis were called to depart and take the team from the LHSC to referring facilities. In 2019, the Ministry announced a $6.8 million investment into safer and faster transport for critically ill newborns and children across the province (Ministry of Health and Long-Term Care, 2019). The funding supports five specially equipped ambulances to support hospital-based neonatal and neonatal-pediatric teams in providing transport to the four children's hospitals in Ontario, including the LHSC (Ministry of Health and Long-Term Care, 2019). While the LHSC's dedicated ambulance is operated and maintained by Middlesex-London EMS, the vehicle is reserved for use by the transport team for pediatric transports. The four hospitals also received a total of $5.8 million to ensure the dedicated pediatric transport teams are available 24 hours a day, seven days a week. The intent of having a dedicated ambulance is to reduce the time to service.

2.5 Factors Associated with Transport Times

Interfacility critical care transport not only serves to transport patients from community hospitals to specialized pediatric care centres, but also to provide patient care during transport that is as similar as possible to the care provided in PCCUs (Kawaguchi et al., 2019). However, transport to tertiary-care centres is a dangerous procedure. The transport environment complicates monitoring as patients are strapped in and covered, making it difficult to assess vitals. In addition, it may be too loud to auscultate patients or communicate with other team members. The cramped space makes it difficult to access the patient, retrieve supplies and ensure that team members are safe. Finally, children are subjected to environments with limited medical resources that place them at a heightened risk of deterioration and adverse events (Gunz et al., 2014).

Thus, patient transports are ideally carried out in the shortest amount of time possible while maintaining the utmost level of care. The total transport time consists of multiple time intervals: the system response interval (the time from receipt of the call to arrival at the referring facility), the stabilization interval (the time from arrival at the referring facility to departure), and the transport interval (the interval from departure from the referring facility to arrival at the accepting facility) (Blackwell & Kaufman, 2002; Orr et

al., 2009; Whyte & Jefferies, 2015). Minimizing the entire out of hospital time, including system response, stabilization, and transport times, is considered beneficial for patient survival (Blackwell & Kaufman, 2002; Whyte & Jefferies, 2015). Components influencing an increase in system response interval can include personnel logistics (delays in deferring the transport to the next shift if the time of call for transport is between shift changes), communications and operations logistics (coordination of transport vehicles with third-parties such as Ornge, private transport companies, Middlesex-London EMS, taxis) and transport logistics (transport vehicle unavailable, incompatible, or malfunctioning) (Blackwell & Kaufman, 2002; Whyte & Jefferies, 2015). Stabilization interval times are mainly influenced by patients' conditions and the time it takes to stabilize them for departure. Finally, the transport interval is similarly influenced by communications and operations, and transport logistics from the system response interval (Blackwell & Kaufman, 2002; Whyte & Jefferies, 2015). As a transport call is made, multiple components come into play and work in tandem with internal (i.e. communications and operations, personnel) and external (i.e. transport vehicle) system assets (Blackwell & Kaufman, 2002). Each of these components has the potential to influence response times. While delays may occur at any point along a call continuum, one strategy that has been found to decrease response times is to allocate more resources into the community, including having dedicated personnel for transport and sustainment costs (Blackwell & Kaufman, 2002).

As of June 2019, with Ministry funding, a dedicated ambulance for pediatric transports was assigned to the LHSC. A Canadian systematic review focused on recommendations for improving the interfacility transport of critically ill newborns found that transport teams with their own dedicated ambulances allow for faster response times (Whyte & Jefferies, 2015). When EMS ambulances are used instead of dedicated ambulances, emergency calls (e.g. 911 calls) compete for their availability due to the mandate to respond to emergency calls, increasing system response times (Whyte & Jefferies, 2015). Having a dedicated ambulance has the potential to reduce the system response interval and the transport interval times, by limiting the need to rely on or coordinate transport vehicles with third parties. In the system response interval, by having their own

ambulance, the lag time in arranging for a vehicle to transport the transport team to the referring hospital can be reduced or eliminated, or if the dedicated ambulance is already on route, it can be rerouted without needing to consult other parties. This simultaneously reduces the time between the call to arrange transportation and the arrival of transportation to home base, as the ambulance is situated nearby. In the transport interval, the transport team can use the same ambulance to return to home base without needing to further arrange a vehicle. Consequently, we hypothesize that having a dedicated ambulance reduces the overall dispatch time of the transport team.

In a cross-sectional Canadian study of thirteen pediatric critical care transport programs, the median transport time from dispatch (from team home site) to arrival at the receiving facility was 195 minutes (range, 90-360 minutes) (Kawaguchi et al., 2019). All programs have a set target time for team mobilization for transport (dispatch from their home site), ranging between 10 and 30 minutes (median, 25 minutes) (Kawaguchi et al., 2019). Two of the thirteen teams nationwide have ground ambulances and/or helicopters dedicated to the transport team (Kawaguchi et al., 2019). Five (63%) teams use planes that are not dedicated to their teams and only one team has a jet dedicated to the team (Kawaguchi et al., 2019). A comparison of air and land ambulances in Ontario showed that transport times for land ambulances were shorter for distances less than 100 km and equivalent for distances of 100 km to 250 km, reflecting the time needed to arrange helicopter transport (Whyte & Jefferies, 2015). Although the literature suggests that having a dedicated ambulance results in faster response times, the impact of a dedicated ambulance on transport times has not been quantified.

2.5.1 Limitations in Literature

A limitation of much of the literature is that most studies focus on adult transports at emergency scenes rather than interfacility transport. Existing studies in pediatric transport literature focus on the frequency and nature of in-transit clinical deterioration and interventions (Barry & Ralston, 1994; Hamrin et al., 2016; Kanter et al., 1992; Kanter & Tompkins, 1989; Orr et al., 2009; Singh et al., 2016; Tijssen et al., 2020). Whilst studies collect and report on the length of transport as a predictor, there is mixed evidence as to

whether it is associated with clinical deterioration (Barry & Ralston, 1994; Hamrin et al., 2016; Kanter et al., 1992; Kanter & Tompkins, 1989; Orr et al., 2009). There is limited literature studying transport time as an outcome (McLean et al., 2017).

The length of a pediatric transport can be measured in distance and/or time and varies depending on the mode of transportation involved (Kanter et al., 1992). A study in the United States found that neither mode of transport (air versus ground) nor transport time was associated with transport morbidity (Kanter et al., 1992). However, the study found that greater transport distance was associated with transport morbidity (Kanter et al., 1992). In contrast, studies in the United Kingdom, Sweden and Canada have shown that there is no significant association between patients travelling long distances and mortality in PCCUs (Hamrin et al., 2016; Ramnarayan et al., 2010; Tijssen et al., 2020). A large observational Canadian study on pediatric patient outcomes found that greater distance (in kilometers) to PCCUs was associated with longer hospital length of stay and shorter total transport time was associated with increased PCCU intervention use (Tijssen et al., 2020). While numerous studies consider the length of transport, it is most often used as a predictor to investigate various patient outcomes.

One study in the United States focused on mobilization time, from the time of the call until the transport's team departure to the referral facility, as an outcome (McLean et al., 2017). Despite finding that longer mobilization times were associated with having to conduct a greater number of pediatric transports, the study does not discuss any other predictors frequently found in pediatric literature. In studies on patient clinical deterioration and interventions, predictors such as a specialized transport teams, distance between facilities, time of day of transports, patient characteristics and conditions, and transport delays are often studied (Barry & Ralston, 1994; Hamrin et al., 2016; Orr et al., 2009; Quinn et al., 2015; Singh et al., 2016; Tijssen et al., 2020). Specialized transport teams have been found to improve patient outcomes but conclusions about faster response times are unclear (Orr et al., 2009; Whyte & Jefferies, 2015). Moreover, a Canadian study found that the number of in-transit adverse events varied per age group and was associated with patient's clinical conditions prior to transport (Singh et al., 2016). Predictors like the time of day and transport delays are relevant as the former

affects travel time due to traffic patterns and the latter is reported to be attributed to delays in the arrival of a land ambulance (Hamrin et al., 2016; Quinn et al., 2015). Although this study does not use patient outcomes as the main outcome, it is noteworthy to discuss transport times and commonly discussed predictors in relation to the bulk of pediatric transport literature.

Chapter 3

3 Methods

This chapter details the methodology used to complete this study. It provides details on validation of the CPTN database, descriptive analyses, and multiple linear regressions to assess the impact of a dedicated ambulance on transport times. The study was a population-based retrospective cohort study of pediatric patients who are transported by the LHSC's Neonatal-Pediatric Transport Team using data from the CPTN database.

3.1 Data Source

The data used in this study were from the CPTN. The CPTN is a newly formed national pediatric transport collaborative database that aims to pool the experience and expertise available to obtain the evidence required to drive decisions that improves transport practices and improves patient safety. The objectives of the CPTN database are to: 1) record the incidence and nature of critical events that occur during the transport of a pediatric patient and patient outcome; 2) identify predictors of critical events during interfacility transport; 3) understand how critical events relate to relevant clinical outcomes; 4) establish benchmarks for assessing quality of care during pediatric transport; 5) devise national standards for transport team processes and characteristics to maximize patient safety and system efficiency that would have national and potentially global impact.

The database was created May 1st, 2018, through nine data entry forms: administrative information, patient information, transport information, transport times, clinical information including Pediatric Index of Mortality III (PIM III), Pediatric Logistic Organ Dysfunction (PELOD), medications and interventions, complications, and patient outcomes. It currently has transport data from the Neonatal-Pediatric Transport Team from the LHSC (London), and is expected to have data from three other Canadian transport services in the future: the Acute Care Transport Services Team from the Hospital for Sick Children (Toronto), the Stollery Pediatric Transport Service from the Stollery Children's Hospital (Edmonton) and L'équipe de transport interhospitalier

pédiatrique du CIUSSS from Hôpital Fleurimont (Centre Hospitalier Universitaire de Sherbrooke) (Sherbrooke). These centres constitute 4 of the 12 pediatric hospitals in Canada and have a combined number onto approximately 1400 annual pediatric transports. The data from the four sites will be inclusive to all pediatric patients (less than 18 years) who undergo interfacility transport by a collaborating transport service to a pediatric hospital and are admitted to a PCCU or other departments. Data are manually inputted into the database at all sites by transport and research teams from transport records and electronic health records (EHR). The existing database is a pilot project to build and test the database using transport data from the LHSC, with the goal of expanding the CPTN across the country to include all Canadian teams in the future.

This study examines CTPN data on all pediatric patients (less than 18 years old) who are transported between healthcare facilities in Southwestern Ontario. Using the database, the study reviewed transports completed by the LHSC Neonatal-Pediatric Transport Team. Data from the LHSC are entered into the data capture platform, Research Electronic Data Capture (REDCap). The transport team is responsible for entering data from paper transport records into REDCap after each transport for the following forms: administrative information, patient information, transport information, transport times, clinical information (PIM III at the “upon first contact with the transport team time” point), medications and interventions, and complications. Meanwhile, the research team cross verifies the data entered by the transport team and enters the patient outcome data from EHR and paper charts into REDCap for the clinical information (PIM III at the “1 hour after arrival at the PCCU" time point), PELOD, and patient outcomes forms. A random 5% of charts are re-abstracted for data reliability and error detection. The database includes data on referral and accepting hospital sites, transport team (e.g., number, disciplinary composition), patient demographics (e.g., age, sex), clinical (e.g., medical problems, vitals during and after transport, patient outcomes), medications and interventions received during transport, transport (e.g., duration, delays, number of legs, mode, complications), and pediatric indicator scores (e.g., PELOD, PIM III). REDCap was accessed through the Lawson Health Research Institute, the research institute of London Health Sciences Centre and St. Joseph’s Health Care London.

3.2 Study Population

The study sample includes all interfacility pediatric transports performed by the LHSC's Neonatal-Pediatric Transport Team from May 1, 2018, to April 30, 2020 (n= 374).

3.3 Research Objective 1: Assessing the Validity of the CPTN Database

3.3.1 Significance of Data Validation

With the proliferation of EHR, there has been increasing interest in conducting research with data collected during routine clinical care (Feder, 2018; Khare et al., 2017; Weiskopf & Weng, 2013). Given that EHR are designed for clinical purposes rather than research use, reuse of EHR data are limited by concerns of data quality and its suitability for research (Feder, 2018; Khare et al., 2017; Weiskopf & Weng, 2013). CPTN data are derived from the LHSC's EHR and paper transport records, thus it is important to conduct data quality assessments prior to database expansion across Canadian teams and before it is used for healthcare research that influences clinical practice. Despite the importance of using study data that are of high quality to draw valid conclusions, the practice of data quality assessment is elusive and not widely used by researchers (Feder, 2018). Analyses of the quality of data serves several purposes. It can highlight the types of data errors that can be resolved in future data entry submissions, gain an understanding of the characteristics of the data and ensure that they are consistent with expected values, and finally, it can help map the data quality results so that researchers may conduct initial assessments of the suitability of the data for specific research studies (Khare et al., 2017). Although there is no definitive agreement on components of data quality in available research, comprehensive reviews of EHR consensually report five dimensions of data quality: accuracy, completeness, consistency, plausibility, and timeliness (Feder, 2018; Kahn et al., 2012; Khare et al., 2017; van Hoeven et al., 2017; Weiskopf & Weng, 2013).

3.3.2 CPTN Database Validation

The first objective of this study is to validate the CTPN database. Advances in knowledge in pediatric transport relies on the availability, quality, and

comprehensiveness of data from cohort studies with large population-based samples (van Hoeven et al., 2017). To begin data validation, data were imported from REDCap to SAS statistical software (version 9.4, SAS Institute Inc., Cary, NC). The validation approach followed the five dimensions of data quality widely reported in literature, where studies identified existing validation frameworks of EHR data or linked multisource data and selected five common data validity concepts (Feder, 2018; Kahn et al., 2012; Khare et al., 2017; van Hoeven et al., 2017; Weiskopf & Weng, 2013). In addition, we followed Van Hoeven's (2017) approach to assessing external validity. We assessed the validity of the CTPN using the following domains: internal consistency (accuracy, completeness, consistency, plausibility, and timeliness) and external validity. Internal consistency outcomes evaluated expectations of what are considered valid values within the CPTN database, or valid relationships between and within variables. External validity, the agreement between the data and external sources, is assessed in two ways: 1) comparison with earlier findings in literature and 2) numbers and findings are checked by presenting them to an expert in the field (van Hoeven et al., 2017).

3.3.2.1 Data Accuracy

We began with data accuracy which aims to verify the extent to which information in the CPTN database is true (Weiskopf & Weng, 2013). Data accuracy can be assessed through two methods, by comparing variables within the database with other external sources or through cross verification using another source of data, such as paper records, information supplied by patients, data review, or direct data entry (Feder, 2018; Weiskopf & Weng, 2013). We assessed data accuracy through cross verification, by double entering a random sample of patient charts using EHR and paper records. Of a sample size of 374 patients, approximately 10% of patient charts (36 charts) were randomly selected to be double entered into the database. We compared each variable from the original 36 charts to the corresponding double entered charts to report the percent difference in data entry. This indicated which variables in the CTPN are accurate and reliable for research, and which variables are prone to errors at a 5% threshold. The 5% threshold for accuracy was chosen to be the same threshold as for missing data (Dong & Peng, 2013; Schafer, 1999). We considered variables with less than 5% in difference of

data entry to be reliable and variables with more than 5% difference in data entry to be unsuited for research until further measures are applied to correct data entry submissions (Dong & Peng, 2013; Schafer, 1999).

Errors were categorized into two types of errors: missing and disagreement. The missing error represents a missing data entry in either the original or the double entered case making it incomparable whereas the disagreement error indicates that the compared variables were not identical. Variables that had both disagreement and missing errors were assigned the error type that applied to the highest number of errors. For each form, we used frequencies to describe the number of variables, the type of variable (categorical, continuous, count, character, or date time), variables without errors, and the types of errors. The frequency of variables that were not applicable for data accuracy assessment was also provided. Non applicable variables were patient identifiers, auto calculated or CPTN database label variables. We also checked for duplicate cases by verifying that there are no transports that have the same date and time using the 'Date and Time of Call' variable.

3.3.2.2 Data Completeness

Data completeness is defined as the degree of missing values within the CPTN database (Feder, 2018; van Hoeven et al., 2017). Through nine frequency tables, one for each form in the CPTN database, we assessed the completeness of each form. Comment boxes that required an entry, such as for variables where 'other' is an option and is followed by a comment box to provide additional details, were included in data completeness. If the comment box was unfilled, the variable was counted as missing data. Comment boxes that were optional were excluded. Except for the five main types of complications in the complications form, variables that had check box responses (select all that apply) and had no recorded data were also excluded from the assessment. Completeness was reported in groups: 100%, 95-99%, 90-94%, 80-89%, 51-79% and less than 50%, to accommodate any preferred thresholds. For each form, we used frequencies to report the number of variables that were assessed for completeness, the type of variable (categorical, continuous, count, character, or date time) at a 95% completion level, and missing data.

There is no general agreement on the proportion of acceptable missing data for statistical inference, as published estimates have ranged from 5% to 20% (Dong & Peng, 2013; Feder, 2018; Schafer, 1999). A 5% missing data threshold was used for this study.

3.3.2.3 Data Consistency

Data consistency pertains to the constancy of data quality and agreement between variables within a database (Chan et al., 2010; Feder, 2018; Weiskopf & Weng, 2013). This entails that two variables recording the same information for a single patient should have the same value, or variables recording different information make logical sense when considered as a whole (Weiskopf & Weng, 2013). Evaluation of data consistency also considers whether measures across time and data sources all have the same units and level of detail and/or coding system (Chan et al., 2010; Kahn et al., 2012; van Hoeven et al., 2017; Weiskopf & Weng, 2013).

The approach for evaluating data consistency is like data accuracy and data completeness, through measures of central tendency, measures of dispersion and frequency distributions (Feder, 2018). We produced frequency tables on variables that should have the same values, for e.g. 'Death or Discharge Date/Time from Receiving Area' should have the same value as 'Hospital Discharge Date', and for values that should make logical sense when considered together, for e.g. 'Date and Time of Call', 'Team Departed Home Base', 'Team Arrived at First Leg Destination', 'Depart Referral Site' and 'Arrive at Accepting Facility' are dates and times that should be in chronological succession.

We also assessed the consistency of units and level of detail within the database. Variables in the CPTN database that require units are patient vitals in the clinical information and PELOD forms, and patient characteristics such as gestational age (weeks) and current weight (kg). Within the CPTN database, all measurements units are standardized units in clinical settings and have been preset in REDCap. Some preset units also have a suggested range: 0.5-150 kg for weight, 20 – 250 bpm for heart rate, 10 – 300 mmHg for systolic and diastolic blood pressure, and 10-200 mmHg for mean blood pressure. We compared variables within the CPTN database and across the literature to

identify inconsistent units of measurement. We reported on the ranges of all variables with units to identify outliers that suggested inconsistent units. These were reported in the data plausibility section as the approach for appraisal of data consistency is similar. If outliers were identified, they were checked with the original medical records to confirm whether data points were entered incorrectly, used a different unit of measurement, or if it was a clinical value out of suggested range.

To ensure that the level of detail does not change over time, we identified variables with comment boxes, and compared whether the amount of typing (i.e., number of characters) has changed since the implementation of the database. No formal analysis was conducted for this, as we only took note if there were long sentences versus a few words. Using frequencies, we described the number of variables with inconsistencies.

3.3.2.4 Data Timeliness

Data timeliness refers to whether data were recorded in the EHR within a reasonable period following measurement or were representative of the patient state at a desired time of interest, and the recency of data to be considered current medically relevant (Feder, 2018; Weiskopf & Weng, 2013). It also considers whether there are unexplained changes in data entry over time within one variable or linkage patterns between multiple variables (van Hoeven et al., 2017).

We are unable to assess whether data were recorded within a reasonable period following measurement or were representative of the patient state at a desired time of interest as the CPTN database does not have dates and times associated with values. However, the database was created using data from paper transport records and EHR. Values used in the database are from paper transport records that were recorded in real time during transport and are all date and time stamped and entered in REDCap accordingly. Values used from EHR are laboratory values that are also date and time stamped. Thus, values in the CPTN database were likely both recorded within a reasonable period following measurement and representative of the patient state at a desired time of interest.

We reported the recency of the data, using the PCCU discharge date variable of the last eligible case to when the data were used for analysis. The PCCU discharge date is the last value entered before a case is marked as complete. To assess unexplained changes of data entry over time, we assessed any changes in data entry for variables that have an auto-calculated option in REDCap and a manual entry option, such as the PELOD scores and the PIM III scores. This ensures that there are no unexplained variations in the calculations.

The formulas for PELOD and PIM III remain unchanged as of 1999 and 2013, respectively (El-Nawawy et al., 2017; Jung et al., 2018). Both scores are calculated based on patient vitals. PIM III scores (PIM III score and PIM III risk of death) are calculated at two time points: upon first contact with the transport team and 1 hour after arrival at the PCCU, whereas PELOD scores are calculated at day 1, day 2, day 5, day 7, day 10, day 14, day 21 and day 28 in the PCCU, if applicable. We reported the frequency of auto-calculated and manual entries for PELOD and PIM III scores.

3.3.2.5 Data Plausibility

Data plausibility examines the overall feasibility or credibility of the data, which is perceived through the agreement of the data with primary data sources, general medical knowledge, or user-perceived reality (Feder, 2018; van Hoeven et al., 2017; Weiskopf & Weng, 2013). Data plausibility relies on whether values appear reasonable in terms of time-related, or natural world limitations and are within clinically plausible ranges (Feder, 2018; Weiskopf & Weng, 2013). The most common methods of assessing data plausibility are to look for values outside clinically plausible ranges, are unlikely changes over time, or are zero values and to compare values with existing external data (Feder, 2018; Weiskopf & Weng, 2013). We calculated the range for all clinical variables with numeric values, such as laboratory or patient vital measurements and verified that they were within suggested ranges preset in REDCap (Feder, 2018; van Hoeven et al., 2017). As the data are from patients in the PCCU, we were unable to use normal ranges for patient vitals found in literature to assess the clinical plausibility of those in an intensive care setting. Thus, in conjunction with verifying external validity, data points were

checked by presenting them to a pediatric critical care intensivist at the LHSC and all data points at the extremes of the suggested range were assessed on a case-by-case basis.

Using frequencies, we summarized the number of variables assessed for plausibility, and the number of variables where plausible data (range) were found. Ranges of variables with units for data consistency assessment are reported simultaneously in Appendix A.

3.4 Research Objective 2: Describing the Characteristics of Transports by the LHSC Transport Team

The second objective of this study is to describe the characteristics of transports completed by the LHSC transport team over the two-year period. To be included in the study, patients had to have been less than 18 years old at time of transport, transported between facilities in Ontario, transported by the LHSC transport team, and alive when the LHSC transport team assumed responsibility for their care.

To assess these inclusion criteria, we used the following data fields from the CPTN database (*Data Dictionary – Pediatric Transport Improvement of Safety*, 2018):

- Patients must have been under 18 years of age during transport. The variable 'Age' was used to determine whether a patient was under 18 years of age during transport. All cases that were aged greater than 18 years were excluded.
- Must have been transported between May 1, 2018, and April 30, 2020. This two-year period was set to ensure complete cases were available for analysis. The inclusion date from the variable 'Date and Time of Call' were set from 2018-05-01 00:00 to 2020-04-30 23:59. All records outside of this period were excluded.
- Must have been transported. A call from a referring facility to an accepting facility can have various outcomes such as advice only received, telemedicine given (specifically triaged out or managed locally), or transports can be deferred to another transport team, completed by the referral site, cancelled, deferred to NICU/obstetrical service, or deferred because no team is available. In this case, we are interested in completed transports by the LHSC, thus the outcome of the

call must have been “transported”. Calls with any other outcome were excluded from the study. This is based on the ‘Outcome of Call’ variable.

- Referring and accepting facility must have been in Ontario. We are limiting our study to facilities that are within Ontario because calls originating outside the province likely stem from extraordinary circumstances. Sites outside of Ontario were excluded. This is based on the ‘Province’ variable, under referral site.
- Must have been transported by the LHSC transport team. Only “LHSC” was included from the ‘Hospital Transport Team’ variable; all other transport teams were excluded as we want to gather information on transports completed by the LHSC transport team.
- Patients must have been alive when the LHSC transport team assumed responsibility for their care. There are multiple outcomes when a transport run is completed. Patients can die at referral sites while the LHSC transport team is being called, or before the LHSC team arrives. Patients may also remain at the referral site for palliation, be stabilized and left at the referral site, be transferred to another transport team, or have an unknown outcome. To ensure that patients were alive under the transport team’s responsibility, only patients who were admitted to home base, admitted to another hospital, or expired during transport with the team were included. This is based on ‘Outcome of Run’ variable.

We described administrative information, patient information, transport complications, patient outcomes, transport information, and transport times. Generally, only variables that satisfy the following criteria were selected:

- Variables with high quality data i.e., passed all five criteria of data validation, such as variables with less than 5% missing data and less than 5% in difference of data entry and where applicable, had high levels of data consistency, timeliness, and plausibility.
- Variables that were not used in the inclusion and exclusion criteria of the sample.

- Variables that contain non-identifiable data. Patients' names, hospital record number, and names of any transport team members were not reported.
- Variables that apply to all patients. Sub-questions that are prompted from a preceding question on the form were not included. For example, for the variable 'Pre-planned transfer', the selection of "Yes" prompts an additional question: 'What was the transfer pre-booked for?'. Since these additional questions do not apply to all patients, they were excluded from descriptive analysis.

The age of patients and referral sites variables were used in the inclusion criteria but were reported as they present useful information about the sample. Date and time variables in the administrative and transport time forms, and system and process errors in the complications form are exempt from the data validation rule. This includes the 'Date and Time of Call' variable from the administrative form, 33 date time variables in the transport time form, and the 'System and Process Errors' variable in the complications form (Appendix A). Despite data quality issues, these variables are necessary in calculating key transport time variables or are representative of any vehicle delays.

We reported the following variables from each of the forms:

1. Administrative Information

   Administrative information provides general characteristics about the transport including when and where it occurred.

   - Admission to the LHSC. This describes whether the accepting facility was the LHSC. It is based on the 'London Hospital' variable under the accepting facility heading in the CPTN database. This was coded as (0) No, not admitted to the LHSC and (1) Yes, admitted to the LHSC.
   - Cities of Accepting Facilities. We reported on the proportion of cities where accepting facilities were located using the 'ON City' variable under the accepting facility heading. The categories were as follows: (1) Greater Toronto

Area (GTA); (2) Hamilton; (3) London; and (4) Other Cities in Ontario. Small cell sizes were combined where appropriate.

- Time Period of Transports. We reported on the proportion of transports using six time periods of four months each: (1) May to August 2018; (2) September to December 2018; (3) January to April 2019; (4) May to August 2019; (5) September to December 2019; and (6) January to April 2020 to capture the 24 months of data between May 2018 to April 2020. Time period is based on the 'Date and Time of Call' variable in the CTPN which is the date and time of the call. Time periods were categorized this way for easy interpretation of the number of transports per year or by season.
- Time of Transports. A new variable for time of transports was created (1) Daytime and (2) Nighttime. Following the LHSC's patient records logging hours for a single day, 7:00 to 6:59, we categorized daytime from 7:00 to 18:59 and nighttime from 19:00 to 6:59 from the 'Date and Time of Call' variable.
- Advice Call Prior. This describes whether there were previous advice calls for a single patient and an associated illness. It is based on the 'Has there already been an advice call for this patient and this illness' variable in the CTPN and was coded as (0) No and (1) Yes.
- Cities of Referral Sites. The proportion of cities of referral sites were reported from 4 categories; (1) GTA; (2) Hamilton; (3) London; and (4) Other Cities in Ontario. This is based on the 'ON City' variable under the referral site heading. Small cell sizes were combined where appropriate.
- Top 5 Referral Facilities admit to the LHSC. The frequency of transports from the five referral facilities with the most transports for admission at the LHSC were reported from the 'GTA Hospital', 'Hamilton Hospital', 'London Hospital', and the 'Other ON Hospital' variables under the referral site heading.
- Pre-planned Interfacility Transfer. This variable indicates whether the transfer between facilities was pre-planned or unplanned. Pre-planned transfers may be more organized in terms of ensuring the transport team was available and no delays in the vehicle arriving to the LHSC to pick up the team. Pre-planned transfers are often booked for repatriation, scheduled procedures, or medical

consults. This is based on the ‘Pre-planned Transfer’ variable, where (0) No and (1) Yes.

- Deferral to the LHSC. This refers to whether a transport was deferred to the LHSC. A deferral is defined as an admission to a site not in the usual region of coverage for the LHSC (i.e., out of regionalization boundaries) (*Data Dictionary – Pediatric Transport Improvement of Safety*, 2018). It is reflective of the home base unit bed availability and not the ability of the transport team to provide transport services. This is based on the ‘Deferral’ variable, where (0) No and (1) Yes.

2. Patient Information

Patient information provide general characteristics about the patients that were transported.

- Age. For reporting purposes, age groups were based on research indicating clinically meaningful age groups specifically for drug utilization and differences in adverse events for children (Williams et al., 2012). Age groups were created using the ‘Age’ variable and were grouped as follows: (0) Infants, aged 0 month to <2 years; (1) Children, aged 2 to <12 years; and (2) Adolescents, 12 to <18 years, to represent the age of patients.
- Weight. The weight of patients was reported in kilograms as means using the ‘Current Weight’ variable according to age groups.
- Sex. The sex of patients refers to biological sex and were reported using the ‘Sex’ variable, (0) for Male and (1) for Female.
- Most Responsible Medical Problem. This variable refers to the most responsible system of the body causing illness to the patient according to the admitting physician. The four options were coded as follows: medical (0); cardiac (1); neurological (2); and surgical (3) from the ‘Most Responsible System’ variable.

3. Complications

Complications describes any complications that occurred during patient transport.

- Had Complications. This variable represents whether complications were experienced during transport. We grouped the following variables from the CPTN database: ‘Complication Group: Clinical’, ‘Complication Group: Equipment’, ‘Complication Group: Vehicle’, ‘Complication Group: Transport Team and/or Patient Safety Issue’, ‘Complication Group: System and Process Errors’ into one single variable called “Complications”, where (0) No and (1) Yes, to report proportions. These five variables are all binary, and if complications occurred during the transport process, the appropriate complications were checked off.
- Type of Complications. This represents the type of complications that occurred during the transport process. The variables ‘Complication Group: Clinical’, ‘Complication Group: Equipment’, ‘Complication Group: Vehicle’, ‘Complication Group: Transport Team and/or Patient Safety Issue’, and ‘Complication Group: System and Process Errors’ were used to report proportions of complication types.

4. Patient Outcomes

Patient outcomes provides information on whether patients died after PCCU admission.

- Death after PCCU Admission. This variable represents whether the patient died during the admission at the LHSC that followed the transport. If yes (1) is selected, it means that the patient died during the admission arising from the transport and if no (0) is selected, the patient survived to discharge/transfer on the admission following the transport, or the patient died during a later admission occurring after this admission. The variable ‘Death’ is only applicable to patients that were admitted to the PCCU at the LHSC, thus we also indicated the proportion of patients where there were no data for this variable.

5. Transport Information

Transport information gives general characteristics on transport team composition and mode of transport.

- Transport Team Composition. It provides the team configuration that completed the transport. From preliminary frequencies using the 'Team Configuration (choice = RN1)' and 'Team Configuration (choice = RRT1)' variables, one registered nurse and one respiratory therapist makes up most of the team configurations. Thus, we reported the proportion of transports completed by (0) Registered Nurse & Respiratory Therapist and (1) Other Composition. Other composition includes any team configuration that is not solely one registered nurse and one respiratory therapist.
- Ad Hoc Team. The 'Ad Hoc' variable indicates whether the team that completed the transport was the LHSC's Neonatal-Pediatric Transport Team or if the team was formed on a needs basis. This was coded as (0) No and (1) Yes.
- Mode of Transport (All Legs). Mode of transport was summarized to include all legs. All three stretches of transport (1) from homebase to referring facility, (2) from referring facility to accepting facility, and (3) from accepting facility to homebase have three possible legs each, totalling 9 possible modes of transport. We reported the most used modes of transports for all 9 legs. The following variables were used in this summary:
    - Mode of transport from homebase to referring facility. This is based on the 'Mode of Transport for the First, Second, and Third leg of the trip from Home Base/Starting Location to reach Referring Site' variables. For each of the three legs of this stretch, the leg was categorized into one of five categories for mode of transport: land ambulance, land private EMS vehicle, air ambulance, walk, and other. Land ambulance refers to vehicles such as Middlesex-London EMS vehicles, including the dedicated ambulance, and was coded as (0). Land private EMS vehicle refers to using privately hired transportation services like Voyago

vehicles and was coded as (1). Air ambulance includes jet fixed wing, propeller fixed wing and rotor flight (helicopter), were coded as (2). Walk was coded as (3) which refers to walking only and no vehicular method was used. Other was coded as (4), describing any other mode of transport not included above such as private vehicles or taxis. The mode of transport for each leg was accounted for in the analysis.

- Mode of transport from referring facility to accepting facility. This is based on the 'Mode of Transport for the First, Second, and Third leg of the trip from Referring Site to Accepting Facility' variables. For each of the three legs of this stretch, the leg was categorized into one of five categories: land ambulance, land private EMS vehicle, air ambulance, walk, and other. The description for each mode is the same as above and were coded in the same way: Land ambulance (0), Land private EMS vehicle (1), Air ambulance (2), Walk (3), and Other (4). The mode of transport for each leg was accounted for in the analysis.
- Mode of transport from accepting facility to homebase. This is based on the 'Mode of Transport for the First, Second, and Third leg of the trip from Accepting Facility to Homebase' variables. For each of the three legs of this stretch, the leg was categorized into one of five categories: land ambulance, land private EMS vehicle, air ambulance, walk, and other. Again, the description for each mode remains the same and were coded as follows: Land ambulance (0), Land private EMS vehicle (1), Air ambulance (2), Walk (3), and Other (4). In the instances that the accepting facility is the LHSC, there were no data for these legs of transport.

6. Transport Times

Transport time information provides characteristics on relevant travel times to the research question and commonly reported travel times in the literature. All

intervals were reported in minutes. These transport intervals are summarized in Table 1.

- Mobilization Time: This interval indicates the time it took the LHSC team to be dispatched and to find an ambulance ready for departure from home base. It is calculated by subtracting 'Vehicle Arrived to Depart from Home Base' from 'Team Dispatched (Decision to "Go")' in the CPTN database. Transports with patients departing from the LHSC for admission to another facility in Ontario were excluded from this time interval calculation as no vehicular transport is involved. The "Walk" option is selected and is representative of the time it takes the transport team to walk to the PCCU within the LHSC.
- Retrieval Time. This is the travel time from the LHSC to referring facilities, which is the difference in time between the 'Team Dispatched (Decision to "Go")' and 'Arrive at Referral Site (to Patient Bedside)'. Transports with patients departing from the LHSC for admission to another facility in Ontario were also excluded from this time interval calculation as the referral site is the LHSC, which is not representative of the retrieval time of interest. The "Walk" option is selected and demonstrates the time it takes the transport team to walk to the PCCU within the LHSC.
- System Response Time. System response interval time is the time from receipt of the transport call to arrival at the referring facility. It encompasses both mobilization and retrieval time intervals. It is calculated by subtracting 'Arrive at Referral Site (to Patient Bedside)' from 'Team Dispatched (Decision to "Go")'. Transports with patients departing from the LHSC for admission to another facility in Ontario were excluded from this time interval calculation as "Walk" is selected in this interval as well.
- Stabilization Time. This interval indicates the time spent at the referring site stabilizing the patient for transport, which is the difference between the 'Arrive at Referral Site (to Patient Bedside)' and 'Depart Referral Site' variables.
- Return Dispatch Time. This interval indicates the time for an ambulance to arrive at the referral site to transport the team and patient to the accepting site. It

is calculated by subtracting ‘Vehicle Arrived to Depart from Referral Site’ from ‘Vehicle Called to Depart from Referral Site’.

- Patient Transport Time. This represents the total travel time with patients onboard from departure of the referring facility to arrival at the accepting facility. It is calculated by subtracting ‘Arrive at Accepting Facility (Patient Admission Time)’ from ‘Depart Referral Site’.
- Total Transport Time. This is the total time from receipt of the transport call to arrival at the accepting facility, where the patient is admitted. It indicates the entire time that it took for the LHSC team to complete a transport and is the difference between ‘Team Dispatched (Decision to “Go”)’ and ‘Arrive at Accepting Facility (Patient Admission Time)’.
- Return to Homebase Time. This interval is the total time it took for the LHSC team to return to homebase after admitting patients to another accepting facility, calculated by subtracting ‘Team Arrived at First/Third Leg Destination’ from ‘Depart Accepting Facility’.

Table 1: Summary of Transport Time Intervals

Transport Time Intervals	From	To	Description
Mobilization Time	Team Dispatched (Decision to "Go")	Vehicle Arrived to Depart from Home Base	Indicates the time it took to dispatch a team and for an ambulance to be ready for departure at home base
Retrieval Time	Team Departed Home Base	Arrive at Referral Site (to Patient Bedside)	Travel time from the homebase (LHSC) to referring facilities
System Response Time	Team Dispatched (Decision to "Go")	Arrive at Referral Site (to Patient Bedside)	Indicates time from receipt of the transport call to arrival at the referring facility
Stabilization Time	Arrive at Referral Site (to Patient Bedside)	Depart Referral Site	Indicates time spent at referring site (stabilizing patient)
Return Dispatch Time	Vehicle Called to Depart from Referral Site	Vehicle Arrived to Depart from Referral Site	Indicates the time for an ambulance to arrive at the referral site
Patient Transport Time	Depart Referral Site	Arrive at Accepting Facility (Patient Admission Time)	Travel time from departure of the referring facility to arrival at the accepting facility with patient onboard
Total Transport Time	Team Dispatched (Decision to "Go")	Arrive at Accepting Facility (Patient Admission Time)	Indicates time from receipt of the transport call to arrival at the accepting facility, where the patient is admitted
Return to Homebase Time	Depart Accepting Facility	Team Arrived at First/Third Leg Destination	Indicates time for the team to return to the LHSC from accepting facilities

Note. This table includes a brief description of transport time intervals and presents the two variables used to calculate time difference per time interval.

We conducted descriptive analyses of the sample and reported frequencies for nominal and ordinal data; means, medians, or ranges for continuous data.

3.5 Research Objective 3: Evaluating the Impact of a Dedicated Ambulance on Transport Times of Critically Ill Children to the Children's Hospital at the LHSC

The third objective of this study is to evaluate the impact of a dedicated ambulance on transport times. The inclusion and exclusion criteria are identical to that of research objective two. However, compared to objective two, we restricted the sample population for this objective to patients who were admitted to the LHSC because we are interested in the amount of time it takes to dispatch the transport team from the LHSC. We also restricted the sample to transfers that are not pre-planned as these transfers are booked in advance.

The inclusion criteria were reflected in the following data fields from the CPTN database (*Data Dictionary – Pediatric Transport Improvement of Safety*, 2018):

- Patients must have been under 18 years of age during transport. The variable 'Age' was used to determine whether a patient was under 18 years of age during transport. All cases that were aged greater than 18 years were excluded.
- Must have been transported between May 1, 2018, and April 30, 2020. This two-year period was set to ensure complete cases were available for analysis. The inclusion date from the variable 'Date and Time of Call' were set from 2018-05-01 00:00 to 2020-04-30 23:59. All records outside of this period were excluded.
- Must have been transported. A call from a referring facility to an accepting facility can have various outcomes such as receiving only advice, telemedicine given (specifically triaged out or managed locally), or transports can be deferred to another transport team, completed by the referral site, cancelled, deferred to NICU/obstetrical service, or deferred because no team is available. In this case, we are interested in completed transports by LHSC transport team, thus the outcome of the call must have been "Transported". Calls with any other outcome were excluded from the study. This is based on the 'Outcome of Call' variable.

- Accepting facility must have been the LHSC. We are limiting our study to admissions to the Children's Hospital at the LHSC to best reflect the time intervals of interest. Sites that were not the LHSC's Victoria Campus (Children's Hospital) were excluded. This is based on the 'London Hospital' variable, under accepting facility.
- Must have been transported by the LHSC transport team. Only 'LHSC' was included from the 'Hospital Transport Team' variable; all other transport teams were excluded.
- Patients must have been alive when the LHSC transport team assumed responsibility for their care. There are multiple outcomes when a transport run is completed. Patients can die at referral sites while the LHSC transport team is being called, or before the LHSC team arrives. Patients may also remain at the referral site for palliation, be stabilized and left at the referral site, be transferred to another transport team, or have an unknown outcome. To ensure that patients were alive under the transport team's responsibility, only patients who were admitted to home base, admitted to another hospital, or expired during transport with the team were included. This is based on 'Outcome of Run' variable.
- Must not have been a pre-planned transfer. Pre-planned transfers are excluded as the ambulances for these transports are often booked ahead of time and do not reflect the time to acquire an ambulance without notice. Only transports that were not pre-planned transfers were included, based on the 'Pre-planned Transfer' variable.

3.5.1 Variables in Bivariate Analyses and Multiple Linear Regressions

3.5.1.1 Independent Variable:

Bivariate analyses were conducted to describe the association of the following predictors on outcomes (*Data Dictionary - Pediatric Transport Improvement of Safety,* 2018). All categories coded as (0) were used as the reference category.

1. Transports at Time Point Before/After Dedicated Ambulance. As the dedicated ambulance was assigned to the LHSC in June 2019, two categories were created representing transports prior to and after having a dedicated ambulance. All

transports from May 1st, 2018, 00:00 to May 31st, 2019, 23:59 were coded as (0) Before Dedicated Ambulance and all transports from June 1st, 2019, 00:00 to April 30th, 2020, 23:59 were coded as (1) After Dedicated Ambulance. The 'Date and Time of Call' variable is used to create the dummy variable as it is the earliest time recorded for each case. Regardless of statistical significance, this independent variable remained in the regression models because it is the variable of interest.

3.5.1.2 Control Variables

1. Time of Transports. In consideration that there may be a difference in ambulance availability to the team depending on the time of the call or in traffic patterns, we adjusted for the time of day. We used the time of transports variable created in objective two; (0) Daytime, representing 07:00 to 18:59 and (1) Nighttime, representing 19:00 to 06:59, which are based on the 'Date and Time of Call' variable in the CPTN database. We used daytime as the reference category as more transports were completed in the daytime, and it is possible that it is harder to secure a vehicle from Voyago during the daytime since they service pre-scheduled non-emergency medical care.
2. Cities of Referral Facilities. This variable was recategorized based on areas that the LHSC team services; the city of Kingston and the city of Ottawa were removed. Transports from referral city sites were coded as (0) Other Cities in Ontario (1) GTA, London and Hamilton, using the 'ON City' variable for referral site. This predictor is useful for controlling for the distance from the LHSC to a referring facility should it impact dispatch times. GTA, London and Hamilton were combined due to small cell sizes.
3. Most Responsible Medical Problem. This variable refers to the most responsible system of the body causing illness to the patient according to the admitting physician. This predictor is useful with the "Return Dispatch Time" outcome as it can control for responsible problems that may affect calling for an ambulance to return to the LHSC. The categories are as follows: (0) Medical; (1) Cardiac; (2) Neurological; and (3) Surgical, based on the 'Most Responsible System' variable.

4. Age of Patients. Age groups were coded as follows: (0) Infants, aged 0 month to <2 years; (1) Children, aged 2 to <12 years; and (2) Adolescents, 12 to <18 years, using the 'Age' variable. This variable considers the possibility that transporting patients of different ages could have delays on dispatch time. For example, it could take longer to set up an incubator for infants than a gurney for adolescents.
5. Sex of Patients. Using the 'Sex' variable in the CPTN database, Males were coded as (0), and Females were coded as (1). This variable considers differences in dispatch times when transporting male or female patients.
6. Transport Team Composition. This variable provides the team configuration that completed the transport. As seen in the descriptive analysis, 98% of interfacility transports were carried out by a team consisting of one registered nurse and one respiratory therapist. Other transports had an additional registered nurse, respiratory therapist, or physician in addition to the usual team composition. Using the 'Team Configuration (choice = RN1)' and 'Team Configuration (choice = RRT1)' variables in the CPTN database, we coded this as (0) Registered Nurse & Registered Therapist and (1) Other composition.
7. Ad Hoc Team. This variable indicates whether the team that completed the transport was the LHSC's Neonatal-Pediatric Transport Team or if the team was formed on a need's basis. This variable was coded as (0) No, representing the LHSC transport team and (1) Yes, representing an ad hoc team, based on the 'Ad Hoc' variable. This is a relevant indicator as it would presumably take longer to arrange an ad hoc team, which would impact dispatch time and total dispatch time.
8. System and Process Errors. This variable includes delays in dispatch time (time of call until team is dispatched), delays in mobilization time (time of dispatch until departing home base), prolonged stabilization time (time team arrived at referral until team departed referral) and prolonged out-of-hospital time (entire return trip). It is representative of any delays associated with acquiring an ambulance to transport the team to referring facilities and is especially relevant to assess delays prior to having a dedicated ambulance. Although the prolonged stabilization time and prolonged out-of-hospital time do not seem to be affected by having a

dedicated ambulance, the associated comments mention delays due to the team being unable to find timely transport. There are also comments unrelated to finding a land ambulance, such as weather conditions and delays in air ambulances, but we are unable to eliminate these instances without manually going through each comment. Thus, we considered all system and process errors. As this variable is already binary, it was recoded as (0) No and (1) Yes, based on the 'Complication Group: System and Process Errors' variable in the CPTN database.

3.5.1.3 Dependent Variables (Transport Time Intervals):

There are three dependent variables in the analysis: vehicle dispatch time, total dispatch time and return dispatch time. These intervals were selected because they are sensitive to having a dedicated ambulance.

1. Vehicle Dispatch Time. This interval is encompassed in mobilization time (time difference between 'Team Dispatched (Decision to "Go")' and 'Vehicle Arrived to Depart from Home Base') from objective two. Vehicle dispatch time indicates the total time between making the call to request an ambulance to when the ambulance arrived to pick up the team. During analysis, this time interval best reflects the time difference in acquiring a land ambulance (dedicated ambulance) versus a private land EMS vehicle. It is the time difference between 'Vehicle Called to Depart from Home Base' and 'Vehicle Arrived to Depart from Home Base' in the CTPN database.
2. Total Dispatch Time. This interval encompasses the total time it took for a team to be dispatched and depart from homebase (LHSC). It is a relevant time interval as multiple attempts to call for an ambulance would be captured within. It is the time difference between 'Team Dispatched (Decision to "Go")' and 'Team Departed Home Base'. Total dispatch time includes the mobilization time interval from objective two.
3. Return Dispatch Time. This is a relevant interval to transports that were completed only by land ambulances. The dedicated ambulance remains at the referring location to take the transport team back to the LHSC whereas prior to

the dedicated ambulance, the team had to call for another ambulance for return to the LHSC. It is calculated through the time difference between 'Vehicle Called to Depart from Referral Site' and 'Vehicle Arrived to Depart from Referral Site' in the CPTN database. This is identical to the return dispatch time interval from objective two.

3.5.2 Analyses

We conducted descriptive analyses of the sample and reported frequencies for nominal and ordinal data; means, medians and ranges for continuous data. To detect a difference of 18 minutes in vehicle dispatch time at an alpha of 0.05 and 80% power, the total sample number of patients required is 132 patients. At our sample size of 328 patients, we can detect differences in vehicle dispatch time of 16 minutes at 99% power. To detect a difference of 16 minutes in total dispatch time (α= 0.05, β = 0.80), the total sample number of patients required is 329 patients. To detect a difference of 14 minutes in return dispatch time, the total sample number of patients required is 56 patients. At our sample size of 328 patients, we can detect differences of 9 minutes in return dispatch time at 100% power.

We verified normality and homoscedasticity assumptions for each outcome by plotting the residuals in normal probability plots and scatterplots, respectively. It was determined that residuals of the models were not normally distributed. To address this violation, the dependent variables: vehicle dispatch time, total dispatch time and return dispatch time were log transformed to achieve normality (Vittinghoff et al., 2005).

In bivariate analyses, we used independent t-tests and ANOVA (or Welch's t-test if heteroscedasticity was found) to identify differences in each of the three dependent variables and the independent and control variables (Jan & Shieh, 2014; Vittinghoff et al., 2005). Heteroscedasticity needed to be controlled for in one bivariate analysis between the independent variable and vehicle dispatch time, in which we used Welch's t-test instead of the independent t-test (Jan & Shieh, 2014). All other bivariate analyses used independent t-tests or ANOVA tests. For ANOVA tests, Bonferroni post-hoc analysis was used for multiple comparisons (Vittinghoff et al., 2005). The control variables that

were statistically significant at the 5% level of bivariate analyses were included as a predictor in the multiple linear regressions (Vittinghoff et al., 2005).

In supplementary bivariate analyses, we created graphs to visualize average times for each dependent variables for every month over the study period, noting when the dedicated ambulance was obtained.

For multiple linear analyses, we verified that multicollinearity assumptions were met among the predictors using tolerance (Alin, 2010). Multicollinearity was not detected. Multivariate linear regressions were used as the three dependent variables are continuous outcomes as well as to accommodate multiple predictors (Vittinghoff et al., 2005). Variables in each regression included the independent variable, one dependent variable, and predictors. Two interactions identified through the bivariate analyses were also entered into each model:

1. Interaction between Time of Transports and Cities of Referral Facilities: this interaction could be relevant as it may be more difficult to allocate an ambulance to travel to cities that are farther away from the LHSC during the daytime since more transports occur during the day than in the nighttime.
2. Interaction between Transports at Time Point Before/After Dedicated Ambulance and Time of Transports: this interaction could be relevant as land ambulances that are not dedicated to the team could be harder to come by during the day than in the nighttime.

We conducted preliminary regression models that included the independent variable and all predictors to obtain the models' adjusted R-squared value and/or Root MSE for assessing model fit (Vittinghoff et al., 2005). The final regression model only included significant predictors from bivariate analyses at the 5% level and were determined as final models because the adjusted R-squared value and/or Root MSE was similar to that of the preliminary models with all predictors included. Log-level estimates were converted into percent by exponentiation for interpretation in the results section using the following formula: $(\exp(\beta 1) - 1) \times 100\%$.

In supplementary analyses, we used frequencies to describe the types of complication that occurred in transports included in the sample.

3.6 Ethics

The project was approved by the Lawson Health Research Institute in London, Ontario, and the Western Health Sciences Research Ethics Board (Western University) (Appendix B). Participant informed consent was not required for this study. No individuals were identified in the analysis. To comply with privacy regulations for minimizing the chance of patient re-identification, results were censored in cells with five or fewer patients.

Chapter 4

4 Results

The following section contains the results from data validation, descriptive analysis, and analyses of the impact of a dedicated ambulance on total dispatch times.

4.1 Research Objective 1: Assessing the Validity of the CPTN Database

4.1.1 Data Accuracy

Table 2 presents data entry results comparing all variables from 36 randomly selected patient charts to their corresponding double entered charts, presented per form. The number of variables range from 20 to 164 variables across the nine forms and are primarily categorical variables, except for the transport times, clinical information and PELOD forms. In general, the administrative information (73%), patient information (85%), transport information (72%) and the complications forms (81%) had the highest accuracy (i.e., perfect match) (Table 2).

Errors in all forms were mostly due to disagreement except for the medications and interventions form, where errors were due to a large amount of missing data (74%). It is important to note that the medication and intervention form was not evaluated per variable but through the total number of entries. This is because individual medications and interventions were not required to be entered into REDCap in a certain order, thus comparing variables from the original charts and the double entered chart would have been incorrect in assessing data accuracy. Finally, these results show that the transport times (74%), medications and interventions (80%), patient outcomes (55%), clinical information (57%) and PELOD (66%) forms have poor data accuracy results (i.e., proportion of errors). The clinical information and the PELOD forms had the highest number of variables where data accuracy assessment could not be completed. There are no duplicate cases based on the ‘Date and Time of Call’ variable. Detailed data accuracy assessment of each variable is shown in Appendix A.

Table 2: Data Accuracy Results Comparing Variables from Patient Charts and their Corresponding Double Entered Charts

Data Accuracy	Forms								
	Admin Information	Patient Information	Transport Information	Transport Times	Medications/ Interventions	Complications	Patient Outcomes	Clinical Information	PELOD
Total number of variables n	**46**	**164**	**46**	**34**	**375***	**113**	**20**	**99****	**128****
Variable types n (%)									
Categorical	35 (76%)	150 (93%)	35 (76%)	1 (3%)	375 (100%)	112 (99%)	11 (55%)	40 (40%)	16 (13%)
Continuous	0 (0%)	3 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (20%)	59 (60%)	96 (75%)
Count	1 (2%)	3 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	16 (13%)
Character	8 (17%)	8 (5%)	11 (24%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
Date Time	2 (4%)	0 (0%)	0 (0%)	33 (97%)	0 (0%)	0 (0%)	5 (25%)	0 (0%)	0 (0%)
Accuracy Assessment n (%)									
No Error – Perfect Match	33 (73%)	137 (85%)	33 (72%)	9 (26%)	76 (20%)	92 (81%)	9 (45%)	35 (43%)	39 (35%)
Error	12 (27%)	24 (15%)	13 (29%)	25 (74%)	299 (80%)	21 (19%)	11 (55%)	47 (57%)	73 (66%)
Assessment not applicable	1	3	0	0	0	0	0	17	16
Types of Errors n (%)									
None – perfect match	33 (72%)	137 (84%)	33 (72%)	9 (26%)	76 (10%)	92 (81%)	9 (45%)	35 (35%)	39 (30%)
Disagreement	8 (17%)	16 (10%)	10 (22%)	19 (56%)	20 (5%)	19 (17%)	11 (55%)	42 (42%)	49 (38%)
Missing	4 (9%)	8 (5%)	3 (7%)	6 (18%)	279 (74%)	2 (2%)	0 (0%)	5 (5%)	24 (19%)
Not applicable	1 (2%)	3 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (17%)	16 (13%)

Note. The frequencies and percentages presented represent variable types per form, exact matches between the data sources, and types of errors found. Around 10% of the sample (374) was used to assess data accuracy; this table shows results between 36 patients' original and double entered charts (n=36).

* n is the total number of entries for medications and interventions

** excludes formulas (PIM III/PELOD)

4.1.2 Data Completeness

Table 3 presents the degree of missing values within the CPTN database. The total number of applicable variables that were assessed for missing values range from 13 to 112 variables across all nine forms. The administrative information (81%), patient information (75%), transport information (84%), complications (87%), and patient outcomes (77%) forms had the highest number of values that were fully complete.

At a 95% completion threshold, the administrative information (93%), patient information (80%), transport times (97%), complications (87%) forms had high completion, with transport information and patient outcomes having full completion (100%). On the other hand, medications and interventions (69%), clinical information (57%) and PELOD (46%) forms have poor completeness. Categorical variables had the highest proportion of variables that were complete at the 95% level in the administrative information, transport information, medications and interventions, and complications forms. Detailed data completeness assessment of each variable is shown in Appendix A.

Table 3: Data Completeness Results Showing the Degree of Missing Values in the CPTN database

Data Completeness	Forms								
	Admin Information	Patient Information	Transport Information	Transport Times	Medications/ Interventions	Complications	Patient Outcomes	Clinical Information	PELOD
Total Number of Applicable Variables n	**31**	**20**	**25**	**34**	**105**	**15**	**13**	**75**	**112**
Complete Values									
100%	25 (81%)	15 (75%)	21 (84%)	23 (68%)	66 (63%)	13 (87%)	10 (77%)	20 (27%)	26 (23%)
95-99%	4 (13%)	1 (5%)	4 (16%)	10 (29%)	6 (6%)	0 (0%)	3 (23%)	23 (31%)	25 (22%)
94-90%	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	11 (15%)	8 (7%)
80-89%	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (7%)	0 (0%)	7 (9%)	5 (4%)
51 - 79%	1 (3%)	2 (10%)	0 (0%)	0 (0%)	6 (6%)	0 (0%)	0 (0%)	11 (15%)	10 (9%)
< 50%	1 (3%)	2 (10%)	0 (0%)	0 (0%)	26 (25%)	1 (7%)	0 (0%)	3 (4%)	38 (34%)
not applicable	15	144	21	0	70	98	7	30	16
Type of Variables with >95% Completion n (%)									
Categorical	25 (76%)	6 (38%)	19 (76%)	1 (3%)	72 (100%)	13 (100%)	4 (31%)	11 (26%)	9 (18%)
Continuous	0 (0%)	2 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (31%)	32 (74%)	34 (67%)
Count	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	8 (16%)
Character	2 (6%)	8 (50%)	6 (24%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Date Time	1 (3%)	0 (0%)	0 (0%)	32 (97%)	0 (0%)	0 (0%)	5 (38%)	0 (0%)	0 (0%)
Missing Values n (%)									
less than 5%	29 (83%)	16 (80%)	25 (100%)	33 (97%)	72 (69%)	13 (87%)	13 (100%)	43 (57%)	51 (46%)
more than 5%	2 (6%)	4 (20%)	0 (0%)	1 (3%)	33 (31%)	2 (13%)	0 (0%)	32 (43%)	61 (54%)
not applicable	15	144	21	0	69	98	7	30	32

Note. The frequencies and percentages presented represent the degree of completion per form, variable types with >95% completion, and missing values. The sample size is 374 patients.

4.1.3 Data Consistency

Three sets of variables had inconsistencies in data entry (Table 4). There was a 20% data inconsistency for ‘Death or Discharge/Time from Receiving Area’ and a 1% data inconsistency for ‘PCCU Discharge Date’ when each variable was compared with the variable ‘Hospital Discharge Date’. Only patients who were admitted to the LHSC’s PCCU had these data (n = 307). The transport time chronology showed a 10% inconsistency. The ranges for variables requiring units showed that data were entered using the same unit of measurement and data points out of suggested range were entered incorrectly. The level of details in comment boxes are unchanged as comments appear to be of similar lengths throughout the database. All variables used to assess data agreement can be found in Appendix A.

Table 4: Data Consistency Results Showing the Constancy of Data Agreement between Variables in the CPTN database

Data Consistency		
Variables*	Total number of variables assessed n	Inconsistency n (%)
Death or Discharge Date/Time from Receiving Area	307**	60 (20%)
PCCU Discharge Date	307**	4 (1%)
Transport Time Chronology	374	36 (10%)

Note. The frequencies and percentages presented represent the variables assessed and data inconsistencies found in data entry. The sample size is 374 patients.

*Comparator variables in Appendix C

**Only 307 patients were admitted to the PCCU and would have patient outcomes data.

4.1.4 Data Timeliness

The PCCU discharge date for the last eligible case was June 29th, 2020, and the database was used for analysis starting December 2020, meaning that the data were at minimum 6 months old.

Only the auto-calculated PIM III score and auto-calculated PIM III risk of death were used for entries at the "First Contact with Transport Team" time point. Different methods of calculating PIM III were used at the "1h after PCCU Arrival" time point. Before June 2019, PIM III scores and risk of death at the "1h after PCCU Arrival" time point were auto calculated based on entered patient vitals. However, all cases after June 1^{st,} 2019, did not have patient vitals data available in REDCap, so manual PIM III and risk of death scores were used. Table 5 presents the number of cases that used auto calculation or manual entry for PIM III scores. From 374 patients, 98% have an auto-calculated PIM III and risk of death scores at the "First Contact with Transport Team" time point. From 307 patients admitted to the PCCU, all patients have a PIM III and risk of death score at the "1h after PCCU Arrival" time point, whether it was an auto-calculated or a manual entry. All PELOD scores were auto calculated at PELOD time points, and thus are not included in the table.

Table 5: Number of PIM III Scores that used Auto Calculation Compared to Manual Entry, at Two Time Points

Data Timeliness	PIM III Time Point	
	First Contact with Transport Team	**1h after PCCU Arrival**
Total number of cases assessed n	374	302*
Filled auto-calculated PIM III Score n (%)	365 (98%)	168 (56%)
Filled auto-calculated Risk of Death Score n (%)	365 (98%)	168 (56%)
Filled manual PIM III Score n (%)	0	136 (45%)
Filled manual Risk of Death Score n (%)	0	144 (48%)
Total Auto-calculated and Manual PIM III n	**365**	**304****
Total Auto-calculated and Manual Risk of Death n	**365**	**312****

Note. The frequencies and percentages presented represent the cases that used REDCap's auto-calculation and/or manual entry for PIM III and Risk of Death scores, per PIM III time point. The sample size is 374 patients.

*Only 307 patients were admitted to the PCCU and would have a PIM III score at this time point. Cases not presented are missing data.
**n may be larger than the total number of cases assessed because few cases have both auto calculated and manual PIM III entries during the transition to only manual PIM III entries. The manual risk of death score sometimes erroneously auto populates without a manual PIM III score entry.

4.1.5 Data Plausibility

Three forms had clinical data that were assessed for plausibility. All forms assessed had relatively high clinical feasibility (Table 6); clinical information (98%), PELOD (85%), and patient information (67%). Values that were not clinically feasible were data entry errors. Detailed data plausibility assessment of variables is shown in Appendix A.

Table 6: Data Plausibility Results of the Data

Data Plausibility	Forms		
	Patient Information	Clinical Information	PELOD
Total number of variables assessed n	**3**	**47**	**13**
Clinical Plausibility n (%)	2 (67%)	46 (98%)	11 (85%)

Note. The frequencies and percentages presented represent the clinical plausibility of applicable variables per form. The sample size is 374 patients.

4.2 Research Objective 2: Describing the Characteristics of Transports by the LHSC Transport Team

From May 1, 2018, to April 30, 2020, the London Neonatal-Pediatric Transport Team completed 374 interfacility transports (Table 7). We did not exclude any patients due to age, date of transport, not being transported, location of referral or accepting sites, transport team, and no patients were not alive when the LHSC transport team assumed responsibility.

Of these transports, 89% (331) were admitted to the LHSC, while the rest were transported from the LHSC and admitted to another facility in Ontario: 8% (31) in the GTA, 3% (12) in Hamilton and other cities (Table 7). In each four-month period, the LHSC team conducted between 55 and 75 transports. Transports were more frequently completed in the daytime, with 62% (223) between 7:00 to 18:59 compared to 38% (141) in the nighttime from 19:00 to 6:59. Majority of transports did not have an advice call prior to transport (364; 97%).

Table 7: Descriptive Analysis Results of Administrative Information

Form	Variable	Frequency n (%)
Administrative Information	Admission to the LHSC	374
	No	43 (11%)
	Yes	331 (89%)
	Cities of Accepting Facilities	374
	London	331 (89%)
	GTA	31 (8%)
	Hamilton & Other Cities in Ontario	12 (3%)
	Time Period of Transports	374
	May - Aug 2018	50 (13%)
	Sept - Dec 2018	57 (15%)
	Jan - Apr 2019	68 (18%)
	May - Aug 2019	55 (15%)
	Sept - Dec 2019	75 (20%)
	Jan - Apr 2020	69 (18%)
	Time of Transports	374
	Daytime	223 (62%)
	Nighttime	141 (38%)
	Advice Call Prior	374
	No	364 (97%)
	Yes	10 (3%)
	Cities of Referral Facilities	374
	Other Cities in Ontario	326 (87%)
	London	35 (9%)
	GTA & Hamilton	13 (4%)
	Top 5 Referral Facilities admit to the LHSC	331
	Windsor Regional Hospital – Metropolitan Site	66 (20%)
	St Thomas Elgin General Hospital	31 (9%)
	Stratford General Hospital	26 (8%)
	Chatham-Kent Health Alliance – Public General Hospital	25 (8%)
	Grey Bruce Health Services – Owen Sound Site	20 (6%)
	All Other Sites Combined	168 (51%)
	Pre-planned Interfacility Transfer	374
	No	360 (96%)
	Yes	14 (4%)
	Deferral to the LHSC	373
	No	367 (98%)
	Yes	6 (2%)
	Missing Data	1

Note. The frequencies and percentages presented represent the descriptions of transports within the CPTN database. The sample size is 374 patients.

The LHSC team transported patients from 49 different hospitals across Ontario to the Children's Hospital at the LHSC. Of 374 transports, 87% (326) of referral sites were in other cities in Ontario, 9% (35) was in London, and 4% (13) were in the GTA and Hamilton. Of the five most frequent referral hospitals, the Metropolitan Site at Windsor Regional Hospital accounted for more referrals than any other single site. Most interfacility transfers were not preplanned (360; 96%) and were not deferrals (367; 98%).

Patients transported were mostly infants (200; 54%) (Table 8). The mean weight of patients transported was 7 kg for infants, 23 kg for children, and 63 kg for adolescents. The majority of patients were male (221; 56%). The most responsible problems causing illness to the patients were of a medical nature (255; 68%), followed by neurological (68; 18%), cardiac (41; 11%) and surgical (10; 3%) natures. Of 374 interfacility patient transports, 51% (190) of transports experienced one or more complication, with a total of 241 complications. The most common were due to system and process errors (163; 68%), followed by equipment failures (37; 15%), vehicle issues (15; 6%), transport team and/or patient safety issues (14; 6%) and clinical complications (12; 5%). Finally, 307 patients were admitted to the PCCU at the LHSC, of which 4% died during the admission following the transport. Further description of the types of system and process errors is available in Appendix D.

Table 8: Descriptive Analysis Results of Patient Information, Complications and Outcomes

Form	Variable	Frequency n (%)
Patient Information	Age	374
	Infants (0 month to <2 years)	200 (54%)
	Children (2 to <12 years)	124 (33%)
	Adolescents (12 to 18 years)	50 (13%)
	Weight **Mean ±SD**	
	Infants	7±4 kg
	Children	23±13 kg
	Adolescents	63±19 kg
	Sex	374
	Male	211 (56%)
	Female	163 (44%)
	Most Responsible Medical Problem	374
	Medical	255 (68%)
	Neurological	68 (18%)
	Cardiac	41 (11%)
	Surgical	10 (3%)
Complications	Had Complications	374
	No	184 (49%)
	Yes	190 (51%)
	Type of Complications	241
	System and Process Errors	163 (68%)
	Equipment Failures	37 (15%)
	Vehicle Issues	15 (6%)
	Transport Team and/or Patient Safety Issues	14 (6%)
	Clinical	12 (5%)
Patient Outcomes	Death after PCCU Admission	307
	No	296 (96%)
	Yes	11 (4%)
	No Data on Patient Outcomes	67

Note. Unless otherwise stated, frequencies and percentages presented represent the descriptions of patients and in-transit complications within the CPTN database. The sample size is 374 patients.

At the LHSC, 98% (366) of interfacility transports were carried out by a team consisting of one registered nurse and one respiratory therapist (Table 9). Other transports had an additional registered nurse, respiratory therapist, or physician in addition to the usual team composition. The team was usually not formed ad hoc (366; 98%). The three most used modes of transportation in any leg of transport are land ambulances (emergency vehicles), private land EMS vehicles (privately hired transportation services) and air

transport (jet fixed wing, propeller fixed wing and rotor flight). Of all 982 legs that were completed within 374 transports, 613 (62%) involved a land ambulance, 227 (23%) involved a private land EMS vehicle, 104 (11%) involved air ambulance, 27 (3%) involved walking and 11(1%) involved private vehicles or taxis in any stretch of transport.

Table 9: Descriptive Analysis Results of Transport Information and Times

Form	Variable	Frequency n (%) or Median (Range)
Transport Information	Transport Team Composition	374
	Registered Nurse & Respiratory Therapist	366 (98%)
	Other Composition	8 (2%)
	Ad Hoc Team	374
	No	366 (98%)
	Yes	8 (2%)
	Mode of Transport (All Legs)	982
	Land Ambulance	613 (62%)
	Land Private EMS Vehicle	227 (23%)
	Air Ambulance	104 (11%)
	Walk	27 (3%)
	Other	11 (1%)
Transport Times	Mobilization Time **Median (Range)**	51 (0 - 350) minutes
	Retrieval Time **Median (Range)**	95 (11 - 965) minutes
	System Response Time **Median (Range)**	156 (5 - 1030) minutes
	Stabilization Time **Median (Range)**	69 (5 - 225) minutes
	Return Dispatch Time **Median (Range)**	10 (1 - 245) minutes
	Patient Transport Time **Median (Range)**	100 (12 - 1650) minutes
	Total Transport Time **Median (Range)**	325 (96 - 2170) minutes
	Return to Homebase Time **Median (Range)**	135 (35 - 328) minutes

Note. The frequencies and percentages presented represent the descriptions of transports within the CPTN database. The medians and ranges presented indicate the length of transport times for each interval. The sample size is 374 patients, except for the mobilization, retrieval, and system response time intervals (n=331) and the return to homebase time interval (n=43).

Upon departure to pick up patients for admission to the LHSC (n=331), the median mobilization time, from the team to be dispatched to arrival of a transport vehicle, is 51 minutes and retrieval time requires 95 minutes (Table 9). Medians rather than means are reported for transport times because medians are more representative of the central location of skewed data (not normally distributed). Overall, the average system response time from when the LHSC team is dispatched from the LHSC to when the team arrives to patients' bedsides at referring facilities was a median of 156 minutes (n=331). Transports where the LHSC is the referring facility were excluded from the mobilization, retrieval, and system response time intervals because the team usually walks to the patient bedside to retrieve them for transport, which would skew the time intervals if these cases were included. The stabilization interval time (n=374) at the referring facility is a median of 69 minutes. The return dispatch time (n=374) or the median wait time for an ambulance to pick up the team from referring facilities to return to the LHSC or to go to an accepting facility is 10 minutes. It takes 100 minutes to travel from referring sites to accepting facilities (patient transport time, n=374). The total transport time (n=374) from dispatch to patient admission is a median of 325 minutes. For transports where the team admits patients to facilities within Ontario (n=43), the median time to return to the LHSC is 135 minutes. There is considerable variation across all transport times.

4.3 Research Objective 3: Evaluating the Impact of a Dedicated Ambulance on Transport Times of Critically Ill Children to the Children's Hospital at the LHSC

4.3.1 Descriptive Analysis of the Sample

We excluded no patients due to age, date of transport, not being transported, transport team, and no patients were not alive when the LHSC transport team assumed responsibility. We excluded 43 patients who were not admitted to the LHSC and 3 patients who had pre-planned transports. Following exclusions, the sample size for this objective is 328 patients (Figure 1).

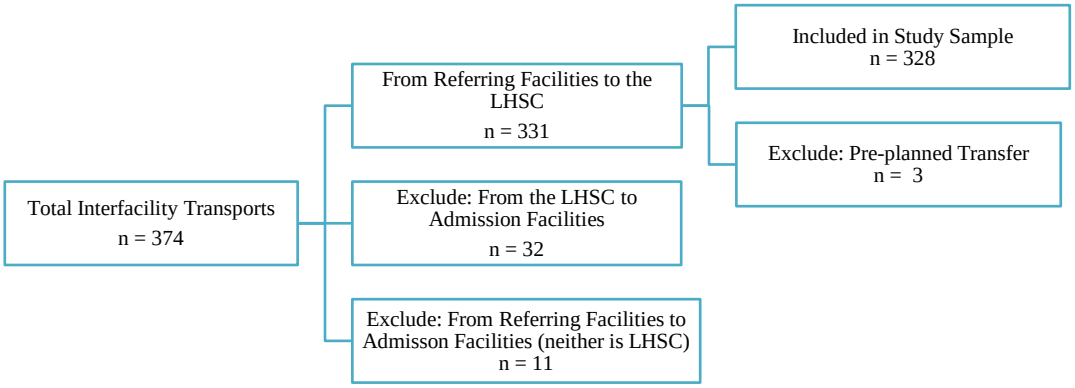


Figure 1: Flowchart for the Inclusion Criteria of the Sample Population

From May 1, 2018, to April 30, 2020, the London Neonatal-Pediatric Transport Team completed 328 interfacility transports from referring facilities in Ontario for admission to the LHSC (Table 10). Prior to June 2019 without a dedicated ambulance, the team transported 167 (51%) patients, and after the dedicated ambulance, 161 (49%) patients were transported. Transports occurred mostly during the day (195, 59%). Most referring facilities, 97% (317), are in other cities in Ontario where the LHSC is the catchment children's hospital, and 3% (11) are hospitals in the GTA, London, or Hamilton.

Table 10: Description of the Sample Population

Description of Sample	
Variables	**Frequency n (%)**
Transports at Time Point Before/After Dedicated Ambulance	328
Before Dedicated Ambulance	167 (51%)
After Dedicated Ambulance	161 (49%
Time of Transports	
Daytime	195 (59%)
Nighttime	133 (41%)
Cites of Referral Facilities	
Other Cities in Ontario	317 (97%)
GTA, London & Hamilton	11 (3%)
Most Responsible Medical Problem	
Medical	239 (73%)
Neurological	65 (20%)
Cardiac	15 (4%)
Surgical	9 (3%)
Age of Patients	
Infants (0 month to <2 years)	160 (49%)
Children (2 to <12 years)	121 (37%)
Adolescents (12 to <18 years)	47 (14%)
Sex of Patients	
Males	189 (58%)
Females	139 (42%)
Transport Team Composition	
Registered Nurse & Respiratory Therapist	321 (98%)
Other Composition	7 (2%)
Ad Hoc Team	
No	320 (98%)
Yes	8 (2%)
System and Process Errors	
No	188 (57%)
Yes	140 (43%)

Note. The frequencies and percentages presented represent the descriptions of patients and transports in the sample population. The sample size is 328 patients.

The most responsible problems causing illness to the patients were of medical (239; 73%), followed by neurological (65; 20%), cardiac (15; 4%) and surgical (9; 3%) natures. Patients were 49% (160) infants, 37% (121) children, and 14% (47) adolescents. A team

of one registered nurse and one respiratory therapist conducted 98% (321) of transports, with 2% (7) transports having additional personnel. The team was usually not formed ad hoc (320, 98%). Of 328 interfacility patient transports, 57% (188) experienced a system and process error complication. Further description of the types of system and process errors experienced by the sample population is available in Appendix E.

The time required for an ambulance to arrive at the LHSC is a median of 38 minutes (Table 11). The average total dispatch time, the total time it took for a team to be dispatched and depart from homebase, is a median of 58 minutes. The time to acquire an ambulance to take the transport team back to the LHSC, is 10 minutes.

Table 11: Summary of Transport Time Intervals

Transport Time Intervals	Median (Range)
Vehicle Dispatch Time	38 (5 to 236) minutes
Total Dispatch Time	58 (0 - 433) minutes
Return Dispatch Time	10 (1 - 150) minutes

Note. The medians and ranges presented represent the length of transport times for each interval. The sample size is 328 patients.

4.3.2 Analyses

The following section provides the bivariate analyses results, followed by details of the average vehicle, total and return dispatch times per month from May 2018 to April 2020, and the multiple linear regression analyses results.

Bivariate analyses evaluating a series of independent variables on vehicle dispatch time show that transport at time point before/after dedicated ambulance, age of patients and system and process errors are statistically significant at the 0.05 level (Table 12). These predictors were retained in the multiple linear regression model on vehicle dispatch time. Note that medians and ranges are reported, but all bivariate analyses were completed using mean differences.

Table 12: Bivariate Analysis Results Evaluating Independent Effects on Vehicle Dispatch Time

Variables	Median Vehicle Dispatch Time (Range)*	P-value
Transports at Time Point Before/After Dedicated Ambulance **[W]		<.0001
Before Dedicated Ambulance	30 (5 - 220) minutes	
After Dedicated Ambulance	46 (10 - 236) minutes	
Time of Transports		0.99
Daytime	38 (5 - 220) minutes	
Nighttime	39 (8 - 236) minutes	
Cities of Referral Facilities		0.12
Other Cities in Ontario	38 (5 - 236) minutes	
GTA, London & Hamilton	45 (6 - 84) minutes	
Most Responsible Medical Problem		0.10
Medical	40 (6 - 236) minutes	
Cardiac	46 (17 - 220) minutes	
Neurological	35 (5 - 181) minutes	
Surgical	63 (25 - 142) minutes	
Age of Patients **		0.02
Infants	45 (5 - 236) minutes	
Children	36 (8 - 200) minutes	
Adolescents	34 (10 - 183) minutes	
Sex of Patients		0.61
Male	37 (5 - 236) minutes	
Female	40 (10 - 220) minutes	
Transport Team Composition		0.11
Registered Nurse & Respiratory Therapist	38 (5 - 236) minutes	
Other Composition	78 (20 - 110) minutes	
Ad Hoc Team		0.34
No	40 (5 - 236) minutes	
Yes	28 (10 - 68) minutes	
System and Process Errors**		<.0001
No	32 (5 - 236) minutes	
Yes	49 (6 - 220) minutes	
Interaction: Time of Transports & Cities of Referral Facilities		0.81
Interaction: Transports at Time Point Before/After Dedicated Ambulance & Time of Transports		0.69

Note: The medians and ranges indicate the length of vehicle dispatch time per predictor, and the p-value indicates its statistical significance on the dispatch time. The sample size is 328 patients.

* Outcome variable was log-transformed in the analysis.
**The mean difference is significant at the 0.05 level.
[W] used Welch's t-test
Bonferroni post-hoc test showed infants vs adolescents p=<0.05; no other significant differences.

The median vehicle dispatch time after having a dedicated ambulance (46 minutes) was longer than the dispatch time before having a dedicated ambulance (30 minutes). Infants had longer median dispatch times than adolescents (45 minutes versus 34 minutes), but not children. There was no difference in the transport times of infants and children, or children and adolescents. Vehicle dispatch times with system and process errors (49 minutes) took longer than dispatches without (32 minutes).

Bivariate analyses evaluating a series of independent variables on total dispatch time show that transport at time point before/after dedicated ambulance, transport team composition, and system and process errors are statistically significant at the 0.05 level (Table 13). All significant variables were retained in the multiple linear regression model on total dispatch time.

Table 13: Bivariate Analysis Results Evaluating Independent Effects on Total Dispatch Time

Variables	Median Total Dispatch Time (Range)*	P-value
Transports at Time Point Before/After Dedicated Ambulance **		<.0001
Before Dedicated Ambulance	50 (10 - 443) minutes	
After Dedicated Ambulance	69 (0 - 304) minutes	
Time of Transports		0.95
Daytime	60 (0 - 360) minutes	
Nighttime	57 (15 - 433) minutes	
Cities of Referral Facilities		0.66
Other Cities in Ontario	58 (0 - 443) minutes	
GTA, London & Hamilton	71 (25 - 105) minutes	
Most Responsible Medical Problem		0.07
Medical	60 (10 - 433) minutes	
Cardiac	80 (36 - 221) minutes	
Neurological	51 (0 - 304) minutes	
Surgical	77 (35 - 188) minutes	
Age of Patients		0.10
Infants	64 (0 - 360) minutes	
Children	55 (15 - 433) minutes	
Adolescents	51 (22 - 304) minutes	
Sex of Patients		0.71
Male	57 (0 - 360) minutes	
Female	59 (10 - 433) minutes	
Transport Team Composition**		0.01
Registered Nurse & Respiratory Therapist	58 (0 - 433) minutes	
Other Composition	106 (36 - 360) minutes	
Ad Hoc Team		0.88
No	58 (0 - 433) minutes	
Yes	55 (33 - 184) minutes	
System and Process Errors**		<.0001
No	51 (0 - 260) minutes	
Yes	75 (25 - 443) minutes	
Interaction: Time of Transports & Cities of Referral Facilities		0.46
Interaction: Transports at Time Point Before/After Dedicated Ambulance & Time of Transports		0.54

Note: The medians and ranges indicate the length of total dispatch time per predictor, and the p-value indicates its statistical significance on the dispatch time. The sample size is 328 patients.

*Outcome variable was log-transformed in the analysis.
**The mean difference is significant at the 0.05 level.

The median total dispatch time after having a dedicated ambulance was 69 minutes, which is longer than the dispatch time of 50 minutes before having the ambulance. A transport team composition of one registered nurse and one respiratory therapist had shorter dispatch times than other team compositions (58 vs 106 minutes). Total dispatch times with system and process errors (75 minutes) took longer than dispatches without (50 minutes).

Bivariate analyses evaluating a series of independent variables on return dispatch time show that transports at time point before/after dedicated ambulance, an ad hoc team, system and process errors, and the interaction between transports at time point before/after having a dedicated ambulance and time of transports are statistically significant at the 0.05 level (Table 14). These variables were retained in the multiple linear regression model on return dispatch time.

Table 14: Bivariate Analysis Results Evaluating Independent Effects on Return Dispatch Time

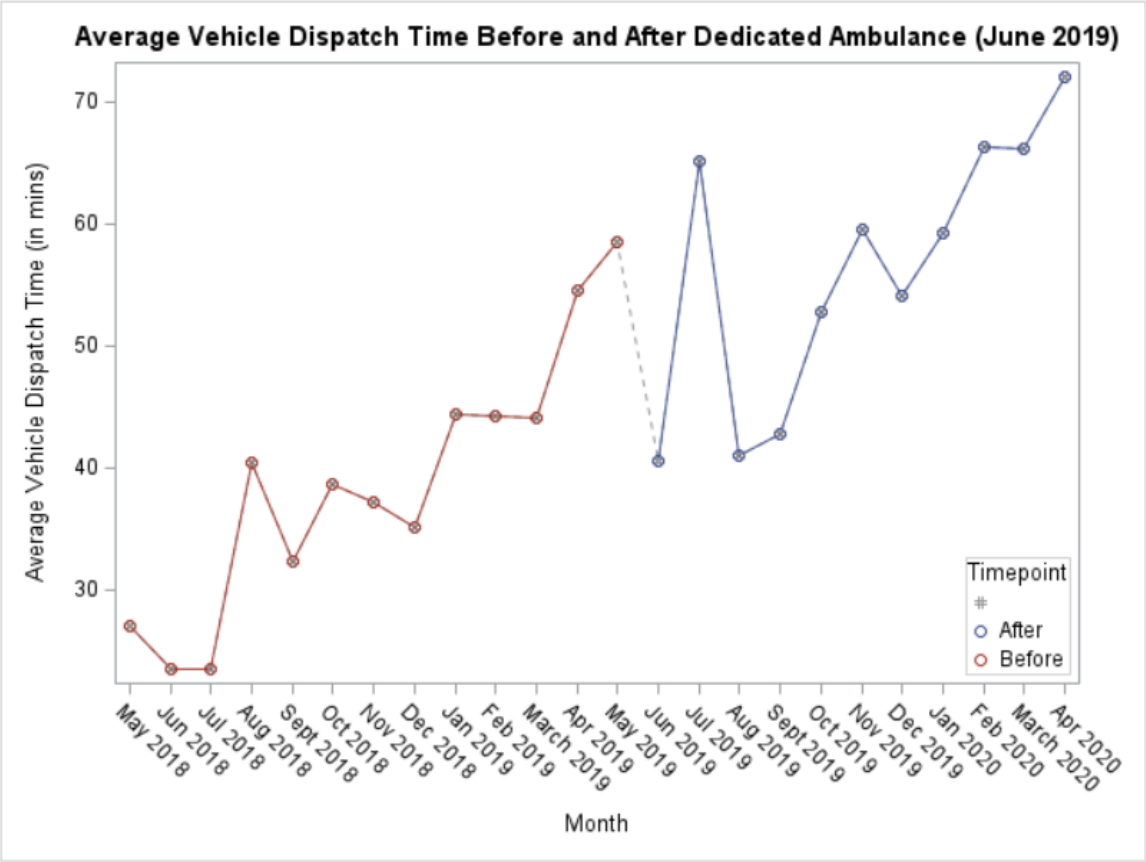
Variables	Median Return Dispatch Time (Range)*	P-value
Transports at Time Point Before/After Dedicated Ambulance **		<.0001
Before Dedicated Ambulance	17 (1 - 150) minutes	
After Dedicated Ambulance	15 (1 - 125) minutes	
Time of Transports		0.71
Daytime	15 (1 - 150) minutes	
Nighttime	17 (1 - 90) minutes	
Cities of Referral Facilities		0.16
Other Cities in Ontario	15 (1 - 150) minutes	
GTA, London & Hamilton	25 (15 - 45) minutes	
Most Responsible Medical Problem		0.36
Medical	17 (1 - 150) minutes	
Cardiac	12 (8 - 50) minutes	
Neurological	15 (1 - 90) minutes	
Surgical	15 (5 - 23) minutes	
Age of Patients		0.10
Infants	17 (1 - 125) minutes	
Children	15 (1 - 45) minutes	
Adolescents	15 (5 - 150) minutes	
Sex of Patients		0.49
Male	17 (1 - 150) minutes	
Female	15 (2 - 125) minutes	
Transport Team Composition		0.13
Registered Nurse & Respiratory Therapist	15 (1 - 125) minutes	
Other Composition	25 (10 - 150) minutes	
Ad Hoc Team**		0.04
No	16 (1 - 125) minutes	
Yes	16 (10 - 150) minutes	
System and Process Errors**		<.0001
No	15 (1 - 104) minutes	
Yes	20 (10 - 150) minutes	
Interaction: Time of Transports & Cities of Referral Facilities		0.93
Interaction: Transports at Time Point Before/After Dedicated Ambulance & Time of Transports **		0.04

Note: The medians and ranges indicate the length of return dispatch time per predictor, and the p-value indicates its statistical significance on the dispatch time. The sample size is 328 patients.

* Outcome variable was log-transformed in the analysis.
**The mean difference is significant at the 0.05 level.

The median return dispatch time before having a dedicated ambulance was shorter than the dispatch time after having the ambulance (17 vs 15 minutes). Using an ad hoc team resulted in a longer median return dispatch time than an existing team. This is not reflected in Table 14 as medians are reported but bivariate analyses using means showed a significant difference. Return dispatch times with system and process errors (20 minutes) took longer than dispatches without (15 minutes). The interaction between transports at time point before/after having a dedicated ambulance and the time of transports was also statistically significant.

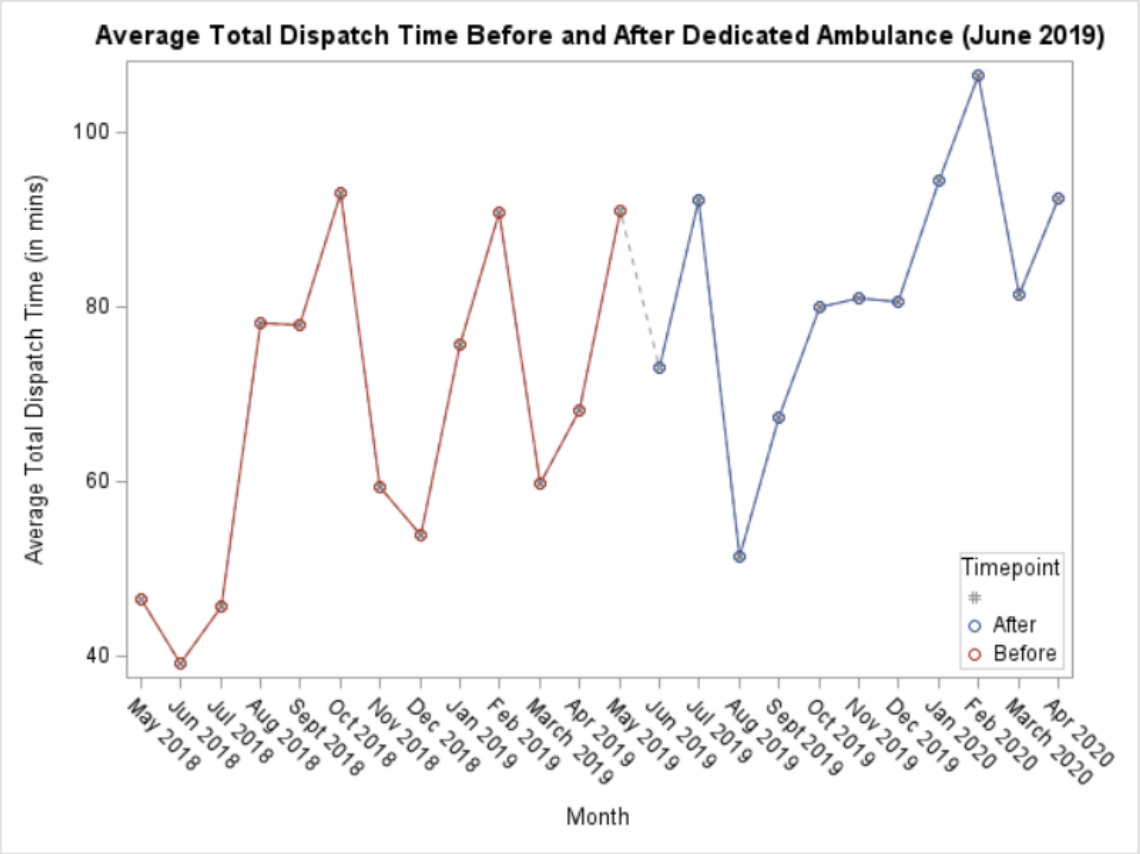
The red scatter points represent averages for vehicle dispatch time prior to having a dedicated ambulance whereas the blue scatter points show average times after having an ambulance (Figure 2). The dotted line signifies when the dedicated ambulance was assigned (June 2019). The number of transports range from 3 to 27 per month and average between 23 to 72 minutes, resulting in large variability in monthly vehicle dispatch times as indicated in the figure. There is an unexpected upward trend in average time throughout the two-year period, with higher average dispatch times after having a dedicated ambulance as shown by the blue line. This was later shown through the regression analysis as average vehicle dispatch time increased by 97% after having a dedicated ambulance, compared to before having the ambulance, holding age and system and process errors constant. However, having the dedicated ambulance may have affected dispatch times in terms of the decreased dispatch time during June 2019. It is necessary to note that vehicle dispatch times seem to be increasing even prior the introduction of the dedicated ambulance (red line) and the pattern appears to have continued after its introduction. This may indicate that external factors are influencing increased monthly vehicle dispatch times.



Note: The sample size is 328 patients.

Figure 2: Average Vehicle Dispatch Time per Month over a Two-Year Period

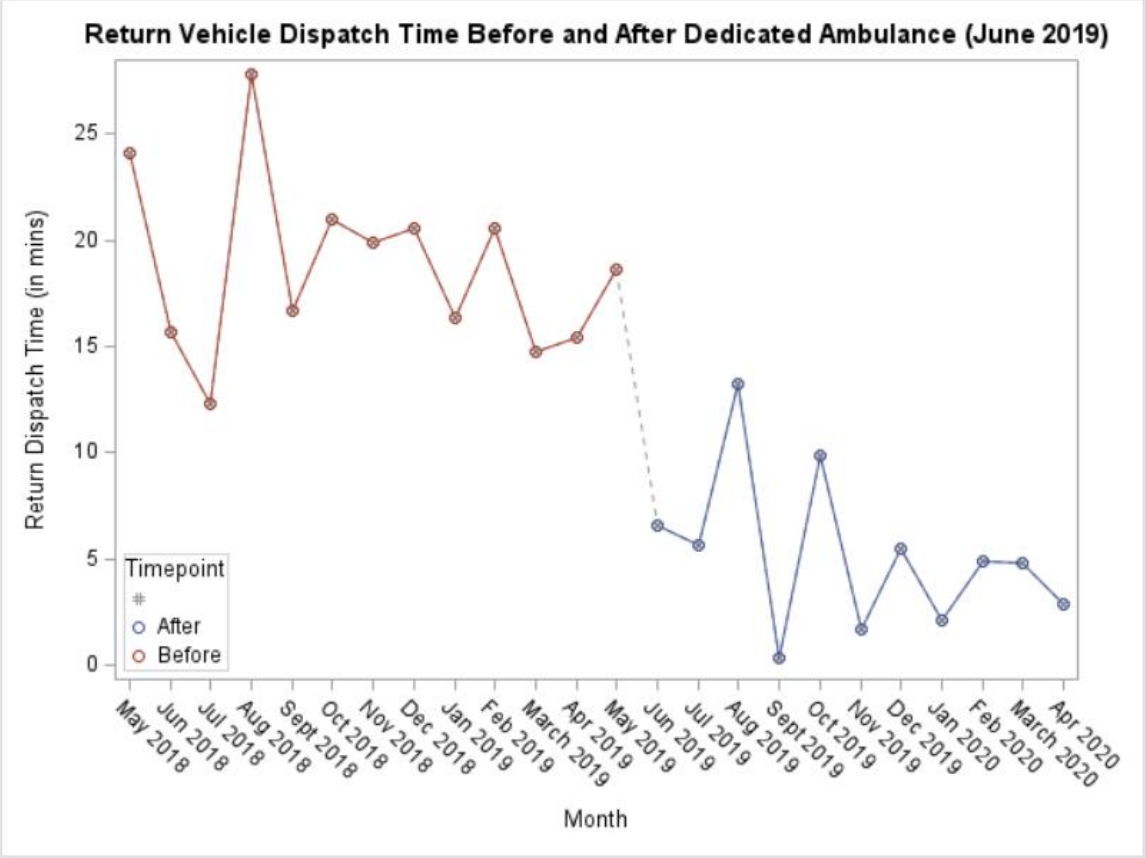
The red scatter points represent averages for total dispatch time prior to having a dedicated ambulance, the blue scatter points show average times after having an ambulance and the dotted line signifies when the dedicated ambulance was assigned (Figure 3). The number of transports range from 3 to 27 per month, ranging between 39 to 107 minutes. There are large fluctuations in average times throughout the two-year period, with higher average times after having a dedicated ambulance. After its introduction, the dedicated ambulance may have influenced dispatch times in regard to the decreased average dispatch time during June 2019.



Note: The sample size is 328 patients.

Figure 3: Average Total Dispatch Time per Month over a Two-Year Period

The red scatter points represent averages for return vehicle dispatch time prior to having a dedicated ambulance, the blue scatter points show average times after having an ambulance and the dotted line signifies when the dedicated ambulance was assigned (Figure 4). The number of transports range from 3 to 27 per month, ranging between 1 minute to 28 minutes. There is a decreasing trend in average time throughout the two-year period as average dispatch times appear to be lower after having a dedicated ambulance. There is also a decrease in average return dispatch time during June 2019 when the dedicated ambulance was introduced. Large variability of monthly return dispatch times are shown in the figure.



Note: The sample size is 328 patients.

Figure 4: Average Return Dispatch Time per Month over a Two-Year Period

4.3.2.1 Vehicle Dispatch Time

Transports at time point before/after dedicated ambulance, age of patients, and system and process errors were included in the model for vehicle dispatch time. The model used for vehicle dispatch time was a weighted multiple linear regression to account for heteroscedasticity (Table 15). Log-level estimates from Table 15 were converted into percent by exponentiation for interpretation using the following formula: $(\exp(\beta 1) - 1) \times 100\%$. The average vehicle dispatch time increases by 97% after having a dedicated ambulance, compared to before having a dedicated ambulance, holding age and system and process errors constant. In other words, after controlling for age and the presence of system and process errors, there is a difference in vehicle dispatch time between before and after having the dedicated ambulance. Compared to transporting infants, the average vehicle dispatch time decreases by 26% when transporting adolescents, holding all other variables constant. The average vehicle dispatch time increases by 26% when there are system and process errors compared to when there is none, holding all other variables constant.

Table 15: Weighted Multiple Linear Regression Analysis to Determine the Effects of Having a Dedicated Ambulance on Vehicle Dispatch Time

Effect	Estimate	Std error	*t*-value	*Pr* > |*t*|	*95% CI ll*	*95% CI ul*
Intercept	3.16	0.07	45.90	< 0.0001	3.02	3.29
Transports at Time Point Before/After Dedicated Ambulance						
Before Dedicated Ambulance	Reference					
After Dedicated Ambulance	0.68	0.07	10.16	< 0.0001	0.55	0.81
Age of Patients						
Infants	Reference					
Children	-0.12	0.07	-1.73	0.085	-0.25	0.016
Adolescents	-0.30	0.10	-3.07	0.0023	-0.48	-0.10
System and Process Errors						
No	Reference					
Yes	0.61	0.07	8.91	< 0.0001	0.47	0.74

Note: The output presented represents the relationship between predictors and vehicle dispatch time. Estimates are log-level estimates and were exponentiated for interpretation. The sample size is 328 patients.

4.3.2.2 Total Dispatch Time

Compared to before having a dedicated ambulance, the average total dispatch time increases by 63% after having a dedicated ambulance, holding transport team and system and process errors constant (Table 16). This means that there is a difference in total dispatch time between before and after having the dedicated ambulance even after controlling for transport team composition and the presence of system and process errors. Log-level estimates from Table 16 were converted into percent by exponentiation for interpretation using the following formula: $(\exp(\beta 1) - 1) \times 100\%$. The average total dispatch time increases by 62% when transported by an assorted transport team compared to a team composed of one registered nurse and one respiratory therapist, holding all other variables constant. The average total dispatch time increases by 75% when there are system and process errors compared to when there is none, holding all other variables constant.

Table 16: Multiple Linear Regression Analysis to Determine the Effects of Having a Dedicated Ambulance on Total Dispatch Time

Effect	Estimate	Std error	*t*-value	*Pr* > |*t*|	*95% CI ll*	*95% CI ul*
Intercept	3.64	0.05	70.60	< 0.0001	3.54	3.75
Transports at Time Point Before/After Dedicated Ambulance						
Before Dedicated Ambulance	Reference					
After Dedicated Ambulance	0.49	0.06	8.39	< 0.0001	0.37	0.60
Transport Team Composition						
Registered Nurse & Respiratory Therapist	Reference					
Other Composition	0.48	0.19	2.53	0.012	0.11	0.86
System and Process Errors						
No	Reference					
Yes	0.56	0.06	9.53	< 0.0001	0.44	0.68

Note: The output presented represents the relationship between predictors and total dispatch time. Estimates are log-level estimates and were exponentiated for interpretation. The sample size is 328 patients.

4.3.2.3 Return Dispatch Time

Compared to before having a dedicated ambulance, the average return dispatch time decreases by 84% after having a dedicated ambulance while holding all other variables constant (Table 17). Namely, there is a difference in return dispatch time between before and after having the dedicated ambulance even after controlling for an ad hoc team, the presence of system and process errors, and the interaction between transports at time point before/after having a dedicated ambulance and the time of transports. This is congruent with Figure 4 where average dispatch times are shorter after having a dedicated ambulance. Log-level estimates from Table 17 were converted into percent by exponentiation for interpretation using the following formula: $(\exp(\beta 1) - 1) \times 100\%$. The average return dispatch time increases by 40% when there are system and process errors compared to when there is none, holding all other variables constant. Having an ad hoc team and the interaction between transports at time point before/after having a dedicated ambulance and the time of transports no longer had a significant effect on return dispatch time after holding other variables constant.

Table 17: Multiple Linear Regression Analysis to Determine the Effects of Having a Dedicated Ambulance on Return Dispatch Time

Effect	Estimate	Std error	*t*-value	*Pr* > |*t*|	*95% CI ll*	*95% CI ul*
Intercept	2.63	0.13	20.88	< 0.0001	2.38	2.88
Transports at Time Point Before/After Dedicated Ambulance						
Before Dedicated Ambulance	Reference					
After Dedicated Ambulance	-1.83	0.15	-12.39	< 0.0001	-2.11	-1.54
System and Process Errors						
No	Reference					
Yes	0.33	0.12	2.84	0.0047	0.10	0.55
Ad Hoc Team						
No	Reference					
Yes	0.28	0.37	0.74	0.46	-0.46	1.01
Interaction: Transports at Time Point Before/After Dedicated Ambulance & Time of Transports						
Before Dedicated Ambulance						
Daytime	Reference					
Nighttime	-0.24	0.16	-1.52	0.28	-0.55	0.07
After Dedicated Ambulance						
Daytime	Reference					
Nighttime	0.17	0.16	1.08	0.13	-0.14	0.47

Note: The output presented represents the relationship between predictors and return dispatch time. Estimates are log-level estimates and were exponentiated for interpretation. The sample size is 328 patients.

Table 18: Supplementary Description of Sample Patient Population

Form	Variable	Frequency n (%)
Complications	Had Complications	328
	No	162 (49%)
	Yes	166 (51%)
	Types of Complications	209
	System and Process Errors	140 (67%)
	Equipment Failures	33 (16%)
	Vehicle Issues	13 (9%)
	Transport Team and/or Patient Safety Issues	12 (6%)
	Clinical	11 (5%)
Patient Outcomes	Death after PCCU Admission	302
	No	291 (96%)
	Yes	11 (4%)
	No Data on Patient Outcomes	26

Note: The frequencies and percentages presented represents descriptions of patient outcomes and in-transit complications of the sample population (n=328).

Table 19: Supplementary Description of In-Transit Complications Before and After Having a Dedicated Ambulance

	Type of Complications					
	Systems and Process Errors	Equipment Failures	Vehicle Issues	Transport Team and/or Patient Safety Issues	Clinical	**Total number of complications n**
Before Dedicated Ambulance n (%)	98 (69%)	21 (15%)	7 (5%)	8 (6%)	9 (6%)	143
After Dedicated Ambulance n (%)	42 (64%)	12 (18%)	6 (9%)	4 (6%)	2 (3%)	66

Note: The frequencies and percentages presented represents the types of in-transit complications experienced by the sample population (n=328).

Chapter 5

5 Discussion

This chapter describes the key findings of this study, with further discussion and elaboration. The strengths, limitations, and future directions for research are discussed as well.

5.1 Overview

The CPTN database was created in May 2018 and is currently based at the LHSC. It is a new pediatric transport database tracking transport and patient characteristics within Southwestern Ontario. The database can be used to establish benchmarks for assessing the performance of pediatric transport service and collect evidence on the quality of care and outcomes of patients. The CTPN database is expected to have data from three other Canadian transport services in the pilot project before national expansion to include all pediatric transport teams across the country.

In this study, we assessed the quality of the CPTN data, conducted an initial descriptive analysis of all transports over a two-year period, and assessed the impact of the LHSC pediatric transport team having a dedicated ambulance on selected transport times. Using five dimensions of data quality, we assessed the suitability of the data in the CPTN database for research purposes and highlighted the types of data entry errors to be aware of in future entries (Khare et al., 2017). The descriptive analysis provided an understanding of the patient population referred to the LHSC such as the frequency of pediatric transports, transport times, complications experienced during transport, and transport information. Finally, the analyses of the impact of a dedicated ambulance provided detailed information about relevant transport times while considering certain predictors.

5.2 Data Validation Results Summary

The CPTN database was assessed along five data quality dimensions. Table 20 provides a summary of the data validation results presented per the nine data entry forms, where applicable (see Tables 2 – 6).

Table 20: Summary of Data Validation Results per Form

Results	Data Validation				
Forms	Data Accuracy (perfect match)	Data Completeness (95% threshold)	Data Consistency	Data Timeliness	Data Plausibility
Administrative Information	73%	83%	n/a	n/a	n/a
Patient Information	85%	80%	n/a	n/a	67%
Transport Information	72%	100%	n/a	n/a	n/a
Transport Times	26%	97%	90%	n/a	n/a
Medications/ Interventions	20%	69%	n/a	n/a	n/a
Complications	81%	87%	n/a	n/a	n/a
Patient Outcomes	45%	100%	n/a	n/a	n/a
Clinical Information	43%	57%	n/a	n/a	98%
PELOD	35%	46%	n/a	n/a	85%

Note: The percentages presented represents the assessment results of the five data quality dimensions for all forms in the CPTN database. These percentages can be found in Tables 2 – 6 in this study. The sample size is 374 where applicable, except for data accuracy (n=36).

It is important to consider the five dimensions together to assess variables. For example, while clinical plausibility is high in the clinical information form, data accuracy and completeness are low. Overall, the patient information and complications forms had better data accuracy and completeness with scores over 80% in both dimensions. Our recommendation is for researchers interested in using this database to evaluate the

detailed descriptions of each variable available in Appendix A and interpret which variables are suitable for research tasks. While there are certainly reliable variables, there are variables where quality can be improved through data cleaning. As the CPTN database is evolving, applying further data quality strategies can strengthen the quality of the current database as well as of future entries.

For example, in terms of data accuracy, there were many disagreement errors in date time variables in the transport time and patient outcome forms. In these variables, if values did not match exactly between the original and the double data entries, we classified it as an error. However, some of the values only had a difference of one or two minutes, with many cases having a difference of less than 10 minutes. Clear decision rules are needed to determine when exact matches are not needed. Similarly, variables that can be entered in any order (e.g. most responsible medical problem) may have errors if the order of entry is not identical in the dataset and the double entered cases.

Four forms had data completeness in excess of 95% while the medications and interventions (69%), clinical information (57%), and PELOD (46%) forms have the lowest completeness out of all the forms (Table 20). The medications and interventions form has a large amount of missing data as medications and interventions that were administered prior to the arrival transport team are not often recorded in the database. Procedures and medications administered prior to the transport team's arrival are not consistently entered into REDCap.

With greater attention to data entry and additional efforts in data cleaning, the CPTN can yield high-quality data and be a promising database to use for pediatric transport research in Canada.

5.2.1 Suggestions to Increase Data Validity in the CTPN Database

To strengthen the quality of the data for future use in research, the CPTN database could benefit from some adjustments outlined in the Canadian Institute of Health Information's (CIHI) framework in the development of national health information standards. Adjustments include limiting the scope of data collection; improving data entry forms;

only collecting data applicable to the majority of patients; standardizing data collection times; improving training of data collectors; and lastly; routinely assessing data quality.

The framework suggests improving accuracy by limiting the scope of data to collecting information that is well understood, objective, and does not have a high response burden (Canadian Institute for Health Information [CIHI], 2012). For example, this can be applied to the CPTN database in variables such as in the 'Level of Care of Referral Site', 'Most Responsible System' and 'Acuity at the Time of Call' that have high accuracy errors at 25%, 22% and 50%, respectively (Appendix A). If the level of care of each referral site is unclear, providing a list of referral sites categorized by level of care could be useful in increasing general understanding.

Improving data entry forms in REDCap can also improve data quality. There is a lack of accuracy in 'Most Responsible System' variable, with few entries disagreeing on the form of respiratory problem (asthma, respiratory, pneumonia, aspiration, or stridor). There is a list of 85 medical conditions to scroll through under this variable, which likely contributes to high response burden (CIHI, 2012). This variable could be better off grouped into alike conditions prior to specifying the exact condition. Variables that are subjective like the acuity variable could also be removed from the database.

CIHI suggests increasing data quality by assessing comparability (CIHI, 2012). Collecting data that are relevant to most of the study population provides more value than data that are only applicable to a small proportion (CIHI, 2012). As an example, this can be applied to the CPTN database by removing variables that are not applicable to most participants, such as the 'Hospital Transit Number' and 'Next Most Responsible System, if any' that are almost never filled or only apply to few patients. Variables that only apply to a small proportion of the population should be removed to create a more comparable database.

Missing data may be due to the different times that data are entered into the CTPN database. For example, PELOD days are specific to time of days between 07:00 and 06:59, so if laboratory values of patient vitals did not fall within this time frame, they are not recorded for the PELOD day and are left blank. This is an occurring problem for

PELOD calculations in the literature and can be mediated by assuming that data for a variable is identical to the previous measurement or by entering a fixed normal value (Leteurtre et al., 2010; Prince et al., 2021). Standardizing for data entry would diminish the amount of missing data.

As data in the CPTN are collected and entered by healthcare workers of the transport team with varying levels of experience with data quality, it would be beneficial to review the specifics of data collection and entry of the CPTN. This also applies to the research team involved. For example, the 'Death or Discharge/Time from Receiving Area' variable had a 20% inconsistency. This likely due to the lack of clarity of this variable as the date of death or the date of discharge from the LHSC is supposed to be entered instead of the date of discharge from the PCCU, which was the common mistake. Additional training, review and/or a data entry manual specifically for the CPTN database could yield more accurate data entry.

Although 5% of charts are re-abstracted for data reliability and error detection, our findings indicate that the research team may need to increase the percentage of charts re-abstracted until data quality improves. If suggestions are applied to the CPTN database, another validation should be completed to assess data quality.

5.3 Descriptive Analysis

The descriptive analysis provided a comprehensive overview of the characteristics of pediatric transports completed by the London Neonatal-Pediatric Transport Team. Results showed that interfacility transports are a high demand service, averaging 4 transports per week. The analysis highlighted the large role that LHSC plays in regional pediatric care; providing interfacility transports to children up to 18 years of age from over 45 centres across Southwestern Ontario. Of these transports, many critically ill patients are admitted to the LHSC's PCCU to receive specialized intensive care. In the literature, there are various conclusions as to whether the mode of transport or transport times are associated with in-transit clinical deterioration (Orr et al., 2009; Schwartz et al., 2015; Singh et al., 2016). Our findings showed that there are few complications related to clinical issues,

suggesting that transport is safe and patients are well stabilized before being transported (Table 19).

Only characteristics that passed data validation were presented in descriptive analyses. Consequently, this left out potentially important information about the sample population that could be of interest to researchers. We excluded reporting clinical information, patient outcomes, and PELOD data in the descriptive analysis due to problems in data quality for some variables. The descriptive study provides baseline information with which to assess changes in the program, such as the addition of a dedicated ambulance. The CTPN database can be used to examine the impact of other program changes to transport characteristics as well as patient care and outcomes.

5.4 Dedicated Ambulance

When comparing the average vehicle dispatch time between before and after having a dedicated ambulance, it was found that the mean dispatch time increased by 97%, from a median of 30 minutes to 46 minutes after having the ambulance. Similarly, the average total dispatch time increased by 63% after having a dedicated ambulance compared to before the dedicated ambulance (median of 50 minutes to 69 minutes). The mean return dispatch time however, decreased by 84%, from a median of 17 minutes to 15 minutes after having a dedicated ambulance. The findings for vehicle dispatch time and total dispatch time outcomes do not support our hypothesis that a dedicated ambulance would decrease total dispatch time.

Vehicle dispatch time and total dispatch time could have increased for various reasons. Dedicated personnel for transport have been cited in the literature as a strategy that can reduce response times (Blackwell & Kaufman, 2002). In May 2019, the Ministry allotted funding for a dedicated ambulance for pediatric transport for the LHSC team, but not for dedicated staff to operate the dedicated ambulance. This funding only allowed for staffing the EMS vehicle when it was deployed (Juha, 2020). In other words, the closest available paramedics were responsible to go pick up the dedicated ambulance from the Middlesex-London EMS station and bring it to the LHSC when called upon. Subsequently in May 2020, the Ministry allocated $1.3 million in provincial funding to

staffing the dedicated ambulance around the clock (Juha, 2020). This allowed for paramedics to be on shift 24/7 at the station to operate the dedicated ambulance. As our analysis was conducted for data prior to May 2020, future research should examine the impact of dedicated EMS staff on transport times.

Another possible explanation for increased ambulance and total dispatch times is due to system and process errors, which include delays in dispatch times, delays in mobilization times, prolonged stabilization time and prolonged out-of-hospital time. The average vehicle dispatch time with system and process errors (49 minutes) took longer than dispatches without (32 minutes). The same is true for total dispatch time, where transports with system and process errors took longer than dispatches without errors, taking a median of 75 minutes and 50 minutes, respectively. These errors largely influence these two dispatch time outcomes as they are representative of delays that occur between the time of the call and team dispatch, as well as between the time of dispatch and until departing the LHSC. Delays could occur on the paramedics' end, whether it be that there are no available paramedics to pick up the ambulance at the station when required, delays bringing the ambulance to the LHSC or in stocking or maintaining the vehicle for departure (Blackwell & Kaufman, 2002).

An increase in ambulance and total dispatch times could also be attributed to the transport team taking their time if they think dispatch is faster with a dedicated ambulance. This is a known bias called the John Henry effect, where people either exert extra effort or reduce effort after an intervention (Irving & Holden, 2013). In this case, the team could be reducing efforts to be as fast as prior to having a dedicated ambulance.

Conversely, our hypothesis was supported for the return dispatch time outcome, as there was a decrease in dispatch time after having a dedicated ambulance. This is because the dedicated ambulance remained at the referral site location after dropping off the transport team to ready the patient for transport. It has eliminated the need for the transport team to call for an ambulance to take the team and the patient back to the LHSC. This is ideal as shorter transport times at any point along a transport continuum are beneficial for patient outcomes (Blackwell & Kaufman, 2002; Whyte & Jefferies, 2015).

Overall, having a dedicated ambulance did not improve transport times where a dedicated EMS vehicle was implicated (i.e., vehicle, total, and return dispatch times) because increases in vehicle dispatch time and total dispatch time outcomes were greater than decreases in return dispatch time. Nevertheless, based on the large variability and secular trends of dispatch times throughout the two-year period, it may be possible that other factors of the transport program can be attributed to these time patterns. A closer examination of dispatch time delays may reveal potential opportunities to further assess having a dedicated ambulance on transport time outcomes.

It is important to note that transport time intervals were calculated with variables that did not pass data validation. The system and process errors variables also had data quality issues. Errors in date time intervals were generally small, between 1 to 10 minutes. It is unlikely that the results are due the data entry errors, given the magnitude of the change in times before and after the dedicated ambulance. The analysis highlights how the CTPN database can be used for quality improvement and evaluate how program changes can affect program operation.

5.5 Study Strengths

As this is the first study to use the CPTN database, it provides important preliminary information about the validity of the data and the sample population for researchers who want to utilize this database. While data quality appraisal of data based on EHR is underutilized in literature, this study used widely reported methods of data assessment to evaluate the quality of the data. Using the CPTN database, we were able to describe pediatric transport in Southwestern Ontario and examine important transport time outcomes. This is also the first study to examine the association between having a dedicated ambulance and transport times in Canada. None of the studies included in the literature review quantified these transport times in relation to having a dedicated vehicle. This study is also one of the very few that uses transport times as an outcome rather than a predictor variable. With a large number of risk factors available, we were able to provide context for these outcomes. We relied wherever possible on high quality data, heightening validity and confidence in findings. The study was sufficiently powered as

there was necessary sample size. In addition, our analysis was completed using complete cases, giving us the advantage of using all the information in the data.

5.6 Limitations

This research has limitations that should be considered. Caution must be taken while applying the results to other settings, as the data may not be generalizable beyond pediatric transports outside of Ontario, specifically for hospitals that may not have a pediatric transport team and/or a dedicated ambulance.

A limitation of retrospective cohort studies using health records is that not all relevant risk factors are available. As pediatric transport literature has indicated, distance between facilities is a pertinent risk factor in transport outcomes (Kanter et al., 1992; Ramnarayan et al., 2010). Although transport time and transport distance may be closely related, a study found that there was no association between transport times and transport outcomes, but this was untrue for transport distance (Kanter et al., 1992). Unfortunately, information regarding distance from the LHSC was not easily accessible to us other than the general grouping of cities of the referring hospitals. Other cities in Ontario, aside from the GTA, London, and Hamilton were grouped altogether, which was not optimal given the differences in distance from the LHSC. For example, Thunder Bay Regional Health Sciences Centre is over 1,300 km from the LHSC while Windsor Regional Hospital is less than 200 km away, but these facilities were grouped together in 'Other Cities in Ontario'. As such, distance could have been an important risk factor to include in our analyses. A solution to this limitation could be to integrate a distance calculator in kilometers between the postal codes of healthcare facilities in REDCap. However, distance can be calculated by road/air distance, or by the most direct path between the facilities. If distance is calculated by road/air distance, the calculation will need to account for the mode of transport. To standardize data collection, the CPTN database's research team needs to decide which distance calculation to incorporate.

Another consequence of retrospective cohort studies using health records is that data are collected and entered by various healthcare professionals. This could affect the consistency of the data. It is also not possible to complete missing data or clarify data. As

a result, data validity is not ideal in the CPTN database. Delays in dispatch and mobilization times could not be easily teased apart from the system and process errors variable used in regression analyses. Descriptive analyses were limited and some variables that did not pass data validation were used for analyses.

5.7 Future Directions of Research

Following the implementation of methods to improve data quality, future studies should re-assess the quality of the database. This can be completed for each of the sites involved in the pilot study, so that site specific issues are identified.

Although much research on pediatric transport in Canada indicates the importance of a dedicated transport team and/or a dedicated ambulance, both of which the LHSC has, system and process errors remain (Singh et al., 2016; Whyte & Jefferies, 2015). Additional studies should aim to identify the cause of these errors. An initial study could be to examine the effect of a dedicated staff for ambulances in conjunction with a dedicated ambulance, on system and process errors.

Future studies could also utilize different data analysis approaches. When sample size permits, conducting an interrupted time series analyses would be appropriate in evaluating the impact of a dedicated ambulance or dedicated staff on transport time outcome measures as interrupted time series analyses are fitting for assessing the effects of interventions.

5.8 Conclusion

Through this study, we assessed the quality of the CPTN database and recommended ways of improving it before expanding to include other centres. These methods can strengthen the future quality of the data set and the evidence generated. Ongoing quality improvements are essential and should be repeated on a routine basis.

Finally, descriptive analyses showed that there is steady demand for pediatric transport services, clearly demonstrating the population and catchment areas that the LHSC serves. It also highlighted potential means of improving transport times, where complications

were mostly related to the transport itself instead of patient clinical conditions. The analyses demonstrated that having a dedicated ambulance alone did not decrease overall dispatch times. Data quality issues may influence these findings and there appears to be external factors affecting dispatch times based on the results shown. Future analyses that consider dispatch time delays are needed to fully understand the impact of a dedicated ambulance on dispatch times. Having dedicated EMS staff to operate the LHSC's pediatric ambulance in addition to the ambulance may further affect dispatch times. Analyses should be completed once these data become available.

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Appendices

Appendix A: Data Validation Results of All Variables in the CPTN Database per form

Data Validation		Data Accuracy		Data Completeness	Data Plausibility	
Variable Name	**Type of Variables**	**Errors n (%)**	**Nature of Error**	**Complete n (%)**	**Measures of Central Tendency mean±SD (min, max)**	**Plausible**
Administrative Information Form						
record_id	count	n/a	n/a	374/374 (100%)		
doc	datetime	4/36 (11%)	disagreement	374/374 (100%)		
hosp_team	categorical	0/36 (0%)	perfect match	374/374 (100%)		
htn	character	1/36 (3%)	missing	54/374 (14%)		
call_exists	categorical	0/36 (0%)	perfect match	374/374 (100%)		
intra	categorical	0/36 (0%)	perfect match	374/374 (100%)		
province	categorical	0/36 (0%)	perfect match	374/374 (100%)		
on_city	categorical	0/36 (0%)	perfect match	374/374 (100%)		
gta_hospital	categorical	0/36 (0%)	perfect match	11/11 (100%)		
hamilton_hospital	categorical	0/36 (0%)	perfect match	2/2 (100%)		
kingston_hospital	categorical	0/36 (0%)	perfect match	0/0 (100%)		
london_hospital	categorical	0/36 (0%)	perfect match	35/35 (100%)		
ottawa_hospital	categorical	0/36 (0%)	perfect match	0/0 (100%)		
other_on_hospital	categorical	0/36 (0%)	perfect match	326/326 (100%)		
level_of_care	categorical	9/36 (25%)	disagreement	372/374 (99%)		
referral_location	categorical	4/36 (11%)	disagreement	372/374 (99%)		
preplanned_transfer	categorical	1/36 (3%)	disagreement	374/374 (100%)		

prebooked	categorical	1/36 (3%)	missing	14/14 (100%)		
details_pro	character	1/36 (3%)	missing	5/5 (100%)		
details_med	character	0/36 (0%)	perfect match	3/4 (75%)		
details_other	character	0/36 (0%)	perfect match	1/1 (100%)		
acuity	categorical	18/36 (50%)	disagreement	374/374 (100%)		
outcome_of_call	categorical	0/36 (0%)	perfect match	374/374 (100%)		
transport_reason___1	categorical	0/36 (0%)	perfect match	0/0 (100%)		
transport_reason___2	categorical	0/36 (0%)	perfect match	0/0 (100%)		
transport_reason___99	categorical	0/36 (0%)	perfect match	0/0 (100%)		
other_details1	character	0/36 (0%)	perfect match	0/0 (100%)		
transport_cancelled	character	0/36 (0%)	perfect match	0/0 (100%)		
deferral_time	datetime	0/36 (0%)	perfect match	0/0 (100%)		
subsequent_call	categorical	0/36 (0%)	perfect match	0/0 (100%)		
outcome_of_run	categorical	0/36 (0%)	perfect match	374/374 (100%)		
province_d	categorical	0/36 (0%)	perfect match	374/374 (100%)		
on_city_d	categorical	0/36 (0%)	perfect match	374/374 (100%)		
gta_hospital_d	categorical	0/36 (0%)	perfect match	31/31 (100%)		
hamilton_hospital_d	categorical	0/36 (0%)	perfect match	8/8 (100%)		
kingston_hospital_d	categorical	0/36 (0%)	perfect match	0/0 (100%)		
london_hospital_d	categorical	0/36 (0%)	perfect match	331/331 (100%)		
ottawa_hospital_d	categorical	0/36 (0%)	perfect match	0/0 (100%)		
other_on_hospital_d	categorical	0/36 (0%)	perfect match	4/4 (100%)		
other_hospital_d	categorical	0/36 (0%)	perfect match	0/0 (100%)		
unit	categorical	3/36 (8%)	disagreement	374/374 (100%)		
team_referred_to	categorical	0/36 (0%)	perfect match	0/0 (100%)		
other_referred	character	0/36 (0%)	perfect match	0/0 (100%)		
type_of_run	categorical	4/36 (11%)	disagreement	373/374 (100%)		

deferral	categorical	1/36 (3%)	disagreement	373/374 (100%)		
comments	character	4/36 (11%)	missing	n/a		
Patient Information Form						
age	continuous	1/36 (3%)	disagreement	372/374 (99%)	4.36±5.33 (0, 17.99) years	Yes
age_days2	count	n/a	n/a	101/374 (27%)		
age_year	count	n/a	n/a	260/374 (70%)		
age_mon	count	n/a	n/a	217/374 (58%)		
gestational_age	continuous	5/36 (14%)	missing	63/374 (17%)	40.84±35.79 (4, 314) weeks	No
weight	continuous	1/36 (3%)	disagreement	374/374 (100%)	19.33±21.07 (2.3, 110) kg	Yes
sex	categorical	0/36 (0%)	perfect match	374/374 (100%)		
system1	categorical	1/36 (3%)	disagreement	374/374 (100%)		
problem1	categorical	8/36 (22%)	disagreement	255/255 (100%)		
other_problem1	character	3/36 (8%)	missing	19/19 (100%)		
problem2	categorical	1/36 (3%)	missing	41/41 (100%)		
other_problem2	character	1/36 (3%)	missing	4/4 (100%)		
problem3	categorical	1/36 (3%)	disagreement	68/68 (100%)		
other_problem3	character	0/36 (0%)	perfect match	2/2 (100%)		
problem4	categorical	0/36 (0%)	perfect match	10/10 (100%)		
other_problem4	character	0/36 (0%)	perfect match	4/4 (100%)		
system2	categorical	12/36 (33%)	missing	n/a		
system3	categorical	2/36 (6%)	missing	n/a		
system4	categorical	0/36 (0%)	perfect match	n/a		
system5	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___1	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___2	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___3	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___4	categorical	0/36 (0%)	perfect match	n/a		

next_problem_medical___5	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___6	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___7	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___8	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___9	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___10	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___11	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___12	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___13	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___14	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___15	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___16	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___17	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___18	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___19	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___20	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___21	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___22	categorical	1/36 (3%)	disagreement	n/a		
next_problem_medical___23	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___24	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___25	categorical	4/36 (11%)	disagreement	n/a		
next_problem_medical___26	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___27	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___28	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___29	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___30	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___31	categorical	0/36 (0%)	perfect match	n/a		

next_problem_medical___32	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___33	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___34	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___35	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___36	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___37	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___38	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___39	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___40	categorical	1/36 (3%)	disagreement	n/a		
next_problem_medical___41	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___42	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___43	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___44	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___45	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___46	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___47	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___48	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___49	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___50	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___51	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___52	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___53	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___54	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___55	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___57	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___58	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___59	categorical	0/36 (0%)	perfect match	n/a		

next_problem_medical___60	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___61	categorical	1/36 (3%)	disagreement	n/a		
next_problem_medical___62	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___63	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___64	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___65	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___66	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___67	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___68	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___69	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___70	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___71	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___72	categorical	3/36 (8%)	disagreement	n/a		
next_problem_medical___73	categorical	2/36 (6%)	disagreement	n/a		
next_problem_medical___74	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___75	categorical	1/36 (3%)	disagreement	n/a		
next_problem_medical___76	categorical	2/36 (6%)	disagreement	n/a		
next_problem_medical___77	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___78	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___79	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___80	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___81	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___82	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___83	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___84	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___85	categorical	0/36 (0%)	perfect match	n/a		
next_problem_medical___86	categorical	0/36 (0%)	perfect match	n/a		

next_problem_medical___99	categorical	1/36 (3%)	disagreement	n/a		
other_next_problem_med	character	1/36 (3%)	missing	17/17 (100%)		
next_problem_cardiac___1	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___2	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___3	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___4	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___5	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___6	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___7	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___8	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___9	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___10	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___11	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___12	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___13	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___14	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___15	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___16	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___17	categorical	0/36 (0%)	perfect match	n/a		
next_problem_cardiac___99	categorical	1/36 (3%)	disagreement	n/a		
other_medical_problems_res_4	character	1/36 (3%)	missing	8/8 (100%)		
next_problem_neuro___1	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___2	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___3	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___4	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___5	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___6	categorical	0/36 (0%)	perfect match	n/a		

next_problem_neuro___7	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___8	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___9	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___10	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___11	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___12	categorical	2/36 (6%)	disagreement	n/a		
next_problem_neuro___13	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___14	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___15	categorical	0/36 (0%)	perfect match	n/a		
next_problem_neuro___99	categorical	0/36 (0%)	perfect match	n/a		
other_medical_problems_res_3	character	0/36 (0%)	perfect match	9/9 (100%)		
next_problem_surg___1	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___2	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___3	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___4	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___5	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___6	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___7	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___8	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___9	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___10	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___11	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___12	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___13	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___14	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___15	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___16	categorical	0/36 (0%)	perfect match	n/a		

next_problem_surg___17	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___18	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___19	categorical	0/36 (0%)	perfect match	n/a		
next_problem_surg___99	categorical	0/36 (0%)	perfect match	n/a		
other_medical_problems_res_2	character	0/36 (0%)	perfect match	2/2 (100%)		
Transport Information Form						
home_refer_mode	categorical	1/36 (3%)	disagreement	374/374 (100%)		
home_refer_mode_other	character	0/36 (0%)	perfect match	0/0 (100%)		
home_refer2	categorical	1/36 (3%)	disagreement	374/374 (100%)		
home_refer2_mode	categorical	2/36 (6%)	disagreement	49/49 (100%)		
home_refer2_mode_other	character	0/36 (0%)	perfect match	0/0 (100%)		
home_refer3	categorical	1/36 (3%)	missing	48/49 (98%)		
home_refer3_mode	categorical	0/36 (0%)	perfect match	43/43 (100%)		
home_refer3_mode_other	character	0/36 (0%)	perfect match	8/8 (100%)		
team___1	categorical	0/36 (0%)	perfect match	n/a		
team___2	categorical	2/36 (6%)	disagreement	n/a		
team___3	categorical	1/36 (3%)	disagreement	n/a		
team___4	categorical	0/36 (0%)	perfect match	n/a		
team___5	categorical	0/36 (0%)	perfect match	n/a		
team___6	categorical	0/36 (0%)	perfect match	n/a		
team___7	categorical	0/36 (0%)	perfect match	n/a		
team___8	categorical	0/36 (0%)	perfect match	n/a		
team___9	categorical	0/36 (0%)	perfect match	n/a		
team___10	categorical	0/36 (0%)	perfect match	n/a		
team___11	categorical	0/36 (0%)	perfect match	n/a		
team___12	categorical	0/36 (0%)	perfect match	n/a		
team___13	categorical	1/36 (3%)	disagreement	n/a		

team___99	categorical	0/36 (0%)	perfect match	n/a		
team___998	categorical	0/36 (0%)	perfect match	n/a		
md1_type	categorical	2/36 (6%)	disagreement	22/22 (100%)		
md2_type	categorical	0/36 (0%)	perfect match	0/0 (100%)		
other_member	character	0/36 (0%)	perfect match	2/2 (100%)		
trans_team	categorical	0/36 (0%)	perfect match	374/374 (100%)		
refer_home_mode	categorical	0/36 (0%)	perfect match	374/374 (100%)		
refer_home_mode_other	character	0/36 (0%)	perfect match	0/0 (100%)		
refer_home2	categorical	0/36 (0%)	perfect match	374/374 (100%)		
refer_home2_mode	categorical	1/36 (3%)	disagreement	50/50 (100%)		
refer_home2_mode_other	character	0/36 (0%)	perfect match	0/0 (100%)		
refer_home3	categorical	0/36 (0%)	perfect match	49/50 (98%)		
refer_home3_mode	categorical	0/36 (0%)	perfect match	47/47 (100%)		
refer_home3_mode_other	character	0/36 (0%)	perfect match	0/0 (100%)		
parent_accmp	categorical	11/36 (31%)	disagreement	374/374 (100%)		
Not_accmp	categorical	18/36 (50%)	missing	186/186 (100%)		
other_accmp	character	1/36 (3%)	missing	16/16 (100%)		
acc_home_mode	categorical	0/36 (0%)	perfect match	42/43 (98%)		
acc_home_mode_other	character	0/36 (0%)	perfect match	1/1 (100%)		
acc_home2	categorical	0/36 (0%)	perfect match	42/43 (98%)		
acc_home2_mode	categorical	0/36 (0%)	perfect match	4/4 (100%)		
acc_home2_mode_other	character	0/36 (0%)	perfect match	2/2 (100%)		
acc_home3	categorical	0/36 (0%)	perfect match	4/4 (100%)		
acc_home3_mode	categorical	1/36 (3%)	disagreement	3/3 (100%)		
acc_home3_mode_other	character	0/36 (0%)	perfect match	1/1 (100%)		
Transport Times Form						
team_dispatch_dt	datetime	10/36 (28%)	disagreement	374/374 (100%)		

veh_call_hb_1	datetime	6/36 (17%)	disagreement	344/344 (100%)		
veh_arv_hb_1	datetime	1/36 (3%)	disagreement	344/344 (100%)		
tem_dep_hb_1	datetime	0/36 (0%)	perfect match	373/374 (100%)		
tem_arr_hb_1	datetime	1/36 (3%)	disagreement	373/374 (100%)		
veh_arv_hb_2	datetime	2/36 (6%)	disagreement	48/49 (98%)		
tem_dep_hb_2	datetime	1/36 (3%)	missing	49/49 (100%)		
tem_arr_hb_2	datetime	1/36 (3%)	missing	49/49 (100%)		
veh_arv_hb_3	datetime	3/36 (8%)	disagreement	42/43 (98%)		
tem_dep_hb_3	datetime	2/36 (6%)	disagreement	42/43 (98%)		
tem_arr_hb_3	datetime	0/36 (0%)	perfect match	43/43 (100%)		
stacked_trip	categorical	1/36 (3%)	disagreement	374/374 (100%)		
arv_rs	datetime	21/36 (58%)	disagreement	374/374 (100%)		
veh_cald_dep_rs	datetime	9/36 (25%)	disagreement	372/374 (99%)		
veh_arv_dep_rs	datetime	9/36 (25%)	disagreement	372/374 (99%)		
dep_rs	datetime	0/36 (0%)	perfect match	374/374 (100%)		
tem_arr_rs_1	datetime	2/36 (6%)	disagreement	374/374 (100%)		
veh_arv_rs_2	datetime	4/36 (11%)	disagreement	47/50 (94%)		
tem_dep_rs_2	datetime	2/36 (6%)	disagreement	49/50 (98%)		
tem_arr_rs_2	datetime	2/36 (6%)	disagreement	50/50 (100%)		
veh_arv_rs_3	datetime	3/36 (8%)	disagreement	45/47 (96%)		
tem_dep_rs_3	datetime	1/36 (3%)	missing	47/47 (100%)		
tem_arr_rs_3	datetime	1/36 (3%)	missing	47/47 (100%)		
arv_ds	datetime	21/36 (58%)	disagreement	374/374 (100%)		
veh_cald_dep_ds	datetime	2/36 (6%)	disagreement	43/43 (100%)		
veh_arv_dep_ds	datetime	3/36 (8%)	disagreement	43/43 (100%)		
dep_ds	datetime	1/36 (3%)	missing	43/43 (100%)		
tem_arr_ds_1	datetime	0/36 (0%)	perfect match	42/43 (98%)		

veh_arv_ds_2	datetime	0/36 (0%)	perfect match	4/4 (100%)		
tem_dep_ds_2	datetime	0/36 (0%)	perfect match	4/4 (100%)		
tem_arr_ds_2	datetime	0/36 (0%)	perfect match	4/4 (100%)		
veh_arv_ds_3	datetime	0/36 (0%)	perfect match	3/3 (100%)		
tem_dep_ds_3	datetime	0/36 (0%)	perfect match	3/3 (100%)		
tem_arr_ds_3	datetime	1/36 (3%)	missing	3/3 (100%)		
Medications and Interventions Form						
med_yn	categorical			373/374 (100%)		
medication1	categorical			244/244 (100%)		
purpose1	categorical			15/15 (100%)		
med_when1	categorical			244/244 (100%)		
med_by_whom1	categorical			244/244 (100%)		
medication2	categorical			n/a		
purpose2	categorical			9/9 (100%)		
med_when2	categorical			177/178 (99%)		
med_by_whom2	categorical			177/178 (99%)		
medication3	categorical			n/a		
purpose3	categorical			11/11 (100%)		
med_when3	categorical			127/127 (100%)		
med_by_whom3	categorical			127/127 (100%)		
medication4	categorical			n/a		
purpose4	categorical			6/6 (100%)		
med_when4	categorical			87/87 (100%)		
med_by_whom4	categorical			87/87 (100%)		
medication5	categorical			n/a		
purpose5	categorical			5/5 (100%)		
med_when5	categorical			56/56 (100%)		

med_by_whom5	categorical			56/56 (100%)		
medication6	categorical			n/a		
purpose6	categorical			1/1 (100%)		
med_when6	categorical			42/42 (100%)		
med_by_whom6	categorical			42/42 (100%)		
medication7	categorical			n/a		
purpose7	categorical			1/1 (100%)		
med_when7	categorical			27/27 (100%)		
med_by_whom7	categorical			27/27 (100%)		
medication8	categorical			n/a		
purpose8	categorical			1/1 (100%)		
med_when8	categorical			19/19 (100%)		
med_by_whom8	categorical			19/19 (100%)		
medication9	categorical			n/a		
purpose9	categorical			2/2 (100%)		
med_when9	categorical			12/12 (100%)		
med_by_whom9	categorical			12/12 (100%)		
medication10	categorical			n/a		
purpose10	categorical			1/1 (100%)		
med_when10	categorical			9/9 (100%)		
med_by_whom10	categorical			9/9 (100%)		
medication11	categorical			n/a		
purpose11	categorical			0/0 (100%)		
med_when11	categorical			7/7 (100%)		
med_by_whom11	categorical			7/7 (100%)		
medication12	categorical			n/a		
purpose12	categorical			0/0 (100%)		

med_when12	categorical			2/2 (100%)		
med_by_whom12	categorical			2/2 (100%)		
medication13	categorical			n/a		
purpose13	categorical			0/0 (100%)		
med_when13	categorical			2/2 (100%)		
med_by_whom13	categorical			2/2 (100%)		
medication14	categorical			n/a		
purpose14	categorical			0/0 (100%)		
med_when14	categorical			2/2 (100%)		
med_by_whom14	categorical			2/2 (100%)		
medication15	categorical			n/a		
purpose15	categorical			0/0 (100%)		
med_when15	categorical			1/1 (100%)		
med_by_whom15	categorical			1/1 (100%)		
medication16	categorical			n/a		
purpose16	categorical			n/a		
med_when16	categorical			1/1 (100%)		
med_by_whom16	categorical			1/1 (100%)		
medication17	categorical			n/a		
purpose17	categorical			n/a		
med_when17	categorical			n/a		
med_by_whom17	categorical			n/a		
medication18	categorical			n/a		
purpose18	categorical			n/a		
med_when18	categorical			n/a		
med_by_whom18	categorical			n/a		
medication19	categorical			n/a		

purpose19	categorical			n/a		
med_when19	categorical			n/a		
med_by_whom19	categorical			n/a		
medication20	categorical			n/a		
purpose20	categorical			n/a		
med_when20	categorical			n/a		
med_by_whom20	categorical			n/a		
no_std	categorical			n/a		
oi	categorical			0/0 (100%)		
int_yn	categorical			373/374 (100%)		
intervention1	categorical			261/261 (100%)		
non_inv_venti1	categorical			37/53 (70%)		
artline_site1	categorical			0/0 (100%)		
cvl_site1	categorical			1/1 (100%)		
us_use	categorical			0/1 (0%)		
int_when1	categorical			261/261 (100%)		
inv_by_whom1	categorical			261/261 (100%)		
attempt1	categorical			113/261 (43%)		
suc1	categorical			148/261 (57%)		
intervention2	categorical			n/a		
non_inv_venti2	categorical			21/26 (81%)		
artline_site2	categorical			0/2 (0%)		
cvl_site2	categorical			0/0 (100%)		
us_use2	categorical			0/2 (0%)		
int_when2	categorical			179/180 (99%)		
inv_by_whom2	categorical			178/180 (99%)		
attempt2	categorical			42/180 (23%)		

suc2	categorical			82/180 (46%)		
intervention3	categorical			n/a		
non_inv_venti3	categorical			6/11 (55%)		
artline_site3	categorical			0/0 (100%)		
cvl_site3	categorical			0/1 (0%)		
us_use3	categorical			0/1 (0%)		
int_when3	categorical			102/102 (100%)		
inv_by_whom3	categorical			102/102 (100%)		
attempt3	categorical			21/102 (21%)		
suc3	categorical			43/102 (42%)		
intervention4	categorical			n/a		
non_inv_venti4	categorical			4/7 (57%)		
artline_site4	categorical			0/0 (100%)		
cvl_site4	categorical			0/0 (100%)		
us_use4	categorical			0/0 (100%)		
int_when4	categorical			63/63 (100%)		
inv_by_whom4	categorical			63/63 (100%)		
attempt4	categorical			18/63 (29%)		
suc4	categorical			27/63 (43%)		
intervention5	categorical			n/a		
non_inv_venti5	categorical			5/7 (71%)		
artline_site5	categorical			0/0 (100%)		
cvl_site5	categorical			0/0 (100%)		
us_use5	categorical			0/0 (100%)		
int_when5	categorical			41/41 (100%)		
inv_by_whom5	categorical			41/41 (100%)		
attempt5	categorical			13/41 (32%)		

suc5	categorical			20/41 (49%)		
intervention6	categorical			n/a		
non_inv_venti6	categorical			1/1 (100%)		
artline_site6	categorical			0/1 (0%)		
cvl_site6	categorical			0/0 (100%)		
us_use6	categorical			0/1 (0%)		
int_when6	categorical			29/29 (100%)		
inv_by_whom6	categorical			29/29 (100%)		
attempt6	categorical			8/29 (28%)		
suc6	categorical			14/29 (48%)		
intervention7	categorical			n/a		
non_inv_venti7	categorical			0/1 (0%)		
artline_site7	categorical			0/0 (100%)		
cvl_site7	categorical			1/1 (100%)		
us_use7	categorical			1/1 (100%)		
int_when7	categorical			18/18 (100%)		
inv_by_whom7	categorical			18/18 (100%)		
attempt7	categorical			4/18 (22%)		
suc7	categorical			7/18 (39%)		
intervention8	categorical			n/a		
non_inv_venti8	categorical			0/0 (100%)		
artline_site8	categorical			1/1 (100%)		
cvl_site8	categorical			n/a		
us_use8	categorical			1/1 (100%)		
int_when8	categorical			12/12 (100%)		
inv_by_whom8	categorical			12/12 (100%)		
attempt8	categorical			2/12 (17%)		

suc8	categorical			7/12 (58%)		
intervention9	categorical			n/a		
non_inv_venti9	categorical			0/0 (100%)		
artline_site9	categorical			0/0 (100%)		
cvl_site9	categorical			0/0 (100%)		
us_use9	categorical			0/0 (100%)		
int_when9	categorical			7/7 (100%)		
inv_by_whom9	categorical			7/7 (100%)		
attempt9	categorical			1/7 (14%)		
suc9	categorical			3/7 (43%)		
intervention10	categorical			n/a		
non_inv_venti10	categorical			0/0 (100%)		
artline_site10	categorical			0/0 (100%)		
cvl_site10	categorical			0/0 (100%)		
us_use10	categorical			0/0 (100%)		
int_when10	categorical			1/1 (100%)		
inv_by_whom10	categorical			1/1 (100%)		
attempt10	categorical			0/1 (0%)		
suc10	categorical			0/1 (0%)		
airway	categorical			n/a		
Complications Form						
com_group___1	categorical	0/36 (0%)	perfect match	14/12 (117%)*		
com_group___2	categorical	1/36 (3%)	disagreement	38/37 (103%)*		
com_group___3	categorical	1/36 (3%)	disagreement	15/15 (100%)		
com_group___4	categorical	0/36 (0%)	perfect match	15/14 (107%)*		
com_group___5	categorical	6/36 (17%)	disagreement	204/163 (125%)*		
clinical_comp___1	categorical	0/36 (0%)	perfect match	n/a		

clinical_comp___2	categorical	0/36 (0%)	perfect match	n/a		
clinical_comp___3	categorical	0/36 (0%)	perfect match	n/a		
clinical_comp___4	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___1	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___2	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___3	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___4	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___5	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___6	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___7	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___8	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___9	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___10	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___11	categorical	0/36 (0%)	perfect match	n/a		
resp_failure___12	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___1	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___2	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___3	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___4	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___5	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___6	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___7	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___8	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___9	categorical	0/36 (0%)	perfect match	n/a		
cardiac_instability___10	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___1	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___2	categorical	0/36 (0%)	perfect match	n/a		

neuro_deter___3	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___4	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___5	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___6	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___7	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___8	categorical	0/36 (0%)	perfect match	n/a		
neuro_deter___9	categorical	0/36 (0%)	perfect match	n/a		
renal_electrolyte___1	categorical	0/36 (0%)	perfect match	n/a		
renal_electrolyte___2	categorical	0/36 (0%)	perfect match	n/a		
renal_electrolyte___3	categorical	0/36 (0%)	perfect match	n/a		
renal_electrolyte___4	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___1	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___2	categorical	1/36 (3%)	disagreement	n/a		
equipment_comp___3	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___4	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___5	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___6	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___7	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___8	categorical	1/36 (3%)	disagreement	n/a		
equipment_comp___9	categorical	0/36 (0%)	perfect match	n/a		
equipment_comp___10	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___1	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___2	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___3	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___4	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___5	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___6	categorical	0/36 (0%)	perfect match	n/a		

vehicle_comp___7	categorical	0/36 (0%)	perfect match	n/a		
vehicle_comp___8	categorical	0/36 (0%)	perfect match	n/a		
system_comp___1	categorical	0/36 (0%)	perfect match	n/a		
system_comp___2	categorical	0/36 (0%)	perfect match	n/a		
system_comp___4	categorical	0/36 (0%)	perfect match	n/a		
system_comp___5	categorical	0/36 (0%)	perfect match	n/a		
system_comp___6	categorical	0/36 (0%)	perfect match	n/a		
system_comp___7	categorical	0/36 (0%)	perfect match	n/a		
system_comp___8	categorical	0/36 (0%)	perfect match	n/a		
system_comp___9	categorical	0/36 (0%)	perfect match	n/a		
system_comp___10	categorical	0/36 (0%)	perfect match	n/a		
system_comp___12	categorical	0/36 (0%)	perfect match	n/a		
system_comp___13	categorical	0/36 (0%)	perfect match	n/a		
trans_com_group___1	categorical	3/36 (8%)	disagreement	n/a		
trans_com_group___2	categorical	9/36 (25%)	disagreement	n/a		
trans_com_group___3	categorical	0/36 (0%)	perfect match	n/a		
trans_com_group___4	categorical	3/36 (8%)	disagreement	n/a		
disp_time_delay___1	categorical	1/36 (3%)	disagreement	n/a		
disp_time_delay___2	categorical	1/36 (3%)	disagreement	n/a		
disp_time_delay___6	categorical	0/36 (0%)	perfect match	n/a		
disp_time_delay___9	categorical	2/36 (6%)	disagreement	n/a		
disp_time_delay___10	categorical	0/36 (0%)	perfect match	n/a		
disp_time_delay___11	categorical	1/36 (3%)	disagreement	n/a		
disp_time_delay___12	categorical	0/36 (0%)	perfect match	n/a		
disp_time_delay___13	categorical	1/36 (3%)	disagreement	n/a		
disp_time_delay___14	categorical	0/36 (0%)	perfect match	n/a		
disp_time_delay___15	categorical	1/36 (3%)	disagreement	n/a		

disp_time_delay___99	categorical	0/36 (0%)	perfect match	n/a		
other_disp_delay	categorical	0/36 (0%)	perfect match	0/2 (0%)		
mob_time_delay___1	categorical	4/36 (11%)	disagreement	n/a		
mob_time_delay___2	categorical	0/36 (0%)	perfect match	n/a		
mob_time_delay___3	categorical	4/36 (11%)	disagreement	n/a		
mob_time_delay___4	categorical	1/36 (3%)	disagreement	n/a		
mob_time_delay___5	categorical	0/36 (0%)	perfect match	n/a		
mob_time_delay___6	categorical	0/36 (0%)	perfect match	n/a		
mob_time_delay___7	categorical	0/36 (0%)	perfect match	n/a		
mob_time_delay___99	categorical	2/36 (6%)	disagreement	n/a		
other_mob_delay	categorical	2/36 (6%)	missing	22/25 (88%)		
stb_time_delay___1	categorical	0/36 (0%)	perfect match	n/a		
stb_time_delay___2	categorical	0/36 (0%)	perfect match	n/a		
stb_time_delay___3	categorical	0/36 (0%)	perfect match	n/a		
stb_time_delay___4	categorical	0/36 (0%)	perfect match	n/a		
stb_time_delay___5	categorical	0/36 (0%)	perfect match	n/a		
stb_time_delay___6	categorical	0/36 (0%)	perfect match	n/a		
stb_time_delay___99	categorical	0/36 (0%)	perfect match	n/a		
other_stb_delay	categorical	0/36 (0%)	perfect match	5/5 (100%)		
ooh_time_delay___1	categorical	1/36 (3%)	disagreement	n/a		
ooh_time_delay___2	categorical	0/36 (0%)	perfect match	n/a		
ooh_time_delay___3	categorical	0/36 (0%)	perfect match	n/a		
ooh_time_delay___4	categorical	0/36 (0%)	perfect match	n/a		
ooh_time_delay___99	categorical	0/36 (0%)	perfect match	n/a		
other_pro_hosp	categorical	0/36 (0%)	perfect match	6/6 (100%)		
ce_comment	character	4/36 (11%)	missing	n/a		
Patient Outcomes Form						

discharge_dod	datetime	12/36 (33%)	disagreement	307/307 (100%)		
death	categorical	0/36 (0%)	perfect match	307/307 (100%)		
death_24hr	categorical	0/36 (0%)	perfect match	11/11 (100%)		
early_int___1	categorical	5/36 (14%)	disagreement	n/a		
early_int___2	categorical	6/36 (17%)	disagreement	n/a		
early_int___3	categorical	0/36 (0%)	perfect match	n/a		
early_int___4	categorical	0/36 (0%)	perfect match	n/a		
early_int___5	categorical	0/36 (0%)	perfect match	n/a		
early_int___6	categorical	3/36 (8%)	disagreement	n/a		
early_int___7	categorical	0/36 (0%)	perfect match	n/a		
int	categorical	0/36 (0%)	perfect match	308/307 (100%)		
int_date	datetime	4/36 (11%)	disagreement	96/97 (99%)		
ext_date	datetime	6/36 (17%)	disagreement	93/97 (96%)		
venti_free_days	continuous	7/36 (19%)	disagreement	93/97 (96%)		
trans_pccu	categorical	0/36 (0%)	perfect match	308/307 (100%)		
admit_post_transport	continuous	0/36 (0%)	perfect match	4/4 (100%)		
pccu_discharge_date	datetime	12/36 (33%)	disagreement	308/307 (100%)		
hospital_discharge_date	datetime	7/36 (19%)	disagreement	308/307 (100%)		
pccu_los	continuous	5/36 (14%)	disagreement	308/307 (100%)		
hosp_los	continuous	4/36 (11%)	disagreement	308/307 (100%)		
Clinical Information (incl. PIM III) Form						
pt_time_point	categorical	n/a	n/a	n/a		
hr_prior	continuous	5/36 (14%)	disagreement	370/372 (99%)	135.42±30.0 (61, 249) bpm	Yes
sbp_prior	continuous	5/36 (14%)	disagreement	358/372 (96%)	100.75±20.1 (10, 170) mmHg	Yes
dbp_prior	continuous	6/36 (17%)	disagreement	358/372 (96%)	61.78±15.15 (10, 147) mmHg	Yes
mbp_prior	continuous	5/36 (14%)	disagreement	355/372 (95%)	73.96±16.28 (10, 120) mmHg	Yes
iono_prior	categorical	0/36 (0%)	perfect match	370/372 (99%)		

iono_prior_med___1	categorical	0/36 (0%)	perfect match	n/a		
iono_prior_med___2	categorical	0/36 (0%)	perfect match	n/a		
iono_prior_med___3	categorical	0/36 (0%)	perfect match	n/a		
iono_prior_med___4	categorical	0/36 (0%)	perfect match	n/a		
iono_prior_med___5	categorical	0/36 (0%)	perfect match	n/a		
epi_max_prior	continuous	0/36 (0%)	perfect match	15/15 (100%)	0.093±0.063 (0.01, 0.2) Mcg/kg/min	Yes
nepi_max_prior	continuous	0/36 (0%)	perfect match	10/11 (91%)	0.13±0.070 (0.05, 0.25) Mcg/kg/min	Yes
da_max_prior	continuous	0/36 (0%)	perfect match	5/5 (100%)	7±3.8 (3,12) Mcg/kg/min	Yes
dob_max_prior	continuous	0/36 (0%)	perfect match	1/1 (100%)	10 Mcg/kg/min	Yes
vaso_max_prior	continuous	0/36 (0%)	perfect match	1/1 (100%)	0.0005 Units/kg/min	Yes
resp_prior	categorical	1/36 (3%)	disagreement	370/372 (99%)		
resp_type_prior	categorical	1/36 (3%)	disagreement	224/226 (99%)		
peep_prior	continuous	1/36 (3%)	disagreement	120/121 (99%)		
ipap_prior	continuous	0/36 (0%)	perfect match	15/17 (88%)		
pip_prior	continuous	2/36 (6%)	disagreement	90/91 (99%)		
epap_prior	continuous	0/36 (0%)	perfect match	15/17 (88%)		
map_prior	continuous	5/36 (14%)	disagreement	97/108 (90%)	10.74±7.56 (0, 78) mmHg	No
fio2_prior	continuous	2/36 (6%)	disagreement	221/224 (99%)	0.41±0.23 (0.21, 1.0)	Yes
flow_prior	continuous	1/36 (3%)	missing	86/86 (100%)	18.10±11.99 (1, 6) L/min	Yes
min_hr_dur	continuous	11/36 (31%)	disagreement	369/372 (99%)	125.12±28.15 (57, 240) bpm	Yes
max_hr_dur	continuous	12/36 (33%)	disagreement	368/372 (99%)	142.13±31.81 (65, 240) bpm	Yes
min_sbp_dur	continuous	8/36 (22%)	disagreement	353/372 (95%)	93.33±17.68 (10,148) mmHg	Yes
max_sbp_dur	continuous	9/36 (25%)	disagreement	353/372 (95%)	105.87±18.26 (10, 175) mmHg	Yes
min_dbp_dur	continuous	8/36 (22%)	disagreement	353/372 (95%)	55.68±13.08 (10, 91) mmHg	Yes
max_dbp_dur	continuous	15/36 (42%)	disagreement	353/372 (95%)	67.68±14.47 (10, 113) mmHg	Yes

min_mbp_dur	continuous	10/36 (28%)	disagreement	352/372 (95%)	68.22±14.60 (10, 110) mmHg	Yes
max_mbp_dur	continuous	14/36 (39%)	disagreement	352/372 (95%)	78.75±15.5 (10, 135) mmHg	Yes
iono_dur	categorical	0/36 (0%)	perfect match	343/372 (92%)		
iono_dur_med___1	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med___2	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med___3	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med___4	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med___5	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med2___1	categorical	1/36 (3%)	disagreement	n/a		
iono_dur_med2___2	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med2___3	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med2___4	categorical	0/36 (0%)	perfect match	n/a		
iono_dur_med2___5	categorical	0/36 (0%)	perfect match	n/a		
epi_max_dur	continuous	2/36 (6%)	disagreement	21/21 (100%)	0.097±0.06 (0.01, 0.2) Mcg/kg/min	Yes
nepi_max_dur	continuous	0/36 (0%)	perfect match	12/13 (92%)	0.13±0.09 (0.05, 0.3) Mcg/kg/min	Yes
da_max_dur	continuous	0/36 (0%)	perfect match	4/4 (100%)	6.25±3.94 (3, 12) Mcg/kg/min	Yes
dob_max_dur	continuous	0/36 (0%)	perfect match	1/1 (100%)	10 Mcg/kg/min	Yes
vaso_max_dur	continuous	0/36 (0%)	perfect match	2/2 (100%)	0.00065±0.00021 (0.0005, 0.0008) Units/kg/min	Yes
resp_dur	categorical	1/36 (3%)	disagreement	370/372 (99%)		
resp_type_dur___1	categorical	0/36 (0%)	perfect match	n/a		
resp_type_dur___2	categorical	0/36 (0%)	perfect match	n/a		
resp_type_dur___3	categorical	1/36 (3%)	disagreement	n/a		
resp_type_dur___4	categorical	0/36 (0%)	perfect match	n/a		
min_peep_dur	continuous	1/36 (3%)	disagreement	125/125 (100%)	6.48±1.62 (5, 12)	Yes
max_peep_dur	continuous	2/36 (6%)	disagreement	125/125 (100%)	6.59±11.72 (5,14)	Yes
min_pip_dur	continuous	1/36 (3%)	disagreement	91/91 (100%)	20.02±6.06 (10, 39)	Yes

max_pip_dur	continuous	1/36 (3%)	disagreement	91/91 (100%)	21.88±6.13 (12, 39)	Yes
min_ipap_dur	continuous	0/36 (0%)	perfect match	18/21 (86%)	15.72±5.91 (9, 35)	Yes
max_ipap_dur	continuous	0/36 (0%)	perfect match	18/21 (86%)	15.44±6.46 (5, 35)	Yes
min_epap_dur	continuous	0/36 (0%)	perfect match	17/21 (81%)	7.71±1.96 (5,12)	Yes
max_epap_dur	continuous	0/36 (0%)	perfect match	17/21 (81%)	7.76±1.95 (5, 12)	Yes
min_map_dur	continuous	4/36 (11%)	disagreement	102/112 (91%)	9.99±3.09 (0, 22) mmHg	Yes
max_map_dur	continuous	4/36 (11%)	disagreement	102/112 (91%)	10.75±3.16 (0, 22) mmHg	Yes
min_fio2_dur	continuous	5/36 (14%)	disagreement	219/225 (97%)	0.37±0.2 (0.21, 1)	Yes
max_fio2_dur	continuous	4/36 (11%)	disagreement	219/225 (97%)	0.44±0.24 (0.21, 1)	Yes
min_flow_dur	continuous	1/36 (3%)	missing	79/79 (100%)	18.01±11.74 (1.0, 60.0) L/min	Yes
max_flow_dur	continuous	2/36 (6%)	disagreement	79/79 (100%)	20.34±13.38 (1.0, 60.0) L/min	Yes
pt_pup_react	categorical	3/36 (8%)	disagreement	372/372 (100%)		
pt_elc_ad	categorical	2/36 (6%)	disagreement	372/372 (100%)		
pt_mec_vent	categorical	3/36 (8%)	disagreement	372/372 (100%)		
pt_base_excess	continuous	8/36 (22%)	missing	368/372 (99%)	-0.597±4.77 (-27.7, 24) Mmol/L	Yes
pt_sys_bp	continuous	5/36 (14%)	disagreement	370/372 (99%)	103.39±19.57 (0, 172) mmHg	Yes
pt_fio2	continuous	10/36 (28%)	missing	285/372 (77%)	0.38±0.24 (0.21, 1.0)	Yes
pt_pao2	continuous	8/36 (22%)	missing	60/372 (16%)	76.85±63.61 (0, 382) mmHg	Yes
pt_fio2_pao2	n/a	7/36 (19%)	disagreement	n/a		
pt_rec_ad	categorical	0/36 (0%)	perfect match	369/372 (99%)		
pt_vhigh_risk_ad	categorical	4/36 (11%)	disagreement	366/372 (98%)		
pt_high_risk_ad	categorical	1/36 (3%)	disagreement	366/372 (98%)		
pt_low_risk_ad	categorical	8/36 (22%)	disagreement	369/372 (99%)		
vhighrisk_score	n/a	n/a	n/a	n/a		
highrisk_score	n/a	n/a	n/a	n/a		
lowrisk_score	n/a	n/a	n/a	n/a		
pt_pim_3_score_cal	continuous	23/36 (64%)	disagreement	365/372 (98%)	-4.41±1.99 (-9.48, 9.55)	Yes
pt_pim_3_risk_of_death	continuous	23/36 (64%)	disagreement	365/372 (98%)	0.048±0.15 (0.0001, 1.0)	Yes

man_pim_3_score	continuous	n/a	n/a	n/a	-4.19±1.82 (-9.28, 2.48)	Yes
man_pim_3_risk_of_death	continuous	n/a	n/a	n/a	0.32±0.24 (0.0001, 0.92)	Yes
pt_time_point	categorical	n/a	n/a	168/168 (100%)		
pt_pup_react	categorical	n/a	n/a	168/168 (100%)		
pt_elc_ad	categorical	n/a	n/a	168/168 (100%)		
pt_mec_vent	categorical	n/a	n/a	168/168 (100%)		
pt_base_excess	continuous	n/a	n/a	168/168 (100%)		
pt_sys_bp	continuous	n/a	n/a	168/168 (100%)		
pt_fio2	continuous	n/a	n/a	101/168 (60%)		
pt_pao2	continuous	n/a	n/a	5/168 (3%)		
pt_fio2_pao2	n/a	n/a	n/a	n/a		
pt_rec_ad	categorical	n/a	n/a	167/168 (99%)		
pt_vhigh_risk_ad	categorical	n/a	n/a	168/168 (100%)		
pt_high_risk_ad	categorical	n/a	n/a	168/168 (100%)		
pt_low_risk_ad	categorical	n/a	n/a	168/168 (100%)		
vhighrisk_score	n/a	n/a	n/a	n/a		
highrisk_score	n/a	n/a	n/a	n/a		
lowrisk_score	n/a	n/a	n/a	n/a		
pt_pim_3_score_cal	continuous	n/a	n/a	168/168 (100%)		
pt_pim_3_risk_of_death	continuous	n/a	n/a	168/168 (100%)		
man_pim_3_score	continuous	7/21 (33%)	disagreement	136/136 (100%)		
man_pim_3_risk_of_death	continuous	7/21 (33%)	disagreement	144/144 (100%)		
PELOD Form						
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	1/28 (4%)	disagreement	308/308 (100%)	53.05±63.61 (0, 215) months	Yes
inv_vent_pel	categorical	2/28 (7%)	disagreement	305/308 (99%)		
pel_pco2	continuous	8/28 (29%)	disagreement	234/308 (76%)	47.28±13.31 (22,116) mmHg	Yes

pel_pao2	continuous	1/28 (4%)	missing	14/308 (5%)	84.87±49.63 (31, 345) mmHg	Yes
pel_spo2	continuous	4/28 (14%)	disagreement	302/308 (98%)	93.52±3.39 (57, 100)	Yes
pel_fio2	continuous	6/28 (21%)	disagreement	303/308 (98%)	0.32±0.16 (0.1 to 1.0)	No
ratio	n/a	n/a	n/a	n/a		
map_pel	continuous	4/28 (14%)	disagreement	299/308 (97%)	66.12±13.2 (29, 110) mmHg	Yes
lactate_pel	continuous	9/28 (32%)	missing	223/308 (72%)	1.95±1.49 (0.5, 12) Mmol/L	Yes
pel_wbc	continuous	9/28 (32%)	missing	125/308 (41%)	13.72±17.71 (0.8, 200) 10^9/L	Yes
pel_plat	continuous	8/28 (29%)	missing	124/308 (40%)	278.44±140.18 (12, 795) 10^9/L	Yes
pel_creat	continuous	7/28 (25%)	missing	113/308 (37%)	46.84±54.46 (9, 398) Umol/L	Yes
pel_gcs	continuous	1/28 (4%)	disagreement	283/308 (92%)	12.21±3.68 (3, 15)	Yes
pel_pupil	categorical	0/28 (0%)	perfect match	274/308 (89%)		
ratio_calc	continuous	n/a	n/a	n/a		
calc_vent	continuous	n/a	n/a	n/a		
calc_pelpco2	continuous	n/a	n/a	n/a		
pel_resp	continuous	n/a	n/a	n/a		
calc_map	continuous	n/a	n/a	n/a		
calc_lact	continuous	n/a	n/a	n/a		
pel_cv	continuous	n/a	n/a	n/a		
calc_wbc_prism	continuous	n/a	n/a	n/a		
calc_plat	continuous	n/a	n/a	n/a		
pel_hem	continuous	n/a	n/a	n/a		
calc_creat	continuous	n/a	n/a	n/a		
pel_renal	continuous	n/a	n/a	n/a		
calc_gcs_pel	continuous	n/a	n/a	n/a		
calc_pupil	continuous	n/a	n/a	n/a		
pel_neuro	continuous	n/a	n/a	n/a		
pelod_score	continuous	11/28 (39%)	disagreement	305/308 (99%)	4.18±2.99 (0, 18)	Yes

pel_score_man	continuous	n/a	n/a	n/a	4.90±9.63 (0, 42)	No
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	2/25 (8%)	disagreement	278/278 (100%)		
inv_vent_pel	categorical	0/25 (0%)	perfect match	276/278 (99%)		
pel_pco2	continuous	6/25 (24%)	missing	155/278 (56%)		
pel_pao2	continuous	3/25 (12%)	disagreement	17/278 (6%)		
pel_spo2	continuous	8/25 (32%)	disagreement	271/278 (97%)		
pel_fio2	continuous	5/25 (20%)	disagreement	274/278 (99%)		
map_pel	continuous	7/25 (28%)	disagreement	269/278 (97%)		
lactate_pel	continuous	7/25 (28%)	disagreement	146/278 (53%)		
pel_wbc	continuous	3/25 (12%)	missing	66/278 (24%)		
pel_plat	continuous	4/25 (16%)	missing	66/278 (24%)		
pel_creat	continuous	2/25 (8%)	missing	45/278 (16%)		
pel_gcs	continuous	2/25 (8%)	missing	263/278 (95%)		
pel_pupil	categorical	4/25 (16%)	disagreement	253/278 (91%)		
pelod_score	continuous	7/25 (28%)	disagreement	276/278 (99%)		
pel_score_man	continuous	n/a	n/a	n/a		
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	3/11 (27%)	disagreement	88/88 (100%)		
inv_vent_pel	categorical	0/11 (0%)	perfect match	87/88 (99%)		
pel_pco2	continuous	3/11 (27%)	missing	51/88 (58%)		
pel_pao2	continuous	1/11 (9%)	disagreement	7/88 (8%)		
pel_spo2	continuous	7/11 (64%)	disagreement	85/88 (97%)		
pel_fio2	continuous	3/11 (27%)	disagreement	86/88 (98%)		
map_pel	continuous	2/11 (18%)	disagreement	84/88 (95%)		
lactate_pel	continuous	4/11 (36%)	missing	47/88 (53%)		
pel_wbc	continuous	4/11 (36%)	missing	23/88 (26%)		

pel_plat	continuous	4/11 (36%)	missing	23/88 (26%)		
pel_creat	continuous	1/11 (9%)	missing	10/88 (11%)		
pel_gcs	continuous	1/11 (9%)	disagreement	84/88 (95%)		
pel_pupil	categorical	0/11 (0%)	perfect match	78/88 (89%)		
pelod_score	continuous	2/11 (18%)	disagreement	87/88 (99%)		
pel_score_man	continuous	n/a	n/a	n/a		
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	2/7 (29%)	disagreement	56/56 (100%)		
inv_vent_pel	categorical	1/7 (14%)	disagreement	55/56 (98%)		
pel_pco2	continuous	3/7 (43%)	disagreement	28/56 (50%)		
pel_pao2	continuous	1/7 (14%)	disagreement	4/56 (7%)		
pel_spo2	continuous	1/7 (14%)	disagreement	54/56 (96%)		
pel_fio2	continuous	4/7 (57%)	disagreement	55/56 (98%)		
map_pel	continuous	3/7 (43%)	disagreement	54/56 (96%)		
lactate_pel	continuous	3/7 (43%)	disagreement	25/56 (45%)		
pel_wbc	continuous	1/7 (14%)	missing	12/56 (21%)		
pel_plat	continuous	1/7 (14%)	missing	12/56 (21%)		
pel_creat	continuous	2/7 (29%)	missing	11/56 (20%)		
pel_gcs	continuous	1/7 (14%)	disagreement	53/56 (95%)		
pel_pupil	categorical	2/7 (29%)	disagreement	49/56 (88%)		
pelod_score	continuous	3/7 (43%)	disagreement	55/56 (98%)		
pel_score_man	continuous	n/a	n/a	n/a		
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	1/6 (17%)	disagreement	29/29 (100%)		
inv_vent_pel	categorical	0/6 (0%)	perfect match	29/29 (100%)		
pel_pco2	continuous	1/6 (17%)	missing	17/29 (59%)		
pel_pao2	continuous	2/6 (33%)	missing	3/29 (10%)		

pel_spo2	continuous	1/6 (17%)	missing	28/29 (97%)		
pel_fio2	continuous	2/6 (33%)	disagreement	29/29 (100%)		
map_pel	continuous	1/6 (17%)	disagreement	29/29 (100%)		
lactate_pel	continuous	2/6 (33%)	disagreement	16/29 (55%)		
pel_wbc	continuous	2/6 (33%)	disagreement	12/29 (41%)		
pel_plat	continuous	2/6 (33%)	disagreement	12/29 (41%)		
pel_creat	continuous	0/6 (0%)	perfect match	4/29 (14%)		
pel_gcs	continuous	1/6 (17%)	missing	28/29 (97%)		
pel_pupil	categorical	1/6 (17%)	disagreement	28/29 (97%)		
pelod_score	continuous	4/6 (67%)	disagreement	29/29 (100%)		
pel_score_man	continuous	n/a	n/a	n/a		
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	1/3 (33%)	disagreement	22/22 (100%)		
inv_vent_pel	categorical	0/3 (0%)	perfect match	22/22 (100%)		
pel_pco2	continuous	0/3 (0%)	perfect match	12/22 (55%)		
pel_pao2	continuous	1/3 (33%)	missing	0/22 (0%)		
pel_spo2	continuous	3/3 (100%)	disagreement	21/22 (95%)		
pel_fio2	continuous	0/3 (0%)	perfect match	22/22 (100%)		
map_pel	continuous	0/3 (0%)	perfect match	22/22 (100%)		
lactate_pel	continuous	1/3 (33%)	disagreement	12/22 (55%)		
pel_wbc	continuous	0/3 (0%)	perfect match	5/22 (23%)		
pel_plat	continuous	0/3 (0%)	perfect match	5/22 (23%)		
pel_creat	continuous	0/3 (0%)	perfect match	1/22 (5%)		
pel_gcs	continuous	0/3 (0%)	perfect match	20/22 (91%)		
pel_pupil	categorical	0/3 (0%)	perfect match	20/22 (91%)		
pelod_score	continuous	0/3 (0%)	perfect match	22/22 (100%)		
pel_score_man	continuous	n/a	n/a	n/a		

day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	2/2 (100%)	disagreement	10/10 (100%)		
inv_vent_pel	categorical	1/2 (50%)	disagreement	10/10 (100%)		
pel_pco2	continuous	#VALUE!	perfect match	4/10 (40%)		
pel_pao2	continuous	1/2 (50%)	missing	0/10 (0%)		
pel_spo2	continuous	0/2 (0%)	perfect match	10/10 (100%)		
pel_fio2	continuous	1/2 (50%)	disagreement	10/10 (100%)		
map_pel	continuous	0/2 (0%)	perfect match	10/10 (100%)		
lactate_pel	continuous	0/2 (0%)	perfect match	4/10 (40%)		
pel_wbc	continuous	0/2 (0%)	perfect match	2/10 (20%)		
pel_plat	continuous	0/2 (0%)	perfect match	2/10 (20%)		
pel_creat	continuous	0/2 (0%)	perfect match	1/10 (10%)		
pel_gcs	continuous	0/2 (0%)	perfect match	9/10 (90%)		
pel_pupil	categorical	0/2 (0%)	perfect match	9/10 (90%)		
pelod_score	continuous	1/2 (50%)	disagreement	10/10 (100%)		
pel_score_man	continuous	n/a	n/a	n/a		
day_of_stay_pel	count	n/a	n/a	n/a		
age_pelod	count	0/1 (0%)	perfect match	5/5 (100%)		
inv_vent_pel	categorical	0/1 (0%)	perfect match	5/5 (100%)		
pel_pco2	continuous	0/1 (0%)	perfect match	2/5 (40%)		
pel_pao2	continuous	0/1 (0%)	perfect match	0/5 (0%)		
pel_spo2	continuous	0/1 (0%)	perfect match	5/5 (100%)		
pel_fio2	continuous	0/1 (0%)	perfect match	5/5 (100%)		
map_pel	continuous	0/1 (0%)	perfect match	5/5 (100%)		
lactate_pel	continuous	0/1 (0%)	perfect match	2/5 (40%)		
pel_wbc	continuous	0/1 (0%)	perfect match	0/5 (0%)		
pel_plat	continuous	0/1 (0%)	perfect match	0/5 (0%)		

pel_creat	continuous	0/1 (0%)	perfect match	0/5 (0%)		
pel_gcs	continuous	0/1 (0%)	perfect match	4/5 (80%)		
pel_pupil	categorical	0/1 (0%)	perfect match	4/5 (80%)		
pelod_score	continuous	0/1 (0%)	perfect match	5/5 (100%)		
pel_score_man	continuous	n/a	n/a	n/a		

Note: The frequencies and percentages presented represent errors in data accuracy and completion in data completeness. The variable name, type of variable, type of errors (data accuracy), measures of central tendency and whether it is clinical plausible is also presented.

* In the complications form, data completeness may be over 100% as these fields are "select all that apply". The numerators are based on how many sub-categories of each complication are selected, while the denominator indicates the frequency of main complications (clinical, equipment failures, vehicle issues, transport team and/or patient safety issues or systems and process errors).

Appendix B: Ethics Approval

Western Research

Date: 22 September 2020

To: Dr. Anna Gunz **Project ID:** 116656

Study Title: Validation of the Canadian Pediatric Transport Network database and the Association between Having a Dedicated Transport Vehicle on Transport Times and Stable Patient Transport.

Application Type: HSREB Initial Application

Review Type: Delegated

Meeting Date / Full Board Reporting Date: 06/Oct/2020

Date Approval Issued: 22/Sep/2020

REB Approval Expiry Date: 22/Sep/2021

Dear Dr. Anna Gunz

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved

Document Name	Document Type	Document Date	Document Version
Data Collection Forms_CPTN	Other Data Collection Instruments	08/Sep/2020	1
Validation of the CPTN_Ethics Proposal_Sept 21 2020_v1	Protocol	21/Sep/2020	1

Documents Acknowledged

Document Name	Document Type	Document Date	Document Version
Ethics Proposal References_Sept 21 2020	References	21/Sep/2020	1

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Patricia Sargeant, Ethics Officer (psargean@uwo.ca) on behalf of Dr. Philip Jones, HSREB Vice-Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix C: Variables used to Assess Data Consistency

Data Consistency		
Variable	Comparator Variables	Comparison Description
Death or Discharge Date/Time from Receiving Area	Hospital Discharge Date	Equal
PCCU Discharge Date	Hospital Discharge Date	Equal
Transport Time Chronology*	Date and Time of Call, Team Dispatched (Decision to Go), Vehicle Called to Depart from Home Base, Vehicle Arrived to Depart from Home Base, Team Departed Home Base, Team Arrived at First Leg Destination, Team Departed on Second Leg of Transport, Team Arrived at Second Leg Destination, Team Departed on Third Leg of Transport, Team Arrived at Third Leg Destination, Arrive at Referral Site (to Patient Bedside), Vehicle Called to Depart from Referral Site, Vehicle Arrived to Depart from Referral Site, Depart Referral Site, Team Arrived at First Leg Destination, Team Departed on Second Leg of Transport, Team Arrived at Second Leg Destination, Team Departed on Third Leg of Transport, Team Arrived at Third Leg Destination, Arrive at Accepting Facility (Patient Admission Time), Vehicle Called to Depart from Accepting Facility, Vehicle Arrived to Depart from Accepting Facility Depart Accepting Facility, Team Arrived at First Leg Destination, Team Departed on Second Leg of Transport, Team Arrived at Second Leg Destination, Team Departed on Third Leg of Transport, Team Arrived at Third Leg Destination	Chronological Sequence

Note. The table presented represent the variables used to assess data consistency, including what variables were used for comparison and how they were assessed. *Vehicle dispatch times for second and third legs were excluded in the chronology as these legs are usually planned ahead of time and would not follow the chronology with other transport time variables.

Appendix D: Types of System and Process Errors in All Transports

Types of System and Process Errors Complications	Frequency n (%)
Total	204
Delay in Dispatch Time	44 (22%)
Delay in Mobilization Time	121 (59%)
Prolonged Stabilization Time	9 (4%)
Prolonged Out-of-Hospital Time	30 (15%)

Note. The frequencies and percentages presented represent the types of in-transit system and process errors in all transports between May 2018 to April 2020. Types of system and process errors are in a "select all that apply" format, and thus are not comparable to the frequencies presented in Table 8. The sample size is 374 patients.

Appendix E: Types of System and Process Errors in the Sample Population

	Type of Systems and Process Errors				
	Delay in Dispatch Time	Delay in Mobilization Time	Prolonged Stabilization Time	Prolonged Out-of-Hospital Time	**Total n**
Before Dedicated Vehicle n (%)	31 (25%)	70 (56%)	8 (6%)	17 (13%)	126
After Dedicated Vehicle n (%)	8 (16%)	32 (64%)	0 (0%)	10 (20%)	50

Note. The frequencies and percentages presented represent the types of in-transit system and process errors in all transports included in objective three. Types of system and process errors are in a "select all that apply" format, and thus are not comparable to the frequencies presented in Table 10. The sample size is 328 patients.

Curriculum Vitae

Name:	Tiffany Liu
Post-secondary Education and Degrees:	University of Waterloo Waterloo, Ontario, Canada 2014-2019 B.Sc. Western University London, Ontario, Canada 2019-2021 M.Sc.
Honours and Awards:	Pediatrics Student Award (Western University) 2020 Trainee Award (Children's Health Research Institute) (Declined) 2020 Western Graduate Research Scholarship 2019 – 2021
Related Work Experience	Graduate Student Assistant Western University 2019 – 2021 Research Assistant London Health Sciences Centre 2020

Publications

Mathews M, Spencer S, Hedden H, Marshall EG, Lukewich J, Buote R, Freeman TR, Gill PS, **Liu T**, Brown JB, McCracken R, McKay M, Meredith L, Ryan D, Ryan B, Schacter G, Sibbald SL, Volpe E, Wickett J, Wong E. Development of a primary care pandemic plan informed by in- depth policy analysis and interviews with family physicians across Canada during COVID-19: a qualitative case study protocol. BMJ Open 2021;11:e048209. doi:10.1136/ bmjopen-2020-048209