

PAIN ASSESSMENT AND MANAGEMENT
IN PEDIATRIC TRAUMA

by

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ABSTRACT

Background/Rationale

Trauma is the leading cause of death in children over one year of age; however, research on pain assessment and management in pediatric trauma patients is scarce.

Objective

The aim was to determine (a) the nature and frequency of pain assessment and management practices and (b) the pain perceptions of children who have undergone a trauma and the health care professionals who provide care to them. Tenets of Critical Realism, the Gate Control Theory of pain, and developmental theory were used to examine the data.

Methods

A two-phased mixed methods study was conducted at a regional pediatric trauma centre. In Phase 1, pain assessment and management practices including time to administration of first analgesia (and the child and situation factors that affect them) were recorded from a retrospective chart review of pediatric trauma patients over a one-year period. Descriptive and multivariable analyses were conducted.

In Phase 2, perceptions of pain management in the Emergency Department from children and health care professionals were examined through interviews. Constant comparative analysis was conducted to develop themes. Findings from Phase 1 and 2 results were triangulated.

Results

In Phase 1, 90/ 104 (86.5%) pediatric trauma patients had a pain assessment recorded; 60 (67%) via narrative notation and 30 (33%) with a validated pain tool. Opioid analgesia, were administered to 76/104 (73%) patients. Median (IQR) time from the traumatic event to administration of the first opioid analgesia was 99 (77-180) minutes.

In Phase 2, nine children revealed their perceptions of the pain and trauma experience. Thirteen health care professionals discussed the priority of pain treatment compared to physiological stability with no standardized approach to pain treatment.

Conclusion

Pain assessment and management for pediatric trauma patient in the Emergency Department is suboptimal. Implications for clinical practice and research targeting interventions to improve the status of pain assessment and management are suggested.

Key words: pediatric trauma, pain, pain assessment, pain management

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LIST OF ABBREVIATIONS

ABCDE	Airway, Breathing, Circulation, Disability, and Exposure
AIS	Abbreviated Injury Scale
ATLS	Advanced Trauma Life Support
CHEOPS	Children's Hospital of Eastern Ontario Pain Scale
CI	confidence interval
DICA	Diagnostic Interview for Children and Adolescents
ED	Emergency Department
EMS	emergency medical services
ENPC	Emergency Nursing Pediatric Course
EPC	electronic patient charts
EPIQ	evidence-based practice for improving quality
FLACC	Face Legs Arms Cry Consolability Scale
GCS	Glasgow Coma Scale
GCT	Gate Control Theory
GRP	gastrin-releasing peptide
HIS	hospital information system
HR	heart rate
IASP	International Association for the Study of Pain
IQR	interquartile range
ISS	Injury Severity Score
KT	knowledge translation
MRN	medical record numbers

MVA	motor vehicle accident
NRS	Numerical Rating Scale
PA	pain assessment
PALS	Pediatric Advanced Life Support
PARiHS	Promoting Action on Research Implementation in Health Services
PAS	parenteral analgesic and sedative
PBCL	Procedure Behaviour Check List
PHIPPA	Personal Health Information Protection Act
PICU	pediatric intensive care units
PTSD	posttraumatic stress disorder
RTS	Revised Trauma Score
SBP	systolic blood pressure
SCIWRA	spinal cord injury without radiologic abnormality
SIRS	systemic inflammatory response syndrome
TID	time in department
TPCC	trauma patient care coordinator
TTL	trauma team leader
US	United States
VAS	Visual Analogue Scale

CHAPTER 1:

INTRODUCTION

Pain in children continues to be underestimated and undertreated, despite many significant theoretical and clinical advances in the assessment and management of pain over the past several decades (Birnie et al., 2014; Groenewald, Rabbitts, Schroeder, & Harrison, 2012). For hospitalized children, the assessment and management of acute pain remains a challenge (Birnie et al., 2014; Groenewald et al., 2012; Stevens et al., 2011); in particular, for moderate to severe acute pain in the pediatric patient with trauma admitted to the emergency department (ED; Ali et al., 2014; Anantha, Stuart, Rajagopalan, Walsh, & Merritt, 2014; Browne, Studnek, et al., 2016; Chafe, Harnum, & Porter, 2016; Drendel, Kelly, & Ali, 2011; Ruest & Anderson, 2016). The precise influence of child and situational factors on this pain is generally unknown. This dissertation will shed light on: pain assessment and management practices in the pediatric population in the ED dealing with acute pain from traumatic injuries; the child and situational factors influencing the pain; and the pain experience from both the child's and health care provider's viewpoints.

Pain Assessment and Management in Children

With Acute Pain From Trauma in the ED

Several researchers have examined the assessment and management of acute pain related to specific traumatic injuries (e.g., fractures, blunt abdominal injuries) in pediatric patients (Chafe et al., 2016; Crandall, Miaskowski, Kools, & Savedra, 2002; Dong, Donaldson, Metzger, & Keenan, 2012; Friedland & Kulick, 1994; Hennes, Kim, & Pirrallo, 2005; Herd, Babl, Gilhotra, Huckson, & PREDICT Group, 2009; Iyer, Schubert, Schoettker, & Reeves, 2011; Johnson, Schultz, & Guyette, 2014; Kraus, Calligaris, Green, & Barbi, 2016; Porter, Chafe,

Newhook, & Murnaghan, 2015; Ruest & Anderson, 2016; Saunders, Adelgais, & Nelson, 2010). These researchers have found several trends in the treatment of pain in children with various single injuries: (a) preschool children receive disproportionately less analgesia for fractures and burns than older children (Dong et al., 2012; Johnson et al., 2014; Porter et al., 2015; Ruest & Anderson, 2016); (b) pain suffered at the scene of an accident, in the ED, and on the hospital unit is, in general, intense and unrelieved (Crandall et al., 2002; Johnson et al., 2014); (c) children with several injuries are less likely to receive analgesia than those with only a single injury (Friedland & Kulick, 1994); (d) pain assessment and intervention occurs more often in adults than in adolescents and children in the pre-hospital setting (Hennes et al., 2005); and (e) children with pain from fractures are researched more often and tend to get opioid analgesia sooner than children with pain from other injuries (Herd et al., 2009; Iyer et al., 2011).

Research has been conducted to examine pain assessment and management in the pre-hospital setting that includes both adult and pediatric patients (Brown, et al., 2014); however, children comprised only a small subset of the study population making it difficult to reach a definitive conclusion. In the research by Brown and colleagues (2014) children comprised only 89/1,336 (6.7%) of the study population. Some research does relate specifically to pain assessment and management for injured children (Browne, Shah, et al., 2016; Browne, Studnek, et al., 2016) but does not define injuries other than to indicate the pain was attributed to injury rather than illness.

Only a few researchers have studied acute pain in children who have sustained several injuries from a major event such as a motor vehicle accident (MVA; Anantha et al., 2014; Devellis, Thomas, Wedel, Stein, & Vinci, 1998; Neighbor, Honner, & Kohn, 2004). Anantha et al. conducted a retrospective chart review of severely injured pediatric and adolescent trauma

patients to evaluate the use of analgesia in the resuscitative phase of trauma. They report that analgesia was given in 64/203 (32%) of cases; patients received analgesia more often if they had been injured in a motor vehicle accident, arrived directly to a trauma centre, and if parents were present. Devellis et al. (1998) evaluated hemodynamic and ventilator compromise in children with multiple injuries who were administered intravenous fentanyl while en route to the ED and found no reported adverse events in spite of reluctance to use opioids en route to the hospital. Neighbor and colleagues (2004) examined the duration from the time of arrival to the ED to first opioid analgesia in both adults and children with injuries from trauma. Children under 10 years of age waited a median time of 162 minutes to receive opioid analgesia, much longer than the median wait time of 77 minutes for adults ($p = .004$; no interquartile range [IQR] reported).

For this research project a pediatric trauma patient was defined as any patient who has received injuries from an untoward event that has had the trauma protocol started in the hospital trauma room. A pediatric trauma patient was defined as a patient who had the trauma protocol initiated at the study hospital. The trauma protocol at the study hospital was triggered if children had injuries that included all penetrating injuries to head, neck and torso; flame burns to head and neck region; two or more proximal bone fractures; obvious pelvic fracture; amputation proximal to elbow and knee; severe maxillofacial injury with airway compromise; two or more system involvement or injuries.

According to the study hospital guidelines, other inclusion criteria considered for triggering the trauma protocol were ejection from an automobile; death at the scene within same passenger compartment; extraction > 20 minutes; roll over; high speed MVC > 70 km/hr; major auto deformity > 50 cm; intrusion into passenger compartment of > 30 cm; auto vs. pedestrian injury > 10 km/hr; pedestrian thrown or run over; cycle crash > 30 km/hr or separation of rider

and bike (cycle = moped, motorcycle, bicycle, ATV); fall > 3 times the victim's height or > 1 to 2 stories; high velocity impact (e.g., skier vs. tree); burns that are massive (> 50% total body surface area), house fire victims, or with multiple injuries (e.g., MVC involving burns) .

Many researchers have examined children with pain from trauma with a single specific type of injury. However, scant research exists on pain assessment and management of children with multiple traumatic injuries. The limited evidence available indicates a prolonged period of time elapses before opioid analgesia is administered to children with trauma. Furthermore, assessment of pain is rarely reported in children with multiple injuries in either the pre-hospital or ED settings. This lack of focused research represents a conspicuous gap in pain investigations in a patient population that may potentially be experiencing severe pain.

Consequences of Unrelieved Pain in Children

There are short- and long-term physiological and psychological consequences of unrelieved acute pain in infants and children. Short-term physiological consequences include (a) a release in stress hormones, resulting in increased metabolic rate, heart rate, and blood pressure (Manworren, Paulos, & Pop, 2004; Playfor et al., 2006); (b) impaired gastrointestinal and pulmonary function causing nausea and dyspnea; (c) immunosuppression (Manworren et al., 2004); and (d) hypercoagulability associated with vaso-occlusive and thromboembolic events (Dunwoody, Krenzischek, Pasero, Rathmell, & Polomano, 2008; Hahnenkamp, Theilmeier, Van Aken, & Hoenemann, 2002). Short-term psychological consequences include anxiety (Mercadante, 2004; Taddio, Soin, Schuh, Koren, & Scolnik, 2005), and agitation or disorganized behaviour (Zink & McCain, 2003). Anxiety from pain can also lead to children's lack of cooperation with hospital procedures (e. g., establishment of an intravenous line), prolonging the procedure and thereby causing additional pain (Taddio et al., 2005).

Long-term physiological consequences of unrelieved pain result in a prolonged stress response and an inability to move about in a normal manner, thus preventing performance of recovery activities (e.g., ambulation or deep breathing and coughing). Consequently, an inability to perform recovery activities may result in hypoxia, hypercapnea, agitation, and combativeness (Manworren et al., 2004). Additionally, persistent alterations in pain sensitivity into the school-aged years (9 to 14 years of age) resulting from repeated neonatal exposure to painful procedures have been demonstrated (Hermann, Hohmeister, Demirakça, Zohsel, & Flor, 2006). Other long-term physiological consequences reported in adults, but that may also pertain to children, include delays in healing (McGuire et al., 2006), loss of appetite (Malick, Jakubowski, Elmquist, Saper, & Burstein, 2001), and potential development of chronic pain (Katz & Seltzer, 2009).

Long-term psychological consequences of unrelieved acute pain in children can lead to chronic pain (Fortier, Chou, Maurer, & Kain, 2011) and posttraumatic stress disorder (PTSD; Marsac, Kassam-Adams, Delahanty, Widaman, & Barakat, 2014). Associations have been made between painful procedures in childhood and blood-injection-injury phobia in up to 10% of adults potentially resulting in avoidance of medical care (Ayala, Meurette, & Ritz, 2009).

Signs of PTSD have been identified after even minor physical trauma (McIntosh & Mata, 2008; Schreier, Ladakakos, Morabito, Chapman, & Knudson, 2005; Zink & McCain, 2003). In adults, short-term psychological consequences of unrelieved pain include fears of progressive pain intensity and anxiety. Long-term psychological consequences in the adult patient include depression and fear about the future (Bär et al., 2005). As with the physiological consequences, short- and long-term psychological consequences documented in adults may also be of concern in children; however, these consequences have not been closely examined in the pediatric ED population.

The consequences of poor pain management for pediatric trauma patients may be of a more acute or exaggerated nature because of the extreme and sudden quality of the event; however, these consequences have yet to be clearly articulated. It is essential to understand and minimize the consequences of acute pain using what we have learned from research.

Factors Influencing Pain Management in Children

Factors directly related to children (e.g., age, sex, type of injury, number of injuries, severity of injuries, mechanism of injury) and the impact these factors have on pain management in pediatric trauma patients have not been thoroughly studied. Several additional situational factors have not been thoroughly examined, including (a) the pre-hospital or ED settings, (b) the in-hospital unit to which children are transferred from the ED, and (c) whether children are transported directly to the hospital from the scene of injury or transferred from another hospital. Child and situational factors may both affect pain assessment and management practices, including how long it takes for the first opioid analgesia to be administered to pediatric trauma patients in the ED after the traumatic event.

Child Factors in Acute Pain Assessment and Management

Age. Age has influenced pain assessment and management in children. Younger children generally receive fewer pain management interventions than adults (Hennes et al., 2005; Izsak et al., 2008). They also receive less analgesia than older children (Stevens et al., 2011). Younger children with a single traumatic injury receive less analgesia than adults in pre-hospital settings (Hennes et al., 2005), and in ED settings (Brown, Klein, Lewis, Johnston, & Cummings, 2003; Probst, Lyons, Leonard, & Esposito, 2005). Generally, younger children receive less analgesia in in-hospital settings (Stevens et al., 2011); however, it has yet to be determined whether these patterns persist in children with multiple injuries in the ED. Anantha et al. (2014) reported no

differences in patterns of analgesia administration related to age in children less than 18 years with severe trauma. Neighbor and colleagues (2004) found that children waited for 162 min to delivery of first opioid analgesia versus adults who waited 77 min ($p = .004$).

Sex and gender. The influence of sex or gender on pain in infants and children is not fully understood. Sex is the biological variable referring to differences defined by sex chromosomes and the presence of anatomical reproductive organs, whereas gender is a cultural construct referring to behaviors thought to be specified by psychosocial expectations based upon assigned sex (Miller et al., 2016).

Sex differences in experimental and clinical pain in adults indicate that females report more severe levels of pain than males and are more affected by chronic painful syndromes such as fibromyalgia, migraines (Melchior, Poisbeau, Gaumond, & Marchand, 2016; Mogil, 2012; Pieretti et al., 2016). Pieretti et al (2016) also report that women show greater response to morphine analgesia and suggest that sex hormones are thought to account for the main differences in pain responses. A study of 2095 Danish girls found that the mean age of menarche, the cornerstone marking puberty for females, was 13.13 years (Lee & Styne, 2013). Since the beginning of puberty is related to a surge in female sex hormones, it can be inferred that puberty is the time that sex differences in pain may begin to appear.

There are several components to the gender construct: gender identity, gender relationships, gender roles, and institutionalized gender. Gender identity is often measured as a dichotomous variable based upon whether an individual identifies with agential (masculine) or communal (feminine) personality traits (Wood & Eagly, 2015). Gender relationships refer to the relationships of men and women in society over time and are exercised through a clear sexual division of labour with women staying at home to care for children while men go outside the

home to work (Alesina, Guiliano, & Nunn, 2013; Bell, Michalec, & Anerson, 2014). Patriarchal models of the medical hierarchy are based on these assumptions about the division of labour and justify nursing's subordination to medicine (Bell, Michalec, & Anerson, 2014). Gender roles are centered on conceptions of femininity and masculinity as dictated by the culture into which one is born and are based upon historical values that persist through generations on what types of behaviours are appropriate or desirable based on sex (Alesina, Guiliano, & Nunn, 2013).

Institutionalized gender refers to the gendered character of institutions such as governments and law societies that require a specific education level, generate more income and where men continue to hold positions of power (Waylen, 2014).

Dimensions of gender begin to emerge as young as two years of age with children choosing specific toys based upon their sex but more commonly occurs at around 11 years of age. However, increasing pubertal development has been consistently associated with increased odds of experiencing pain in girls while increasing age is not always associated with increased probability of experiencing pain conditions (LesResche, Mancl, Drangsholt, Saunders, & Von Korff, 2005).

Characteristics of HCPs (i.e., age, sex, duration of experience, race) affect pain treatment decisions. Females are perceived by physicians as experiencing greater pain intensity (Hadjistavropoulos, McMurtry, & Craig, 1996) and male and female physicians prescribe more analgesia to male and female patients, respectively (Safdar et al., 2009) making provider characteristics an important determinant in pain management decisions. Using virtual human patients to examine the impact of 154 HCPs' characteristics on pain management Bartley et al. (2015) reported that younger practitioners rated females as having greater pain unpleasantness and were more willing to prescribe opioid analgesia to female patients when compared with

middle-aged and older-aged practitioners. Bartley et al. (2015) also reported that female practitioners prescribed more non-opioid analgesia and provided analgesia to people of colour more frequently than older practitioners.

In healthy school-age children, more complaints of pain were documented in girls than in boys from Grades 3 to 9 in research examining the prevalence and co-occurrence of self-rated pain and perceived health (Sundblad, Saartok, & Engström, 2007). Adolescent girl surgical patients, 12 to 18 years old, have reported more postoperative pain than boys (Logan & Rose, 2004).

No significant sex differences in assessment and management of acute pain were detected in a chart audit of pain assessment and management practices in the ED in children with severe injuries (Anantha et al., 2014) or single injuries (Herd et al., 2009). In the adult population, patterns of sex differences have been noted in the treatment of injuries in the pre-hospital setting; females receive significantly less morphine than males (Lord, Cui, & Kelly, 2009; Michael, Sporer, & Youngblood, 2007). These inconclusive findings warrant further examination in children with several injuries attained from trauma.

Type of injury. No researchers have related pain management to type of injury in the pediatric trauma patient; however, the extent of tissue injury is not necessarily directly related to the amount of pain experienced by patients (Arntz & Claassens, 2004). In the pain research on children with a single traumatic injury, children with fractures receive pharmacological pain interventions more readily than other, more subtle, types of injuries such as abdominal injuries (Herd et al., 2009).

Number of injuries. Much of the pain research on children with trauma has been conducted on children with a single traumatic injury (Crandall et al., 2002; Hennes et al., 2005;

Herd et al., 2009; Iyer et al., 2011; Porter et al., 2015). Such children experienced delays in pain management. The constellation of injuries characteristic of the pediatric trauma patient has received only limited attention (Anantha et al., 2014; Izsak et al., 2008; Neighbor et al., 2004). Anantha et al. reported that 64/203 (32%) of severely injured patients received analgesia in the resuscitation phase of trauma; 43/64 (67%) patients were given pain control during the primary survey and 21/64 (33%) during the secondary survey. Izsak et al. found that only 93/696 (13.4%) of children injured in the pre-hospital setting received either pharmacological or physical and psychological pain interventions. Neighbor and colleagues found that children waited longer than adults for first opioid analgesia.

Mechanism of injury. Each trauma patient suffers injuries in a specific way; the mode of injury is referred to as the mechanism of injury. Motor vehicle collisions and falls are among the most common mechanisms of injury reported in the pediatric trauma patient (Anantha et al., 2014; Izsak et al., 2008). Some patterns have been noted between pain and specific mechanisms of injury in children with several injuries (Anantha et al., 2014; Izsak et al., 2008; Neighbor et al., 2004), but clear associations between mechanism of injury and pain assessment and management have not been made. In a retrospective chart review evaluating analgesia pattern in severely injured children, Anantha et al. (2014) reported children who experienced an MVA received analgesia significantly more often, accounting for 37/64 (58%) of the children that received analgesia. Izsak et al. reported that although children with falls accounted for the largest percentage of children transported to hospital, at 198/696 (28.4%), only 29/198 (14.6%) received a pain intervention in the pre-hospital setting. However, of the 47/696 (6.8%) children with burns, 24/47 (51.1%) received a pain intervention (no other statistics were reported). Identification of any association may aid in promotion of improved pain management.

Severity of injury. Research on severity of injury scores focuses primarily on the prediction of mortality rates (Boonthep, Intharachat, & Iemsomboon, 2012). Few researchers have focused on the relationship between severity of injuries and pain management for pediatric trauma patients in the ED. Both Anantha et al. (2014) and Neighbor et al. (2004) used the Injury Severity Score (ISS; Baker, O'Neill, Haddon, & Long, 1974) in their research and reported no significant differences in a patient's likelihood of receiving opioid analgesia based on the ISS. However, connections between the ISS and pain may be valuable in assessment and management of pain in children with several injuries from trauma.

The original development, and validity and reliability of the ISS tool included patients who came from a number of hospitals (see Appendix A). The ISS incorporates the Abbreviated Injury Scale (AIS) since it provides a measure of the severity of each injury. However, the ISS increases the correlation between severity of injury and mortality when compared to the AIS by providing a measure of the severity of all injuries combined, thereby recognizing the contribution to mortality of second and subsequent injuries. The ISS score is based upon the injuries of the patient regardless of setting and represents a "numerical description of the overall severity of injury in persons who have sustained injury to more than one area of the body" and is defined as the sum of the squares of the highest AIS grade in each of the three most severely injured areas (Baker et al., 1974). The ISS was evaluated for concurrent validity in children; the method involved comparison of the pediatric trauma score (PTS) against the ISS (Tepas, Mollit, Talbert, & Bryant, 1987). A linear relationship between PTS and ISS was documented that was statistically significant to $p < .001$.

Situational Factors in Acute Pain Assessment and Management

Pre-hospital or ED setting. Researchers who study acute pain assessment and management in relation to traumatic injuries have focused on either the pre-hospital setting (Browne, Shah, et al., 2016; Hennes et al., 2005; Izsak et al., 2008), or the ED setting (Ali et al., 2014; Brown et al., 2003; Crandall et al., 2002; Herd et al., 2009; Iyer et al., 2011). The pre-hospital setting includes the scene of the incident and transport to the in-hospital setting, whether by ground or air. The ED setting includes the trauma room, a specialized room within the hospital ED where a team of health care providers (HCP) assemble, with advanced life-support equipment to provide emergency care and repeated standardized assessment for patients with multiple injuries from traumatic events (Buduhan & McRitchie, 2000). Differences in these two settings may affect processes implicit in the provision of care. The difference between care provided in the trauma room setting and care provided in the emergency room setting is that, in the trauma room setting, there is an urgent need to assess for the presence of critical injuries and to provide care to maintain hemodynamic stability. The urgency of care provision in the trauma patient may outweigh efficient attention to pain. In the emergency room setting, although many children present with painful clinical conditions, the children are frequently not critically ill and pain interventions can be provided in a timely manner with no concern for hemodynamic stability delaying efficient and timely provision of pain treatment.

Researchers examining the pre-hospital setting have demonstrated minimal assessment and management of pain in pediatric trauma patients; it is less likely to be addressed than pain in adult trauma patients (Hennes et al., 2005; Izsak et al., 2008). Devellis and colleagues (1998) conducted a trial of fentanyl administration for pain management of children with multiple injuries in a pre-hospital setting; no untoward effects were found when analgesia was

administered at 0.33 to 5.0 mcg/kg. Focusing on treatment of children with acute pain from multiple injuries in a pre-hospital setting, Izsak and colleagues found that only 93/696 (13.4%) received either pharmacological, or behavioural, or psychological pain interventions.

Researchers examining treatment of acute pain in children with traumatic injuries within a hospital ED setting highlight marked delays in treatment of pain; however, most have studied only children with a single traumatic injury (Herd et al., 2009; Iyer et al., 2011; Crandall et al., 2002; Brown et al., 2003).

Transfer from another hospital. Each hospital has its own culture where clinical practice is concerned. Differences in pediatric pain management practices and the clinical practice guidelines and policies in situ between hospital EDs have been demonstrated (Anantha et al., 2014; Petrack, Christopher, & Kriwinsky, 1997). Anantha et al. (2014) reported that early analgesic use was significantly increased when a patient arrived directly at a pediatric trauma centre (OR, 2.01, CI, 1.03-3.93, $p = 0.042$). The time when a child has been transferred from another institution has been reported to influence patterns of analgesia in pediatric trauma patients, and warrants further attention. Petrack et al. (1997) examined pain practices for patients with isolated long bone fractures in three different types of EDs finding significant differences between pain management in community hospitals and academic medical centres.

Admission unit. Just as each hospital has its own mode of pain treatment, so does each unit within the larger hospital setting (Lauzon Clabo, 2008; Samuels & Fetzer, 2009; Stevens et al., 2011). Lauzon Clabo examined pain assessment practices in two postoperative units and demonstrated that each unit had their own predominant patterns of pain assessment. Stevens and colleagues examined pain practices for 3,822 children undergoing painful procedures in eight hospitals (including 32 hospital units) across Canada: 1684 (44.1%) in medical units; 1,183

(31.0%) in critical care units; and 955 (25.0%) in surgical units. Medical units reported using more psychological pain interventions on 295/1212 (24.3%) patients; conversely, surgical and critical care units reported using more pharmacological pain interventions on 539/680 (79.3%) and 708/799 (88.6%) patients respectively. Samuels and Fetzner demonstrated that pain practices varied between the individual nurses who provided care. When the care of a child with multiple injuries is transferred from the ED to an in-hospital unit, pain assessment and management practices may be influenced by the patterns of practice for that specific unit.

Time to first opioid analgesia. Neighbor and colleagues (2004) examined ED opioid administration for patients with acute trauma requiring hospitalization. The mean ($\pm SD$) time to first opioid analgesia was 40 (± 41.1) minutes following arrival in the ED. Overall median time to first opioid analgesia after arrival in the ED was 95 minutes (no IQR reported); however, only 10% (55/540) of the sample was children (Neighbor et al., 2004). For the subset of children in this study, the time to first opioid analgesia was 162 minutes (no IQR reported). Adults aged 11 to 64 years comprised 71% (383/540) of the study sample. The median time to first opioid analgesia for adults was 77 minutes (no IQR reported), significantly less than that for children ($p = .004$). One possible reason for such delays may be the widespread use of current trauma algorithms of care, consisting of repeated standardized primary and secondary assessments used for both children and adult trauma patients, which places pain as a lower priority than the identification and treatment of injuries (see Appendix B).

Children's Perceptions of Pain

Qualitative methodologies have been used to explore pain experiences from the perspective of children in various contexts, such as after spinal fusion and/or pectus repair surgery (Noel, Rabbitts, Ghafari, & Polermo, 2015) and pain after tonsillectomy (Idvall, Holm,

& Runeson, 2005); yet little research exists on the pain perceptions of children with multiple injuries in the ED. Crandall et al. (2002) interviewed adolescents who sustained traumatic abdominal injuries. Participants indicated that severe pain prevailed during transport to hospital and throughout the ED stay. Crandall, Kools, Miaskowski, and Savedra (2007) expanded upon interview data reported in 2002 and found that adolescents used active internal control process to manage and endure their pain. Given the scant amount of research in this area, and that the research by Crandall et al. (2002) is dated, further research is warranted to gain fundamental insight into the child's pain experience, the contextual and patient-specific factors that affect the pain, and types of effective interventions for relieving it.

Researchers have determined that discrepancies exist between children's pain and reports of their pain by the HCPs who care for them (Polkki et al., 2010). Frequently, HCPs underestimate the intensity and amount of pain children experience (Maciocia et al., 2003; Marquié et al., 2003). Although researchers hypothesize that clinicians believe that pain assessment is an important first step in the management of pain, they do not document the use of developmentally appropriate pain assessment tools in routine clinical practice (Stevens et al., 2011); thus, pain management remains suboptimal in children (Smyth, Toombes, & Usher, 2011). Additionally, knowledge discrepancies about (a) exaggerated fears of addiction and respiratory depression; (b) misconceptions about pharmacokinetics of common analgesic agents (Al-Shaer, Hill, & Anderson, 2011; Twycross, 2010; Van Hulle Vincent & Gaddy, 2009); and (c) inadequate interpretations of the child's descriptions of pain (Harden, Scott, Backett-Milburn, & Jackson, 2000) have been demonstrated. To my knowledge, no research has been done examining the perceptions of HCPs caring for the pediatric trauma patient in the ED.

Problem Statement

Researchers have yet to adequately address pain assessment and management in the pediatric trauma patient, focusing primarily on children with a single traumatic injury. The constellation of injuries that often defines the trauma patient likely represents a strikingly different pain experience. Additionally, the entire scope of the traumatic event from the child's perspective, including the event itself, pre-hospital and ED settings, has eluded careful study. Rather, the pre-hospital and ED settings have been researched as separate entities. Perceptions of HCPs caring for children with multiple injuries have not yet been probed. The key gaps in the existing research pertain to (a) knowledge of the nature of pain assessment and management practices for pediatric trauma patients from the time of the event in the pre-hospital setting through the stay in the ED, including the child and situational factors that affect them; (b) perceptions of pain from the vantage point of the pediatric trauma patient; and (c) the HCPs' perceptions of the pediatric trauma patient. There are most likely a number of factors contributing to poor pain assessment and management in pediatric trauma. For this research constructs from developmental theory, concepts from theories of pain physiology and several causal mechanisms associated with critical realism may be at play. Within critical realism some of the factors that will be considered relate primarily to a) juvenile ageism that results in power differentials children experience, b) symbolic violence that obscures subtle harm within socially acceptable practices, and c) organizational culture that maintains the status quo in the delivery of care for pediatric trauma patients, even when pain is not included in this delivery.

Purpose

The purpose of this research is to examine the pain experience of pediatric trauma patients from the time of the traumatic event (pre-hospital) and encompassing the ED (hospital)

settings. This research also addresses the lack of knowledge on the nature and frequency of pain assessment and management practices for children with multiple injuries. An examination of the child and situational factors that influence pain practices, especially when the pediatric trauma patient receives the first opioid pain intervention, are determined. The child's perception and HCP's perception of the child's pain experience are explored. Results inform future interventions and raise awareness of the importance of pain in the pediatric trauma patient.

CHAPTER 2:

LITERATURE REVIEW

This chapter describes the literature review and how the results of this review formed the foundation for the present study. A systematic review of the published peer-reviewed scientific literature focused on pain assessment and management in pediatric trauma was undertaken.

Medline, Embase, CINHALL (Cumulative Index to Nursing & Allied Health Literature), and PsycINFO databases were searched from database inception to Jan, 2012. Queries for each database were developed and carried out in consultation with a reference and information services librarian working at a pediatric academic tertiary care center.

The titles and full abstracts of studies identified through the search were eligible for inclusion if they met the following criteria: (a) English language; (b) clinical study of any design; (c) patient population of children and adolescents (0 – 21 years) receiving pain assessment and management for traumatic injuries; and (d) pain examined as a primary or secondary outcome.

All search-identified titles and abstracts were assessed for inclusion. Full-text articles of abstracts that were potentially relevant to this review were obtained, read and assessed. A systematic approach to the data abstraction process was utilized to describe the characteristics of the identified studies in detail. Study data related to patient population, trauma, pain assessment, pain management, pain measure, results and study design were abstracted as appropriate. All abstracted data were categorized using a standardized table. Only primary data sources were included in this review; therefore, systematic reviews and meta-analyses on the topic were not presented. All steps of this review were done by the investigator only.

The search strategy resulted in the identification of 2,676 titles and abstracts for review. Of these, 2,655 were excluded with 186 duplicates and 2,310 that did not meet the inclusion

criteria. The full-text articles for the remaining studies were retrieved and reviewed. A further 159 articles were excluded primarily because the definition of trauma did not align with that of the present study. A total of 21 studies were subjected to data abstraction and included in this review. Weekly alerts generated from the initial literature search produced a further 6 studies for a total number of 27 studies in the review over the period from 2012-2017.

The review is organized with research on (a) incidence and prevalence of trauma in children; (b) acute pain in children in the ED; (c) child factors influencing assessment and management of acute pain; (d) situational factors associated with pain in children with traumatic injuries; and (e) physiological and psychological consequences of unrelieved acute pain. As well, literature related to children's perceptions of acute pain from trauma, and HCPs' perceptions of children's pain from trauma in the pre-hospital and hospital ED settings, is reviewed.

Incidence and Prevalence of Trauma in Children

Trauma is the leading cause of death in children over one year of age in Canada (Lier, Henning, Schroeder, & Stuber, 2008; Mikrogianakis, Valani, & Cheng, 2008; Canadian Institute for Health Information, 2014). From 2009 to 2010, people under the age of 20 years accounted for 15% ($n = 615$) of all trauma cases in Ontario and 11% ($n = 7,035$) of in-hospital days (CIHI; Ontario Trauma Registry, 2011). Motor vehicle accidents accounted for nearly half these cases (292/615, 47.5%) followed by unintentional falls (134/615, 21.8 %). Data from 2010 to 2011 indicated that the mean length of hospital stay for individuals younger than 19 suffering from traumatic injuries ranged from 9.2 to 12.6 days. The most recent statistics available show the overall incidence of trauma to have been 315.2 per 100,000 children in Ontario for 2010 to 2011 (Ontario Trauma Registry, 2012). Approximately 30% to 45% of children with trauma acquired multiple injuries (Alterman, Daley, Kennedy, Raju, & Lee, 2010). Because these injuries were

largely tissue damaging and acquired while the child was still conscious, it can be assumed that these children experienced very intense levels of acute pain.

Acute Pain in Children in the Emergency Department

The ability of children to experience pain has been seriously considered by clinicians and researchers only since the 1980s, when pain research burgeoned (Anand & Hickey, 1987; McGrath & Craig, 1989; Schechter, 1989). In 1988, the first meeting of the Special Interest Group on Pain in Childhood, a group that promotes education and encourages research about children's pain within the International Association for the Study of Pain (IASP), convened in Seattle, U.S.A. These early researchers and clinicians demonstrated that children do feel pain, can express it, and that untreated pain has harmful effects. Despite the growing body of research, recognition of pain in children and its management has remained less than optimal (McGrath et al., 2008; Stevens et al., 2011). A review of acute pain management that examined painful procedures and associated pain interventions in hospitalized children across eight pediatric tertiary care centres in Canada showed that only 844/2987 (28.3%) children received a pain intervention specifically for their painful procedure (Stevens et al., 2011). Reasons for less than optimal pain assessment and management specifically for injuries in children have been attributed to (a) fear of adverse reactions or drug dependency; (b) the belief that children do not experience pain in the same way as adults; and (c) the inability of children, especially very young children, to verbally articulate their experience of pain (Alexander & Manno, 2003). Anantha et al. (2014) cited reasons for withholding analgesia in pediatric trauma patients as reduced exposure to pediatric trauma compared to adult trauma, and apprehension about administering analgesics to children for fear of causing complications, losing the ability to perform adequate neurological assessments, or missing progressing injuries. Alpen and Morse

(2001) cited as additional reasons for withholding analgesia the notions that localized pain assists in diagnosis, and fears among HCPs that analgesia could reduce the level of consciousness and increase the risk of respiratory failure and/or hemodynamic instability in critically injured patients.

Generally, pain in children has been acknowledged as being difficult to assess and, as a result of poor assessment, often is not treated optimally. In an overview of pain evaluation in children, Manworren and Stinson (2016) suggested there are three approaches to measuring pain: (a) self-report (what a child says), (b) behavioural (how a child behaves), and (c) physiological indicators (how a child's body reacts). Inclusion of the three aforementioned fundamental components of evaluation indicate that the most appropriate pain assessment tools for the pediatric trauma patient may be the Procedure Behaviour Check List (PBCL; LeBaron & Zeltzer, 1984), the Procedure Behavioural Rating Scale-Revised (PBRs-R; Katz, Kellerman, & Seigel, 1980), or the COMFORT scale (Ambuel, Hamlett, Marx, & Blumer, 1992). The PBCL and the PBRs-R are appropriate because both scales take into account distress, and fear or anxiety as well as pain intensity; both scales are also frequently used for pain assessment with painful procedures, which the pediatric trauma patient must endure. The COMFORT scale is most often used in critical care settings where children may experience constraints on behavioural expressions of pain, as when they are on ventilation support. Inclusion of a self-report assessment tool would also be necessary, and the Numerical Rating Scale (NRS) has been shown to be a valid measure of pain intensity in children aged 7 and older in postoperative settings (Voepel-Lewis, Burke, Jeffreys, Malviya, & Tait, 2011).

A review of self-reported pain intensity measurement in children and adolescents by Huguet, Stinson, and McGrath (2010) provides recommendations for validated self-report pain

intensity scales for children of various age groups. From this review, it may be inferred that an appropriate pain tool would be the Visual Analogue Scale (VAS) since it covers a wider range of ages (3 years and up) as compared to the other self-report pain scales reviewed.

The Registered Nurses' Association of Ontario's (RNAO; 2013) *Assessment and Management of Pain* states that pain should be assessed upon (a) admission to hospital or initial contact with a HCP; (b) after a change in medical status; and (c) before, during, or after a procedure. Additionally, a validated pain tool should be used for pain report and a comprehensive description of the patient's pain characteristics need to be documented. A multimodal pain management approach is recommended, including pharmacological, physical, and psychological interventions that maximize efficacy and minimize any adverse effects of the pharmacological interventions. Frequency of pain reassessment is based upon presence of pain, pain intensity, stability of the patient's medical condition, whether the pain is acute or persistent, and the practice setting. These basic guidelines can be used as a backdrop against which to gauge pain practices within the context of the pediatric trauma patient.

Chafe et al. (2016) measured the long-term effects of a pain management intervention protocol that had previously been implemented, in a pediatric ED in Newfoundland. In earlier research at the same hospital, reported by Porter et al. (2015), patients provided with analgesia within 60 minutes of being triaged with acute supracondylar fracture increased from 24/160 (15%) to 13/24 (54%; $p < .001$; no statistics reported) after targeted efforts were made to educate nurses, residents, and physicians, and medical directives were implemented allowing nurses to administer nonopioid analgesia without first being seen by a physician. Three years after this directive was implemented, the effects of the program were evaluated to see if the improvements initially reported were still in effect. Although initial improvements in timely pain management

were discovered, discrepancies were found several years later between adherence to the policy and the perceptions of caregivers.

Busyness of the ED (that prevents optimal care) was cited by ED nurses as a barrier to providing timely pain assessment and treatment. It was noted, particularly by nurses, that when a large number of patients presented to the ED simultaneously, there was a negative impact on the flow of patients and the ability to provide pain care in a timely manner. Underuse of nonpharmacological pain interventions that could offer pain relief, such as ice or an arm sling, was noted by ED physicians. The physicians felt that splinting or the application of a back slab to reduce pain were underutilized and suggested that training initiatives include instruction on appropriate nonpharmacological pain interventions.

The accuracy of self-reported pain assessment was questioned by ED staff, who felt that it did not reflect pediatric patients' pain state; children in Chafe et al.'s (2016) study were defined as those younger than 12 years. Conversely, parents in this research were certain that their children's self-reports of pain were accurate. Combining the self-report pain intensity score (identified either by mild/moderate/severe or on a scale of 1 to 10) with clinical judgement was suggested as a means of offsetting staff uncertainty about self-reported pain alone.

Some injuries or conditions were thought to be associated with a certain level of pain and ED nursing staff were found to apply this assumed understanding to their observations of the patient's behaviour, thereby affecting the pain intensity score they documented. They adjusted their assessment of pain intensity depending on (a) the condition of the child when they presented to the ED; (b) the self-reported pain intensity score provided by the child; and (c) the child's pain behaviours.

While Chafe et al. (2016) noted positive changes following implementation of the pain improvement protocols, almost half the children remained without analgesia and documentation of pain intensity scores remained rare. Barriers to improvement were identified as (a) being unaware of the extent to which poor pain management was a problem; (b) busyness of the department at times; (c) too great a focus on pharmacological rather than physical or psychological interventions; (d) reluctance to give pain medication to patients with head injuries or developmental delays; (e) assumed inaccuracy of pain assessment scores; and (f) proscription against administering opioids built into medical directives. Several opportunities to improve for ongoing efforts to advance pain management were identified.

Ali et al. (2014) conducted a survey of 72 EDs in Alberta (of which two were pediatric and 70 treated both adults and children), querying the existence of policies and procedures for pediatric pain assessment, documentation, and management. Ali and colleagues found that 42/59 of respondents (71.2%) reported using a pain measurement tool in the ED. Pain was documented more than half the time in 22/44 institutions (54%).

Anantha et al. (2014) conducted a retrospective audit evaluating use of analgesia in the resuscitative phase in severely injured (ISS > 12) children less than 18 years of age. Patients were identified from the London Health Sciences Centre's trauma registry from 2007 to 2010. Of the 203 patients included in the study sample, 64 (32%) received analgesia and 139 (68%) did not receive analgesia. Among the 64 patients who received analgesia, 43/64 (67%) patients received pain control during the primary survey and 21 (33%) patients received analgesia during the secondary survey. Univariate analysis did not reveal any significant differences in analgesia administration between the analgesia and non-analgesia groups for age, gender, injury type, injury profile or arrival patterns.

Analgesia was used significantly more frequently in children who experienced an MVA versus children who experienced a fall, intentional injury or other injuries. Children who experienced an MVA received analgesia more often, accounting for 37/64 (58%) children that received analgesia but only 58/139 (42%) children that did not receive analgesia ($p = 0.026$, $\chi^2 = 9.29$). There were significant differences in analgesia administration if a trauma team activation was initiated upon the child's arrival to hospital. Trauma team activation occurred in 39% of the analgesia group but in only 17% of the non-analgesia group ($p = 0.001$, $\chi^2 = 14.9$). Parents were present in 17% of the resuscitations in the analgesic group compared to being present in only 6% of the non-analgesic group ($p = 0.010$). The analgesic group had a higher median ISS (IQR) of 22 (16-29) which was significantly more than the non-analgesic group ISS (IQR) of 17 (16-25) ($p = 0.027$).

Pain assessment data were not reported by Anantha et al. (2014); however, investigators cited pain as one of the most common symptoms in trauma. Although analgesia usage was reported as occurring during very early stages of the traumatic event during the primary and secondary survey, there were no times measured in minutes from time of the traumatic event to administration of first opioid analgesia.

Ali et al. (2014) described pediatric pain management procedures, policies, practices, and perceived barriers to and facilitators of optimal pediatric pain management in 72 EDs in Alberta. They reported suboptimal use of pain management protocols with only one-quarter of institutions having a policy for pain management for IV insertion. Given current evidence for efficacy and shortened time to onset, topical anaesthetic creams should be a first-line option for pediatric line insertions. They also noted that oral sucrose was used in less than 5% of the EDs despite evidence of its safe and effective use for procedural pain (Harrison et al., 2017). There was also a

lack of policies related to pain management; only one-third of EDs had a policy for mandatory pain documentation. Ali et al. (2014) and Chafe et al. (2016) demonstrated that improvements in pain assessment and management are challenging and complex in the busy environment of the ED.

Stang, Hartling, Fera, Johnson, and Ali (2014) conducted a systematic review to identify quality indicators specific to assessment and management of pain in the ED. Twenty-three articles were reviewed, three of which included children in their research. Quality indicators such as pain assessment (e.g., documented pain assessment with a validated tool, pain assessments before and after pain relief treatment) and management processes (e.g., offering analgesia at triage, timely access to opioid analgesia) were identified in the review but none of the indicators had been developed specifically for pediatric patients.

Data from these research studies refer to the broad pediatric pre-hospital and/or ED patient population and do not specifically measure pain practices for pediatric trauma patients as defined for the current research project; however, the research included here indicates that patterns of suboptimal pediatric pain assessment and management practices persist.

Friedland and Kulick (1994) examined the pain management of pediatric patients with painful fractures, possibly with multiple injuries, in the pre-hospital and hospital ED settings in a regional pediatric ED and trauma centre in the United States. Using a descriptive, retrospective review of its trauma registry, the researchers examined the charts of 99 children to obtain information about analgesia administered. Of these, 52 (53%) received opioids while in the ED, including eight of the 11 (72%) children with multiple fractures (OR, 0.6; 95% CI, 0.1, 2.8, $p = 0.5$). No clinical or statistical differences were reported between the children who received analgesia and those who did not when comparing by age. While this research is dated, its specific

examination of children in an ED with several injuries from a traumatic event is the focus of the present research project, and the lack of more recent studies on the topic points to the pressing need for more research on pain for pediatric trauma patients.

Child Factors Influencing Assessment and Management of Acute Pain

Several child factors (i.e., age, sex, number of injuries, types of injuries, mechanism of injury, and severity of injuries) can affect pain assessment and management of children with multiple injuries in the ED.

Age. Hostetler, Auinger, and Szilagyi (2002) described parenteral analgesic and sedative (PAS) use in EDs throughout the United States. A total of 43,725 pediatric encounters for patients with an orthopaedic or wound injury were analyzed in this secondary database analytical research. A very low rate of pain management PAS interventions for orthopaedic injuries in both the adult and pediatric age groups was found which suggested that, although the difference was statistically significant, clinical significance was not evident with low rates of pain management for both children (1.3%, OR 0.3, CI 0.2 – 0.3 and adults (5.0%, OR 1.0, CI 1.0; $p < .001$). Combined interactions of age, race, and Medicaid insurance coverage indicated that African-American children covered by Medicaid insurance were at risk for less PAS for both wound and orthopaedic injuries (OR 0.1, 95% CI 0.1–0.2, $p < .001$).

The results from Hostetler and colleagues' (2002) study would have been more meaningful if they had engaged in more distinct stratification according to age, by aligning age groups with developmental stages. Study subjects were recruited from a large database; while accessing data from a large database provides access to a large sample size, examination of variations in analgesia and sedation was not the initial intent for gathering the data. However,

analysis was stratified by diagnoses and did provide detailed patterns of analgesia use with specific diagnoses common to the ED.

Brown et al. (2003) analyzed 2,828 ED records from 1997 to 2000 of patients; both adults and children with closed extremity or clavicle fractures. The records included analgesic use, making it possible to compare their use in the two age groups and in pediatric and non-pediatric facilities. Both adults and children, even when pain was documented as moderate to severe, frequently were not given analgesia: 64% received analgesics; of this group, 42% received opioids. The 102 children younger than 4 were less likely to receive analgesia than the adults: 54% (CI 0.41–0.67) were given analgesia of any type, while only 21% (CI 0.11–0.31) received opioids (no other statistics were reported). When Brown et al. (2003) compared children treated in pediatric and non-pediatric EDs, they found little difference between the two types of facilities: adjusted relative risk [RR] 1.1; CI 0.9 to 1.3 in the former versus RR 0.9; CI 0.6 to 1.2 in the latter. The study did not include pre-hospital reports; therefore, whether some patients received analgesia prior to arrival to the ED cannot be determined. In addition, it is not possible to determine whether patients were coming in for follow-up appointments, which may bias results presented as being indicative of treatment for recent fractures.

Murphy et al. (2016) examined the charts of 2,635 children younger than 16 years with pain as a documented symptom who attended four EDs in Ireland to describe pain management practices. Of the children's charts examined trauma was the cause of pain in 2,071/2,365 children (78%). Injuries reported were 1,041/2,365 (40%) due to falls, 346/2,365 (13%) due to MVAs, 325 (12%) due to sporting injuries, 217 (8%) to Other (e.g., finger caught in door frame, object falling on child), 82 (3%) due to burns, 60 (2%) due to assault, and 45 (2%) charts had data missing. Of the 2,635 children 856 (32%) had a formal pain assessment during transport to

the nearest hospital. Upon arrival in the ED 1,422 of these children (54%) had a documented pain assessment and 1,234 (46.8%) received analgesia. These data indicate poor pain management in the pre-hospital setting for children with documented pain as a symptom. Children were stratified according to the following age groups: infant (< 1 year), toddler (1 to 3 years), preschooler (4 to 5 years), school-age child (6 to 12 years), and adolescent (12 to 15 years). Of the total sample of charts examined, there were 941 school-age children (36% of the total). For the sample of school-age children, pain assessments were reported in 387/941 children (41%; OR 1.440, CI 1.235-1.679). Children in the infant, toddler, and preschool age groups had fewer pain assessments recorded. Infants had 8/112 recorded pain assessments (8%; OR 0.159, CI 0.077-0.327), toddlers had 81/602 pain assessments recorded (16%; OR 0.320, CI 0.250–0.411), and preschoolers had 78/310 pain assessments recorded (34 %; OR 0.693, CI 0.529–0.907).

Rahman et al. (2015) surveyed 191 primary care paramedics and advanced care paramedics in Edmonton, Alberta and reported that, although pain scales and clinical judgement were used for 162 of the adults (85%) and 165 of the adolescents (86%), children were six times more likely than adults to be assessed by clinical judgement alone; pain scales were utilized for only ten children (5%), while clinical judgement alone was used for 59 (31%). Rahman et al. (2015) defined children as being younger than 7 years, and adolescents as between 7 and 17 years, which differs from the stratification used in research by Murphy et al. (2016) indicating the need for a more consistent approach that aligns with developmental theory.

Sex and gender. Herd et al. (2009) reported that no significant differences between gender in the delivery of analgesia were observed in children visiting the ED with femur fractures, migraine headaches, or abdominal pain. Friedland and Kulick (1994), also reported no

clinical or statistical differences in gender between children with painful fractures and at risk for multiple injuries in the pre-hospital and hospital EDs who received analgesia and those who did not. No other researcher has reported on sex or gender differences in pain assessment and management for children with traumatic injuries although in the general pediatric literature, there is some indication that such differences do exist (Logan & Rose, 2004; Sundblad et al., 2007; Zubieta et al., 2002). Logan and Rose (2004) examined the influence of gender on acute postoperative pain and patient-controlled analgesia in adolescents, and found that girls reported higher daily pain ratings, with a mean (*SD*) of 4.5(1.7), than boys 3.7(1.8) ($p = 0.05$). Sundblad et al. (2007) assessed the prevalence of self-reported pain and perceived health problems in children of 9, 12, and 15 years of age, and reported that twice as many girls (159/931; 17%) than boys (80/977, 8%) reported experiencing pain from headaches once a week or more often ($p < 0.001$; no other statistics reported). Zubieta et al. (2002) examined the differences in μ -opioid receptor-mediated antinociceptive responses in adults and reported that men demonstrated larger magnitudes of μ -opioid system activation than women in the anterior thalamus, ventral basal ganglia, and amygdala.

Type of injury. Herd et al. (2009) conducted a chart audit of analgesia practices in 10 pediatric EDs in Australia and New Zealand. This retrospective audit focused on patients with migraine, abdominal pain, and/ or femoral shaft fracture. While in the ED, there were marked delays in administering analgesia for all three conditions. Although all the patients were discharged from the ED with a pain-related diagnosis, fewer than half had pain scores documented at any time. The absence of pain score documentation was reported in this research even though pain measurement is thought to be an essential component of pain-reducing interventions in both adult and pediatric EDs (Fink, 2000). Herd and colleagues (2009) reported

that the percentages of analgesia administration were quite high: 121/196 (62%) for patients with migraine; 122/197 (62%) for patients with abdominal pain; and 138/177 (78%) for patients with a fractured femur. However, rates for receiving opioid analgesia were reported to be much lower at 11%, 14%, and 49% respectively for migraine, abdominal pain, and fractured femur. Children were subject to long waits for opioid analgesia: a median (IQR) time of 103 (85–229) minutes for those with migraine; 137 (88–197) minutes for those with abdominal pain; and 26 (13–72) minutes those with a fractured femur. Pediatric patients with migraine are not commonly given opioids as first-line agents of treatment in the ED (Hurtado, Vinson, & Vandenberg, 2007). This practice may account for the low frequency of opioid administration noted for this patient population. Patients with abdominal pain also may receive less opioid analgesia due to the fear of masking a surgical diagnosis.

Izsak et al. (2008) evaluated the frequency of pre-hospital pain assessment and pain interventions for 696 emergency medical services (EMS) trauma charts. Pain was most frequently documented in bicycle-related (40/47, 85.1%) and sports-related injuries (63/78, 80.8%), and other vehicle crashes (8/10, 80%). All pain interventions were given more frequently to children with burns (24/47, 51.1%), stabbings (2/8, 25%), and assault (4/9, 21.1%) (no statistics or p values were reported).

Hostetler et al. (2002) compared pain treatment associated with orthopaedic and wound injuries. Patients received very poor pain management although children with orthopaedic injuries received marginally more analgesia than those with wound injuries: 5.6% (OR 0.8, CI 0.6-1.4, $p = .05$) received PAS for orthopaedic injuries, and 2.3% (OR 0.8, CI 0.6-1.0, $p = 0.05$) of those with wound injuries.

Overall, pain treatment for orthopaedic injuries has been studied more than other injuries (Brown et al., 2003; Herd et al., 2009; Hostetler et al., 2002; Iyer et al., 2011) and although orthopedic injuries are an aspect of pediatric trauma, they are often only one of several injuries demanding care among pediatric patients.

Number of injuries. Most researchers examine pain associated with single traumatic injuries such as orthopaedic injuries (Alexander & Manno, 2003; Brent et al., 2009; Brown et al., 2003; Herd et al., 2009; Hostetler et al., 2002), migraine headache (Herd et al., 2009), abdominal injuries (Herd et al., 2009), burns (Hennes et al., 2005), and wound injuries (Hostetler et al., 2002). Only a few researchers have examined pain in children in the ED who present with multiple injuries (Devellis et al., 1998; Izsak et al., 2008; Neighbor et al., 2004).

Devellis and colleagues (1998) conducted a retrospective review of one urban program's trauma scene responses comparing vital signs of pediatric trauma patients, pre- and post-fentanyl administration, while en route to hospital via aero medical transport. Observations were collected from inpatients' flight records narrative and medication sections including postflight observations; in a 5.5-year period from October 1991 to March 1997. Fentanyl was administered 211 times to 131 patients with a mean age of 6.2 years (0.1–14 years). Seventy-nine of the 131 patients were intubated and received 139 of the 211 total fentanyl doses (65.9%). Vital sign assessment was done 1 to 35 minutes after fentanyl administration with the mean interval being 9.5 minutes. Hemodynamic and ventilator compromise were evaluated and no untoward events were reported. No accounts of naloxone administration were recorded en route or within two hours of arrival at a hospital. Fentanyl was cited as a potent pain reliever, easy to titrate, maintaining a favourable hemodynamic profile, and efficacious; all of which make fentanyl a suitable pre-hospital and hospital ED analgesic agent. Devellis and colleagues (1998) surmised

that along with comfort, attaining pain relief enhanced the ability to assess the injured pediatric patient. Histamine-mediated hypotension associated with morphine is not seen with administration of fentanyl and its shorter acting effects, were cited as an advantage. Fentanyl administration in the pre-hospital setting for children with chest pain, fractures, or burns did not have any deleterious side effects.

One limitation of the research by Devellis et al. (1998) is that it focused on safety and signs of untoward effects resulting from pre-hospital opioid administration and did not examine pain intensity. Although the differences in systolic blood pressure (SBP) and heart rate (HR) were statistically significant, the clinical significance was small. Thus, more research is required to make a definitive judgement on the safety of fentanyl use for multiply injured children in a pre-hospital setting. Few details on statistical approaches were provided in the account of SBP, HR, and oxygen saturation values. This research was limited to pediatric patients with very specific injuries and so these findings cannot be generalized to other populations.

Izsak and colleagues (2008) evaluated pre-hospital pain assessment and pain interventions over a three-year period for children with trauma aged 16 years or younger. A total of 696 EMS trauma charts in Toledo, Ohio were reviewed and the frequency of pain assessment and interventions determined. There was only one chart that reported using a validated pain assessment tool, the Verbal Rating Scale (VRS; Chesney & Shelton, 1976). Of all subjects, 93/696 (13.4%) received pain interventions. No pain interventions were given to 379/446 (85%) of children with documented pain. Pharmacological interventions were used in 15/696 (2.2%) of patients and physical (i.e., splinting) and behavioural (i.e., distraction) interventions were used in 86/696 (12.4%) of patients. The researchers carefully stratified the injuries and pain interventions, which helps in identifying the types of patients most often given analgesia and the

pain interventions used. Morphine was given to 10/696 (1.4%) children. The most frequently used nonpharmacological interventions were splinting and traction, which were applied to 36/696 (5.2%) children. Saline flush and dressings were applied to 12/696 (1.7%) children. There is no evidence to support that a saline flush with dressing is a pain intervention.

Neighbor et al. (2004) conducted a retrospective cohort study of trauma team activation patients requiring hospitalization during a one-year period in 1999. A total of 540 charts were reviewed. The main outcome measure was ED opioid administration. A total of 258 (47.8%, CI 0.43–0.52; *p* value not reported) patients received intravenous opioids within three hours of ED arrival with the median time to receiving of first opioid dose 95 minutes (no range was reported). Five patients received opioid analgesia in the pre-hospital setting. Among those who received opioids, the mean ($\pm SD$) time to opioid administration was 40.1 (± 41.1) minutes. Multiple logistic regression analysis indicated that patients who were 10 years of age or younger, 65 years of age or older, intubated, and with a lower Revised Trauma Score (RTS; Champion et al., 1990) indicated that more severe injuries were predictive of failing to receive opioid analgesia.

The chart review by Neighbor et al. (2004) examining ED opioid administration to severely injured patients did not stratify types of injuries by age. Stratification of injuries by age would have provided more clarity as to the nature of pain treatment with diverse types of injuries. Also, of the total number of patient charts examined ($n = 540$), only 55 (10.2%) belonged to children.

Mechanism of injury. Anantha et al. (2014) conducted a retrospective chart audit of 203 severely injured children and reported that analgesia was used significantly more frequently in children who experienced an MVA versus children who experienced a fall, intentional injury, or

other injuries. Children who experienced an MVA received analgesia more often accounting for 37/64 (58%) children that received analgesia.

Neighbor et al. (2004) conducted a retrospective cohort study of 540 trauma team activation patients for the 1999 calendar year examining the mechanism of injury in relation to pain treatment and found that patients with burns or those who had been in a motorcycle crash were more likely to receive analgesia.

Izsak et al. (2008) also reported on mechanism of injury stating the presence of pain was documented proportionately more in children who had experienced (a) a bicycle crash, 40/47 (85.1%); (b) sports-related injuries, 63/88 (80.8%); or (c) a vehicle crash other than a motor vehicle, 8/10 (80.0%). Pain interventions were given proportionately more often to children who suffered (a) burns, 24/47 (51.1%); (b) stabbings, 2/8 (25%); and (c) vehicle crashes other than a motor vehicle, 2/10 (20%). The mechanisms of injury most often associated with reports of pain documentation and pain interventions are in contrast to mechanisms of injury most often presented. The most frequently reported mechanisms of injury were (a) falls, 198/696 (28.4%); (b) pedestrian versus vehicle, 126/696 (18.1%); and (c) motor vehicle crash, 107/696 (15.4%).

Mechanism of injury may make a contribution to understanding children's pain experience. This hypothesis is worth exploring to gain more precise data about pain in children with multiple injuries. We do know that the most common mechanisms of injury for children are MVAs and falls (Ontario Trauma Registry, 2011). In the adult population, the mechanism of injury is more often examined in relation to very specific injuries obtained from trauma. For example, whiplash is a common traumatic injury that is precisely examined in terms of how the injury occurred and how to treat it effectively. Insight into how an injury occurs leads to targeted

treatment and adds weight to gaining more knowledge of mechanisms of injury for children with multiple injuries.

Severity of injuries. There has been scant research using the ISS (Baker et al., 1974) in relation to pain in children with trauma (Anantha et al, 2014; Neighbor et al, 2004). While there has been research in the trauma population on the development and validity of severity of injury scores in both adult (Haider et al., 2011) and pediatric (Eichelberger, Mangubat, Sacco, Bowman, & Lowenstein, 1988) trauma populations, correlations between severity scores and pain have received little attention. Anantha et al. (2014) reported that children with a higher median ISS score received significantly more analgesia than children with a lower median ISS score (22 versus 17, respectively). Neighbor and colleagues (2004) reported there were no significant differences in a patient's likelihood of receiving opioid analgesia based on the ISS. Details on research relating to child factors in acute pain are summarized in Appendix C.

Situational Factors in Assessment and Management of Acute Pain

Three situational factors thought to influence pain assessment and management in multiply injured children include: (a) the pre-hospital and hospital ED settings; (b) whether the child was transferred from another institution; and (c) the unit the child is transferred/admitted to from the ED. These three factors can also influence the length of time from the traumatic event to delivery of first opioid analgesia.

Pre-hospital and ED settings. Friedland and Kulick (1994) examined the pain management of pediatric patients with painful fractures and at risk for multiple injuries in the pre-hospital and hospital ED phases of care in a regional pediatric ED and trauma centre in the United States using a descriptive review of its trauma registry. The charts of 99 children were

reviewed; 52/99 (53%) received opioids while in the ED. The study sample included 17 children with multisystem injuries.

There were no clinical or statistical differences between children who received analgesia and those that did not. The factors considered were age, sex, race, mechanism of injury, vehicle speed, height of fall, time elapsed from injury until arrival in the ED, transport method, pre-hospital analgesic use, mortality, ISS, and initial ED vital signs, Glasgow Coma Scale (GCS) (Teasdale & Jennet, 1974), Trauma Score (Champion, Sacco, et al., 1981), and Pediatric Trauma Score (Tepas, Mollitt, Talbert, & Bryant, 1987). No analgesia was administered in the pre-hospital setting.

Friedland and Kulick (1994) examined pain management in pediatric patients with painful fractures in both the pre-hospital and ED settings. This study is limited by the small sample size in subgroups, making it impossible to detect differences in analgesic use. In addition, the research is over two decades old and may not reflect pain assessment and management practices in use today. Even though the research is outdated, it is discussed here because the study sample included children who were at risk for multiple injuries, the focus of the present research, and there are few studies pertaining to pediatric trauma patients.

Hennes et al. (2005) examined the knowledge of 202 emergency medical technicians-paramedics (EMT-Ps) and the medical records of patients ($n = 5,383$) with chest pain, extremity injuries, or burns in the pre-hospital setting. The study sample comprised young children aged 0 to 7 years ($n = 96$), older children aged 7 to 17 years ($n = 188$), and adults ($n = 5,099$). The pain assessment tool used for all age groups was reportedly a nonspecified Verbal Pain Scale (0–10) even though this type of scale is not valid for very young children. Pain scores were documented for 4% of pediatric patients compared to 67% of adults ($\Delta = 63\%$, CI 60, 65). Fewer

interventions were given to children than adults. Morphine was given to the older children with extremity fractures, 7/173 (4%) (95% CI 2, 8), and with burns, 1/3 (33%) (95% CI 1, 90). None of the 12 older children (95% CI 0, 26) who complained of chest pain received morphine. Regardless of injury, none of the younger children who had chest pain ($n = 3$), extremity fracture ($n = 85$), or burns ($n = 8$), received morphine. Adults with extremity fracture received analgesia 4.3 times more often than children and adolescents and 1.5 times more often for burns. Statistical significance was not reported. Emergency medical technicians-paramedics identified an inability to assess pain in younger and older children as a major barrier to delivering analgesia to these age groups. Other barriers included lack of (a) medical oversight; (b) protocols; and (c) education of EMS providers. An additional reason for withholding analgesia in the pre-hospital setting has been identified as the preconceived notion that analgesic administration has potentially deleterious physiological consequences (Silka, Roth, & Geiderman, 2002).

Transfer from another hospital. Anantha et al. (2014) evaluated analgesia use in 203 charts of children and adolescents with severe injuries, and reported significant correlations between analgesia use and direct arrival at a pediatric trauma centre (OR, 2.01, CI, 1.03-3.93, $p = 0.042$). Direct arrival at the pediatric trauma centre was associated with significantly higher analgesia use compared to patients who initially presented to a peripheral hospital.

Petrack et al. (1997) examined pain practices for patients with isolated long bone fractures in three different types of EDs. Significant differences between pain management existed between the community hospital and the academic medical centre. Pediatric patients received significantly less analgesia than adults at the combined (pediatric 23/40, 58% versus adult 35/40, 88%, $p < .003$) and community (pediatric 15/40, 38% versus adult 26/40, 65%, $p < .02$) ED settings, but not at the separate adult and pediatric centre (pediatric 26/40, 65% versus

adult 27/40, 68%). There was no research found on pain practices for children in a community hospital transferred to a tertiary trauma unit.

Admission unit. Variations in type of analgesia prescribed and administered have been demonstrated between units within the same pediatric hospital (Jacob & Puntillo, 2000; Stevens et al., 2011). Jacob and Puntillo (2000) examined the prescription and administration of analgesia in eight different specialty units within one pediatric hospital and determined that patients received morphine, meperidine, and acetaminophen with codeine administered most often. Morphine was used more often in neonatal intensive care units (NICUs; 86.4%); surgical units (78%); pediatric intensive care units (PICUs) and medical intensive care units (MICU; 70%); postanaesthesia care (PACU; 63%); haematology and oncology units (56.5%); and less often in the burn/rehabilitation unit (46%); ED (38.4%); and medical respiratory (33.3%) units. In addition, mean doses of morphine prescribed were below the recommended dosages of morphine varying from 6% below in the ED to 77% below in PACU. Recommended doses were not specified by Jacob and Puntillo (2000); however, the investigators did state they used dosage guidelines from the American Pharmaceutical Association. The recommended dose of morphine for acute pain in children over 6 months and less than 50 kg is 0.2 to 0.5 mg/kg/dose (Krauss, Calligaris, Green, & Barbi, 2016).

Stevens et al. (2011) also found differences between types of units in an analysis of painful procedures and pain interventions recorded within a 24 hour period in 32 inpatient units in eight pediatric hospitals across Canada. Of the three types of units examined, PICUs reported the highest proportion of painful procedures with a median 10.0 per day (IQR 4.0-17.0, mean 11.5, SD 8.7) compared to medical units with a median 2.0 per day (IQR 1.0-4.0, mean 3.4, SD 3.3) or surgical units with a median 2.0 per day (IQR 2.0, mean 1.0-4.0, SD 2.8) ($p < 0.001$ for

differences across unit types). Surgical units and PICUs reported using more pharmacological interventions for pain compared to medical units; PICUs reported that 708/799 patients (88.6%, CI 85.5-91.8) received any pharmacological intervention; surgical units reported 539/680 patients (79.3%, CI 72.7-85.9) received any pharmacological intervention; and medical units reported 600/1,212 patients (49.5%, CI 41.4-57.7) ($p < 0.001$ for differences across unit types). Conversely, medical units reported using more psychological interventions with 295/1,212 patients (24.3%, CI 8.0-40.7) receiving any psychological interventions than PICUs that reported 150/799 patients (18.8%, CI 5.1-32.4) ($p = 0.19$) receiving any psychological interventions. Results from these researchers highlight how pain practices differ between units with diverse specialties. Details on research relating to the situational factors in acute pain are summarized in Appendix D.

Time from Traumatic Event to First Opioid Analgesia

Neighbor et al. (2004) conducted a retrospective cohort chart study of trauma team activation patients for details on opioid administration. A total of 258 patients received intravenous opioids within three hours of ED arrival with the median time to receiving of first opioid dose 95 minutes (range was not reported). Five patients received opioid analgesia in the pre-hospital setting. Among those who received opioids, the mean ($\pm SD$) time to opioid administration was 40.1 (± 41.1) minutes. Children, defined as being younger than 10 years, constituted only a minor subset of the study sample (55/540, 10%). For this subset, the median time from arrival in the ED to delivery of first opioid analgesia was 162 minutes (range was not reported).

Brent et al. (2009) developed and evaluated an intervention in a pediatric ED to reduce the time to initial administration of pain medications for extremity fractures from one hour to 30

or 42 minutes (i.e., a 71% decrease). Interventions included clinical care pathways, standing medication orders, standing radiology orders, and bedside registration. The amount of time from admission to the ED until the first administration of pain medication decreased to 45 (58%) minutes during the first year of the study. The statistical significance was not reported, nor was the sustainability of these results beyond the first year.

Iyer et al. (2011) evaluated a quality improvement initiative instituted at the Cincinnati Children's Hospital Medical Center in response to significant delays associated with analgesia delivery for children presenting with clinically apparent fractures of the radius/ulna, elbow/humerus, femur, or tibia/fibula/ankle. Examination of medical records over a one-year period of children who received intravenous opioids and were diagnosed with an acute extremity fracture requiring closed orthopaedic reduction revealed for 80% of these patients, time to analgesic delivery exceeded 45 minutes post arrival at the hospital ED. To reduce this time and improve the quality of analgesia delivery, they developed the "orthopaedic evaluation process" intervention. Components of this intervention included (a) standardizing triage decisions by identifying appropriate patients with apparent extremity fractures and moving them to a designated patient area; (b) activating appropriate care providers by paging them to the designated room; (c) aligning care delivery with the necessary resources by gathering other necessary members of the care team to the patient in the designated room with all the necessary intravenous equipment and analgesic agents; and (d) fostering cooperative completion of the tasks to be performed by physicians and nurses by having the physicians place the necessary orders and resolve any potential communication errors with nurses immediately.

From January 2007 through July 2009, patients who presented with isolated long-bone fractures, and received at least one dose of intravenous opioids, were assessed for the proportion

who received intravenous opioids within 45 minutes of arrival. The provision of analgesia and the time to delivery of the analgesic were used as the outcome measures. During the post intervention period, of 138 children diagnosed with acute fracture, the proportion of patients receiving the first dose of analgesia within 45 minutes increased from a mean of 20% to 70% (statistic and/or p value not reported), and the proportion of parents who rated their children's pain management as excellent increased from 54% before 2007 to 77% after 2007 (statistic not reported, $p = .0073$). Thus, simple low-level-technology interventions, such as identifying pediatric patients and streamlining care, have significant effects on pain processes in the ED.

Overall, results from these studies reflect suboptimal pain assessment and management practices for pediatric patients in the pre-hospital and ED settings. Only three researchers have examined pain assessment and management of children with multiple injuries (Devellis et al., 1998; Izsak et al., 2008; Neighbor et al., 2004). All three found delays in the delivery of first opioid analgesia to children with multiple injuries. Most of the researchers did not measure the amount of time to first analgesia from the time of injury. The review of existing literature demonstrates that there is a major gap that requires attention.

Physiological and Psychological Consequences of Unrelieved Pain

Physiological consequences. The immediate physiological effects of unrelieved pain include (a) increased heart rate; (b) increased respirations; (c) increased blood pressure; (d) anxiety; and (e) discomfort (Izsak et al., 2008; Zempsky, Cravero, Committee on Pediatric Emergency Medicine, & Section on Anaesthesiology & Pain Medicine, 2004). In any trauma patient, whether adult or child, a delicate balance exists between maintaining physiological stability and treating pain in a potentially life-threatening situation.

Major systemic, neuroendocrine stress responses can occur in response to a traumatic injury. They are often delayed but can be catastrophic once the cascading effects of these responses begin (Hill, 2000; Schreiber, 2005; Wetzel & Burns, 2002). This defence response includes early inflammation that is initially advantageous but if prolonged is highly detrimental (Tzioupis, Katsoulis, Manidakis, & Giannoudis, 2005). This complex, metabolic and immunologic change induced by trauma is known as systemic inflammatory response syndrome (SIRS). Commonly, SIRS is followed by a counter-regulatory anti-inflammatory response that should result in a return to homeostatic balance (Tzioupis et al., 2005). Pain can contribute to an acute neuro-endocrine response. Multiple trauma as a stimulus for this response is marked initially by an acute effect on cardiovascular function and performance, intravascular volume, and metabolism that lasts for several days (Wetzel & Burns, 2002). These effects may be augmented by many of the primary or secondary effects of multiple traumas, which include hypotension, hypovolemia, hypothermia, hypoxemia, and pain (Tzioupis et al., 2005). A higher metabolic rate distinctive to children may lead to an exaggerated response, although little literature exists on this aspect of the response to trauma in children (Haug & Foss, 2000). Metabolic rate and lung capacity move towards adult ranges when children reach the ages of 8 to 10 years (Bliss & Silen, 2002). The differences in metabolic rate, hemodynamic responses, and lung capacity characteristic of children underscore the need for caution when administering analgesia and, in general, when caring for pediatric trauma patients.

Factors related to the unique anatomy and physiological development of children must be taken into account in the treatment of pediatric trauma (Alterman et al., 2010; Bliss & Silen, 2002; Haley, Graham, & Dumas, 2004; Haug & Foss, 2000). Specific anatomical differences and the impact of these differences are outlined in Appendix E. Generally, because children have a

smaller body mass than adults, a greater force per unit body area occurs in a traumatic episode (Haug & Foss, 2000). The anatomical differences and response times of children to trauma cause unease for care providers when pain treatment is being considered, and demonstrate the complex nature of responses to multiple injuries in children. Side effects of analgesic agents combined with the unique aspects of children's anatomy and physiological response to trauma can potentially interfere with or complicate the response by compromising brain perfusion and neurological monitoring (Neighbor et al., 2004). Lack of pain control can perpetuate all the physiological compensatory mechanisms by contributing to increased heart rate, respiration, blood pressure, anxiety, and discomfort (Izsak et al., 2008; Zempsky et al., 2004).

The physiological contributions of unrelieved pain compounded with injuries obtained during a traumatic event can impede recovery from multiple injuries and, given the distinctive features of their anatomy, have more profound effects on children than adults. Highlighting the unique characteristics of children's anatomy acknowledges the delicate balance required to safely deliver analgesia to manage acute pain and provide care for pediatric trauma patients in the ED.

Psychological consequences. The short-term psychological consequences of unrelieved pain in children include anxiety that can lead to lack of cooperation, which may result in attempts at painful procedures necessary for care having to be repeated (Taddio et al., 2012). Disorganized behaviour or agitation has also been seen in children after a traumatic event with physical injury (Zink & McCain, 2003).

Long-term psychological consequences of unrelieved pain in children may include (a) feelings of hopelessness and helplessness (Mercadante, 2004); (b) conditioned anxiety responses; (c) increased pain perception; (d) diminished effectiveness of analgesia for subsequent

procedures (Taddio, Shah, Gilbert-MacLeod, & Katz, 2002; Taddio et al., 2005); (e) development of a needle phobias which can result in avoidance of medical care (McMurtry et al., 2015); and (f) posttraumatic stress disorder (PTSD) (McIntosh & Mata, 2008; Schreier et al., 2005; Zink & McCain, 2003). The consequences of poor pain management unique to the pediatric trauma patient have not as yet been articulated.

The relationship of unrelieved acute pain to PTSD in pediatric trauma also requires further study. Poor pain management has been suggested as a trigger for PTSD (McIntosh & Mata, 2008). Approximately 22% of children develop PTSD after a traumatic event (McIntosh & Mata, 2008; Zink & McCain, 2003), with one researcher suggesting that the rate of PTSD associated with even mild to moderate trauma in children is as high as 47% (Schreier et al., 2005). Children with PTSD may experience nightmares, angry outbursts, irritability, or different (e.g., repetitive) patterns of play, and/or disorganized or agitated behaviours (Carrion, Weems, & Reiss, 2007; Zink & McCain, 2003).

Zink and McCain (2003) conducted a longitudinal descriptive study of 143 children aged 7 to 15 who described the psychological effects of motor vehicle accidents. The Child Behaviour Checklist (CBCL; Achenbach & Edelbrock, 1991); the CBCL consists of a Social Competency Scale and a Behavioral Problem Scale. The CBCL Behavioral Problem Scale and PTSD section of the Diagnostic Interview for Children and Adolescents (DICA; Reich, 2000) were used at two and six months after the event. Up to six months after the event, 22% of the children met the criteria for PTSD, with no significant differences in age, sex, race, type of injury, or cause of injury. Zink & McCain also reported that when there had been a very serious threat to their life or to the life of a family member or other significant person, or a death occurred during the traumatic event, the development of PTSD was greater, although no statistical evidence was

cited for these observations. Psychological sequelae in relation to pain and pain management after serious injury in children and adolescents require further study. Rates of PTSD reported by Zink and McCain were comparable to findings by other researchers (Crandall et al., 2002).

Children's Perceptions of Acute Pain in Trauma

Little is known about children's pain experience during acute trauma. However, it is essential to consider that even very young children may have accurate memories of painful procedures and events (Chen, Zeltzer, Craske, & Katz, 2000) although these memories can be influenced by many intrapersonal, interpersonal, and contextual factors (Jaaniste, Noel, & von Baeyer, 2016). Thus, children's memory of a painful and traumatic event must be considered early in their hospitalization to prevent serious consequences such as the possible development of PTSD (Young, 2005). When children have been exposed to an increased number of medical procedures, they may display fear of medical procedures and symptoms of PTSD, and as young adults, may exhibit fear of pain and avoidance of medical procedures (Rennick, Johnston, & Dougherty, 2002).

Crandall et al. (2002) examined adolescents aged 11 to 17 with a mean age of 14.15 ($SD = 2.38$) who had experienced multiple sites of acute blunt injury. Genders were equally represented. Nearly all (91%) of the adolescents recalled that they experienced their worst pain at the scene of the accident and in the ED, but also that a very intense level of pain had persisted into hospitalization. The adolescents remembered the causes (i.e., movement, procedures), sites (i.e., injury sites), intensity, and quality of their pain as well as actions by staff to manage pain and the consequences of their pain (i.e., restriction of movement and the ability to do self-care). Immobility was the most frequently used action to control their pain with "not moving" considered of paramount importance. Cognitive actions to control pain took multiple forms

including emotional control, distraction, and thought stopping. Emotions and sleep were both construed as functions that would alter their perception of pain and were within their ability to control, which indicates adolescents' attempts to cover overt displays of distress. Presence of supportive family and friends was reported to be very comforting to all the subjects throughout all aspects of their experience. Adolescents who received patient controlled analgesia (4/13, 30%) recalled it as helpful, but only three reported adequate pain relief. All the adolescents reported a therapeutic benefit to recalling their experiences. Crandall, Miaskowski, et al. (2002) helped adolescents who experienced blunt trauma reveal how disturbing their pain experience was through the interviews, and in a way that conveyed the intensity of their pain and how they managed it.

Most of the evidence related to pain in traumatic experiences has been gathered in relation to adults (O'Brien & Fothergill- Bourbonnais, 2004; Zohar et al., 2001), with only one researcher examining pain from traumatic injuries in adolescents (Crandall et al., 2002). The impact of the event can potentially alter the life course of a child depending on the sequelae of traumatic injuries (Wetzel & Burns, 2002). Details on research relating to children's experience of pain are summarized in Appendix F.

HCPs' Perceptions of Pediatric Trauma Patients' Pain

Examination of the perceptions held by HCP who care for pediatric trauma patients is a critical step to better understanding their pain experience and the potential barriers to and facilitators of pain care. Some of these HCPs administer pain-relieving interventions. However, to the best of our knowledge, no researchers have examined how HCPs caring for pediatric trauma patients in the ED perceive their patients' pain experience.

Hennes et al. (2005) examined the knowledge of 202 EMT-paramedics (EMT-Ps) and compared their perceptions of how they managed pain with how they actually delivered pain interventions in adults and children prior to arrival at a hospital (reviewed above). Of the 202 EMT-Ps, 155 (77%) completed a cross-sectional survey assessing (a) knowledge of pain protocols; (b) estimates of the number of patients with pain; (c) frequency of administering pain medication; and (d) barriers to administering morphine. Medical records of patients with chest pain, extremity injuries, or burns were examined for those patients who had a recorded morphine dose. Technicians perceived they administered morphine to 37% of adults with chest pain (actual was 197/4671, 4%); 24% with extremity injuries (actual 37/314, 12%); and 89% with burns (actual 16/114, 14%). There were no reasons reported indicating why the technicians overestimated their actual administration of analgesia. For the combined group of adolescents (ages 8 to 17) and children (ages 0 to 7), survey responders estimated that they administered morphine to 1/34 (4%) of adolescents and children with extremity injuries (actual was 7/258, 2.7%), but did not remember the last time they treated any adolescent or child for chest pain or burns during the previous one month. Actual administration of morphine to the adolescent and child age groups with burns was 1/11 (9%).

The research by Hennes et al. (2005) is limited as the survey instrument was not an externally validated tool. Another limitation was social desirability bias (cited by the authors as a potential influencing factor in spite of the fact that the survey was anonymous), and recall bias as responders did not remember if they had treated a child with chest pain or burn pain in the previous month. Furthermore, the number of subjects in the burn sample was very small ($n = 11$) calling into question the significance of the comparison.

Maciocia et al. (2003) examined correlations in estimations of pain among children, their guardian, and a HCP attending a pediatric ED in a prospective, observational cohort study of 73 children, aged 4 to 14, with pain caused by an acute injury. The upper limb was the most common site of injury with 39/73 (53 %) of the children suffering from this type of fracture. The HCP group consisted of nurses, physicians, or emergency nurse practitioners. HCPs scored significantly lower [median (IQR) FACES score = 2 (1–3) ($p < .001$)] than patients [4 (3–4)] or guardians [3 (2–4)] using the Wong-Baker FACES Scales (Wong & Baker, 1988). Significant correlations between pain intensity scores were obtained using the two scales for HCPs (Spearman $R = 0.88$; 95% CI 0.82-0.93), guardians (0.83; 0.74-0.89) and patients (0.42; 0.21–0.59). It is essential to further investigate the perspectives of HCPs regarding how they feel patients experience pain; using a qualitative approach may reveal the underlying reasons why HCPs score pain intensity lower than their patients. Research related to pain perceptions of HCPs is summarized in Appendix G.

Summary of Literature Review

There are few published studies in the health care literature that focus on pain assessment and management in pediatric trauma patients, and several gaps in the research have been identified. Minimal research exists on the nature and frequency of pain assessment or management practices in the initial stages of care for children with trauma in pre-hospital, ED, or trauma room settings. Limited research addresses individual child factors related to pain assessment and management practices. Children with single injuries receive fewer pharmacological pain interventions for pain management than adults with similar injuries (Brown et al., 2003; Hostetler et al., 2002; Neighbor et al., 2004; Petrack et al., 1997). Few researchers have examined differences in sex or gender with regards to pain interventions in the

pediatric trauma patient; however, because a pattern of sex related differences does exist in pain experiences (Sundblad et al., 2007; Logan & Rose, 2004; Zubieta et al., 2002), investigation of the influence of gender may guide specific intervention development.

Few researchers have examined constellations of injuries commonly used to define a trauma patient. Pain associated with single fractures is frequently examined. Pain associated with severity of injuries and mechanism of injury in the pediatric trauma patient has been examined but results are inconclusive. Patterns seen in the child factors with single injuries should be confirmed in children with multiple injuries to assist in the development of treatment modalities.

Situational factors are postulated to influence pain assessment and management in the pediatric trauma patient, as well as the time period between the traumatic event and delivery of first opioid analgesia. While most research indicates there are delays in pain treatment, time between when injuries occurred until administration of the first opioid analgesia is not clearly known at present. The influence on pain practices of whether a child was transferred from another institution to a tertiary care trauma hospital is not known; although, differences in pain assessment and management between different types of EDs has been established. As well, there has been little focus on how differences in unit culture influence pain practices in pre-hospital or ED settings.

Very few qualitative studies have been undertaken on pediatric patients' experience of pain from multiple injuries. Only one research study explored the experience of pain for children with blunt traumatic injuries (Crandall et al., 2002). These children recalled experiencing severe pain in the early stages of their traumatic event. No research has been conducted as to how HCPs caring for children with multiple injuries perceive their pain practice in a clinical situation. The

perspectives of these two groups is needed to provide a foundation to build substantive knowledge about the pain of this subset of pediatric trauma patients.

Since critical realism contributes to the theoretical foundation of this study, explanations using causal mechanisms will be explored within the interpretation of the results of this research. The proposed causal mechanisms thought to be contributors to inadequate pain treatment for pediatric trauma patients include juvenile ageism, organizational culture, weighted summary, habitus, and symbolic violence. Although I could not find literature linking tenets of critical realism constructs to pain in children, the aforesaid causal mechanisms logically relate to the overall treatment of children in our society. Given that hospitals are a microcosm of our society, examination of the causal mechanisms within the context of the pediatric ED makes these specific causal mechanisms particularly relevant. A clear understanding of the causal mechanisms, obtained from data collected in this research, will allow linkage of study data to the proposed causal mechanisms through analysis of different types of data (e.g., quantitative and qualitative) advancing a deeper understanding of the pain state of this patient population.

CHAPTER 3:

PHILOSOPHICAL AND THEORETICAL UNDERPINNINGS

Suboptimal pain assessment and management in pediatric trauma patients in the ED is puzzling, in view of the many pharmacological, behavioural, physical, and psychological interventions with few adverse effects that are available and have a strong evidence base (Browne, Shah, et al., 2016; Browne, Studnek, et al., 2016; Chafe et al., 2016; Kim, Strait, Sato, & Hennes, 2002; Iyer et al., 2011; Zohar et al., 2001). Why these interventions are not being implemented effectively in the ED is not clearly understood. However, a number of reasons have been suggested. For children with abdominal pain, HCPs interviewed by Poonai et al. (2016), reasons included (a) the patient's pain was not severe enough, and (b) a surgical condition would be obscured. Further disadvantages for the pediatric trauma patient pertain to (a) false assumptions on the part of the HCP that pain has been adequately treated (Hennes et al., 2005); (b) systematic use of trauma care algorithms that currently place pain as a lower priority (see Appendix B); and (c) unfounded fears of the adverse effects of opioid analgesia (Anantha et al., 2014; Hennes et al., 2005; Zohar et al., 2001). Assumptions from critical realism, a philosophy of perception most commonly associated with the writings of philosopher and social scientist Bhaskar (1978), suggest that the reasons may be found in the social sphere, positioning the critical realist approach in a most favourable place to examine less obvious accounts of suboptimal pain treatment in children. For this reason, a critical realist perspective incorporating a postpositivist lens provides the overarching theoretical premise for this inquiry.

It is imperative that any discussion pertaining to pain include integration of theories of pain, which focus on the physiological pathways of pain. Gate Control Theory (GCT; Melzack & Wall, 1965) introduces the notion of how pain pathways, an element of the *actual* layer of reality

in critical realism, are affected by cognition. Expansion of the cognitive awareness element of pain theory into broader considerations of the social world is facilitated by the critical realist attention to social influences.

Any examination of the experiences of children must integrate an application of developmental theory. Children's developmental stages influence the way they understand what is going on around them as well as how they are treated by their parents and care givers. While developmental theory as such will not be overtly discussed, elements of it are woven in throughout, and are fundamental to all discussions regarding children. In this chapter, the inquiry into the treatment of pain in children with trauma is theoretically conceptualized, and some of the postulated causal mechanisms that are encountered in suboptimal pain management of these children are identified.

Critical Realism

Critical realism is based primarily upon the writings of Bhaskar (1978), who posited that there is space for the natural and the social sciences to work together to answer questions about our world. (The dimensions of the natural world most relevant to this research are the physiological pain pathways.) The four major tenets of critical realism of relevance for this study are: (a) reality is stratified over three domains rather than a single reality that is waiting to be discovered; (b) there is significant focus on the interplay between social structure and human agency in explaining the daily experiences of the individual; (c) there are causal powers or generative mechanisms that may explain why structure and agency interact the way they do at any given time; and (d) there are emergent forces at play that contribute to agency and structure coming together the way they do in any one given instance (Clark, Lissel, & Davis, 2008; Danermark, Ekstrom, Jacobsen, & Karlsson, 2002; Elder-Vass, 2010; McEvoy & Richards,

2003). Critical realism is a philosophy that espouses methodological eclecticism and focuses on explanations (Clark et al., 2008). Methodological eclecticism embraces many research methods, espousing a mixture of both quantitative and qualitative methods, the proposed design for this research project (McEvoy & Richards, 2006).

The underlying purpose of critical thought in qualitative research, an element of the design of the mixed methods approach of this study, is to guide the processes of probing dominant discourses and uncovering who specifically gains from maintenance of the current status quo. The dominant discourse in relation to pain management is rooted in a perspective that gives primacy to pathophysiology and upon which trauma care algorithms are based. Pharmacological pain interventions are grounded in experimental research from authoritative, traditional, positivist paradigms that produce objective findings to describe cause-and-effect relationships. Evidence for the power and pre-eminence of scientific verification in medication administration in pain management is apparent in the legal documentation required for the administration of opioid analgesia and for clinical practices surrounding the use of opioid analgesics. For example, opioid analgesics must be kept in locked cupboards, and a written record for each instance of opioid use is required. In contrast, there is an almost complete absence of documentation of behavioural, physical, or psychological interventions.

Layers of Reality

Critical realism provides the overall theory that situates this study. It offers a philosophy particularly relevant to health care, in that it acknowledges the legitimacy of different perspectives among individuals including, in this research, those of HCPs and patients (Angus, Miller, Pulfer, & McKeever, 2006). Critical realism also acknowledges the myriad structural and social components that impinge upon all individuals.

Bhaksar (1978, 1998) suggested that the social structure of the world is layered with distinct strata and that, as humans, we are not aware of these domains. These layers of reality are referred to as *empirical*, *actual*, and *real*. In the empirical layer or domain, humans observe and perceive phenomena. The domain is characterized by all that can be observed or perceived by the observer (Angus et al., 2006; Clark et al., 2008; McEvoy & Richards, 2003). In pain assessment and management, the empirical layer encompasses the HCPs' observations of pain, using various pain tools and their perceptions of children's pain. How HCPs perceive the pain of pediatric trauma patients and how they have or have not treated this pain exists in the empirical world. How the children perceive their pain and pain management also represents the empirical world.

The actual world consists of the natural world that has always existed, although we are only able to see some aspects of it. It can be described as conveying events that happen or exist regardless of how observers perceive them. It encompasses the empirical world. Pain physiology, including neuronal transmission and injuries along with potential complications, exist in the actual world.

The real world consists of events in the world that evolve from generative mechanisms originating in the actual world. The real world is what exists socially. Social phenomena affecting human agency comprise part of the real world; they are not visible or empirical objects. Generative mechanisms are a key concept in critical realism. They provide explanations for why things happen in our world. Social concepts that affect how pain is managed in pediatric trauma patients exist in the real world. The social concepts posited as potential causal mechanisms for this research proposal include *juvenile ageism* and widely accepted guidelines that systematically delay pain management, both of which are perpetuated by organizational culture, and which remain unquestioned now, thereby maintaining the status quo (see Figure 1).

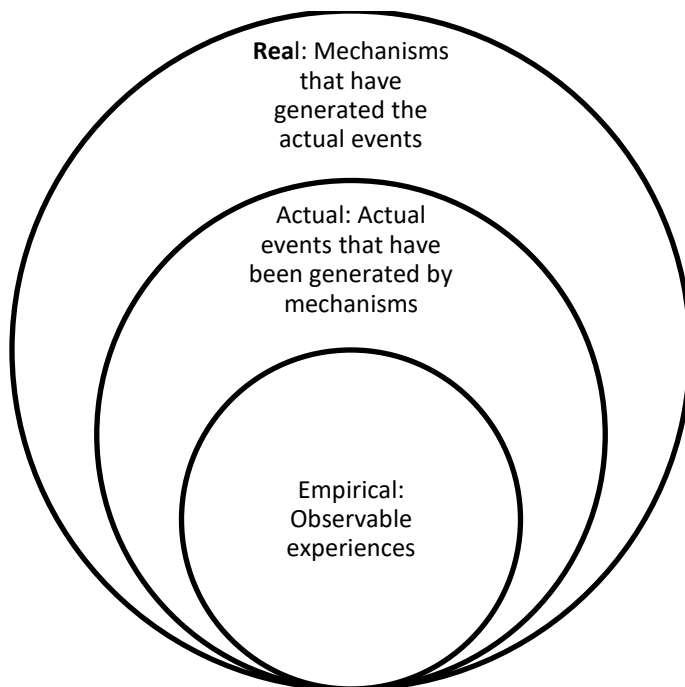


Figure 1. Diagrammatic representation of critical realism.

An important aspect of layered reality is that there can be a misalignment between the actual, real, and empirical domains. Such misalignment is termed *transfactuality*. Human perceptions in the empirical domain are prone to inaccuracies that can be demonstrated by scientists' continued revisions through the centuries of the increased understanding of the physiology of pain. Neurotransmitters have performed through the body's nervous system in the same way, in the actual domain, even before humans knew or devised experiments to explore it in the real domain. Observations and the interpretation of these observations occur in the empirical domain (Clark et al., 2008). Very simple theoretical propositions about pain (Melzack & Wall, 1965) have now evolved; more complex models are now understood to comprise the neurological basis for pain experience (Woolf & Salter, 2000).

Another example of transfactuality is seen in the misinterpretation, usually underestimation, of children's pain by parents and HCPs, a misinterpretation that is a pervasive

phenomenon (Brudvik, Moutte, Baste, & Morkin, 2017; Chambers, Reid, Craig, McGrath, & Finley, 1998). While observable in the empirical domain, it has causal mechanisms in the real domain.

Critical realism attempts to explain how social structures and human agency together result in a phenomenologically mediated experience of the world. There is a synergistic existence between social structures and individuals that coalesces in a particular manner, causing individuals to respond to the world surrounding them in a particular way. In creating the world for an individual, critical realism supports the notion that social structure and human agency intersect and yet are quite distinct from each other (Elder-Vass, 2010).

This intersection is especially relevant with regard to health care phenomena and processes, where human agency occupies a large space. Human agency is what allows individuals to make decisions, but the institution of medicine, including hospital bureaucracy, does not provide a comfortable space for individual responses or decisions. The HCPs caring for pediatric trauma patients are faced with complex factors that may possibly prevent them from providing appropriate pain treatment. For example, physicians may have concerns about adverse effects of opioids. Nurses in the ED trauma room may see the need for analgesia, but do not hold the authority to fully provide optimal and effective pain relief and, if newly trained to the trauma room, may not be mature enough in their role to confront the physician. The notion of agency for children depends upon their developmental stage, but it may be compromised due to physical injury, and therefore may not be able to be fully realized. Parents are likely distraught in these chaotic and emotionally demanding circumstances and dependent upon HCPs to provide any necessary care decisions. In the pediatric trauma patient scenario, patients and HCPs intersect in the trauma room at the moment of crisis, bringing each individual's human agency together in

the environment of the organization of the social structure of the hospital to play out their social roles. The notion of human agency as applied to the child within the trauma scenario is problematic at best and even more so with a younger child; should the experience be negative, the notion of agency from the child's perspective may become further diminished.

Another concept in critical realism is *emergence theory* (Blitz, 1992), which provides the critical realist with a way to understand how all phenomena within the layers of reality merge together, forming an individual's reality.

Emergence Theory

Emergence theory posits that an entity has capabilities that are not held by any of its individual parts (Elder-Vass, 2010). For example, hydrogen and oxygen are said to have emergent properties that give them the ability to become water when they come together. This analogy can be brought to bear on social structures and human agency as a causal power according to Elder-Vass (2010). Assumptions about emergence theory are supported by principles of critical realism; social structures impinge upon the individual in everyday life, resulting in a merging of both structure and agency, together allowing people to function in the world in which they live.

Emergence theory parallels with the concept of stratification in critical realism. Stratification refers to all the layers of reality combining in a unique situation such as, in this research, the trauma room in the hospital at the instance of a traumatic event. Stratification implies that when all three layers of reality come together with the agent, a certain reality is created (Bhaskar, 1998), a unique circumstance for the individual. Emergence theory is relevant to the discussion of children with traumatic injuries, because their emergent mental state and that

of each staff member involved with them is brought into the pre-hospital scenario, and into the ED trauma room.

Structure and Agency

The interplay between structure and agency in determining a phenomenological experiencing of everyday life is a basic tenet of critical realism (Angus et al., 2006). For critical realists, social structure holds a temporal priority over human agency, which results in a perpetuation or reproduction of the culture and society into which one is born. The social structures that influence the pain experience of pediatric trauma patients within the trauma room, and which may contribute to poor pain assessment and management, are poorly understood. In critical realism, social structures, as mediated through human agency, are termed *causal mechanisms* or *causal powers*. Clark and colleagues (2008) used the term *deep complex causation* to refer to the contributions of causal powers. The causal powers contributing to suboptimal pain management in children are discussed in the following section, as an initial step in the long-term process of shifting the status quo of current embedded approaches to pain management in the pediatric trauma patient.

From the perspective of this study, organizational culture and ageism were considered mechanisms perpetuating poor pain assessment and management practices in children with multiple injuries. Both phenomena infiltrate the subjectivities of those involved in the assessment and management of the pain of pediatric trauma patients in the trauma room. Looking at the potential contributions of individuals as well as the social context provides a more robust analysis of the disparities that may be occurring (Angus et al., 2006). Contributions from the children also affect how pain is conveyed and perceived by caregivers.

Generative Mechanisms

Organizational culture. Organizational culture is one of several mechanisms through which society's views of children are brought to bear when dealing with the treatment of children's pain in the trauma room. Organizational culture is often ascribed a layered quality. As a concept, organizational culture is rooted in qualitative, anthropological research on cultural studies of different societies and was applied to organizations in the 1970s. It represents the intersection between culture theory and organization theory (Smircich, 1983). Organizational culture arises from beliefs, attitudes, values, and behaviour norms that are shared among colleagues within an organization. In the vernacular, it is "the way things are done around here," including the way things are understood, judged, and valued (Deal & Kennedy, 1982). The organizational culture of the hospital is the ethos or society in which certain individuals play out their role as HCPs.

It has been suggested from emergence theory that culture has emergent properties, made up of the organizations' constituent parts. The culture of an organization has been referred to as the "personality" of the organization (Olson, 1998). Allaire and Firsirotu (1984) conceptualized the idea that organizations were like small societies, each with their own culture, like all other societies. There is no one definition of organizational culture; however, there are several definitions that have evolved over time.

EDs are part of a complex system with many constraints that emergency clinicians must manage. These constraints point to a complex mix of organizational factors shaping the culture of a typical ED (Nugus et al., 2011), including (a) a continued arrival of patients driven by beliefs, expectations, and the needs of the community serviced; (b) expectations of patient flow throughput; (c) hospital or community bed capacity beyond the control of the ED; and (d) limited

resources. In their study of two pediatric and two adult and pediatric ED settings in a large urban centre in the United States, Hemmergarn, Glissen, and Dukes (2001) found that organizational culture, more than profession, experience, or sex, influenced the provision of emotional and mental health support to families.

Hallett (2003) conceptualized organizational culture as a negotiated order that emerges through the interactions between all those within the organization, but is primarily influenced by people with symbolic leadership who have the power to define the situations in which the interactions take place. Both formal and informal interactions generate the culture of an organization. For example, the hierarchical structures in most hospital environments demonstrate the primacy of the medical model of care that carry through to the context of the ED trauma room with the trauma team leader as the physician in charge of medical/surgical care.

Habitus. Hallett (2003) used Bourdieu's (1988) concept of *habitus* to describe how the day-to-day practice of individuals influences organizational culture. This concept has utility for its ability to link micro actions within an organization to broader social structures. Habitus refers to individuals' unconscious behaviours and attitudes—their enduring thoughts, actions, and perceptions—internalized through early socialization into the world. It is an unconscious adaptation of individual agents to the social circumstances into which they find themselves (Sallaz & Zavisca, 2007). Bourdieu suggested that it was through the process of habitus that dominant cultural practices are socially reproduced.

Habitus, as defined by Bourdieu (1988) and applied by Hallett (2003), allows for the introduction of social structures such as juvenile ageism to seep into the organizational culture, and therefore be perpetuated by players within an organization such as a hospital and within the micro culture of the trauma room. Through the habitus process, the application of the current

trauma care algorithms, placing pain as a lower priority, continue to be utilized in the care of children with trauma. The use of current trauma algorithms (see Appendix B), is suggested as a major factor in a systemic perpetuation of poor pain management practices in both adults and children. The same notion of habitus is at work with the systematic use of trauma algorithms in the adult trauma population. Children consistently receive less pain treatment than adults while in the general ED setting (Brown et al., 2003; Ali et al., 2014). The overall inequality of pain treatment between adults and children is a convention that is very likely to continue, from the pre-hospital setting through into the ED setting, and into all areas of the in-hospital setting, if left unexamined. Bourdieu's notion of habitus has relevance for every individual HCP in the pre-hospital and ED settings as they bring their social influences into their day to day work and interactions with patients.

Juvenile ageism. Juvenile ageism may be another generative mechanism for suboptimal pain assessment and management in children. Although most commonly associated with the prejudicial actions against older people, ageism is defined more broadly as discrimination based purely upon age (*The American Heritage Dictionary of the English Language*, 2009). The term *ageism* was introduced in the late 1960s as an example of social marginalization and discrimination. The notion of juvenile ageism, defined by Westman (1991) as prejudice and discrimination against the young, characterized by abuse and neglect of children, has not had as widespread a usage or examination as ageism associated with the elderly (Westman, 1991).

Maria Montessori (1870–1952), Italy's first female physician, started an educational movement built on the vision that helping children would improve society. Montessori embraced children's natural intelligence and curiosity espousing a learning environment that was highly individualized (Edwards, 2002). Montessori summarized some of the ways juvenile ageism has

played out, including (a) interference with the normal development of children; (b) the attitude that adults always know what is best for children; and (c) assumptions based upon faulty thinking that children need to be taught didactically, ignoring their natural curiosity and imagination. Montessori posed these assumptions as evidence of prejudicial practices towards children dating from early in the 20th century.

Mayall (2000b) suggested that children are a distinct social group that has always been controlled by adults, who have put them in a position of lower social status. Mayall deconstructed notions of childhood by highlighting some of current social assumptions. He challenged us to take children's needs seriously, and to examine where barriers that make it easier to exclude children than include them in our society are erected (Mayall, 2000b). How parents understand children and childhood itself is influenced in powerful and significant ways by the way they were treated in their own childhood; in essence, the weighted summary of personal experience (see below, Weighted Summary).

There is the sense among researchers, Mayall (2000a) suggested, that children's personal accounts cannot be relied upon. Researchers' interpretations of data related to children's experiences may be overly influenced by taken-for-granted perspectives about children's lesser social role. They may appropriate and assume too much power over children's voices. Mayall's research on children as a social group highlighted that children themselves realize they are socially and morally inferior to adults, and very aware of the power differentials between the two groups. Kelley, Mayall, and Hood (1997) proposed giving children a distinct voice in research or policy development relating to their own issues.

In caring for pediatric trauma patients, factors influencing the perceptions that HCPs have with regards to pain treatment are open to social influences they may not be aware of. Efforts

must be made to gain insight into these unseen forces that could potentially provide explanations for suboptimal pain treatment. We are all gendered, aged, and classed, and the social position that children hold in society is certain to emerge in research contacts with them (Eichler & Albanese, 2007; Warren, 2001). Reflexivity on the care of the child in the ED, focusing on the treatment of pain, is a major focus of this research. The process of reflexivity involves making a deliberate effort to scrutinize one's own self in relation to a subject (Hsiung, 2008). Reflexivity affords the opportunity to understand how local forces function within a field of wider forces, allowing for the revelation of how some voices are privileged and others are silenced, and of how these dynamics are produced and reproduced (Burawoy, 1998).

Children's pain was virtually unacknowledged until the 1980s, suggesting the presence of juvenile ageism in historical contexts. The active role of attitudes associated with juvenile ageism is also suggested in rates of child abuse, reported to be 32.1% in a sample of 25,113 adults across the 10 provinces of Canada (Afifi et al., 2014). It continues to be a sustained social problem. Juvenile ageism is conceptualized as potentially operating as one of several mechanisms resulting in the delay of pain management treatments for children.

Weighted summary. Weighted summary may also be a causal power or generative mechanism for the way pain assessment and management for the pediatric trauma patient is being enacted in the ED trauma room. Critical realists use the concept of weighted summary to indicate the emergent properties of past experience and neuronal activity when considering actions or reactions to social phenomena. Our mental states, such as beliefs, seem to be underpinned at the neuronal level by connections of varying strengths between neurons. Weighted summary, according to Elder-Vass (2010), refers to the notion that networks of neurons and the synaptic connections between them make up much of our brains and are

conditioned or configured by our experience. These connections tend to be strengthened when we have experiences that confirm the mental state, and weakened when we have experiences that undermine it. These neural connections do not represent individual experiences one at a time, but a weighted summary of them. Our experiences are the cause of the configurations of neurons and synapses that are the emergence base of our mental states.

The weighted summary of our experiences has an emergent relationship or emergent property. Weighted summaries are brought into the ED by each individual staff member, patient, and parent. They each bring their own weighted summary to bear in the process of any pain assessment, and this can have a direct influence on their sense of personal agency. One's sense of personal agency may be diminished if one has very negative experiences of pain. Weighted summary emphasizes the impact of previous pain experiences, thus encapsulating the means through which previous pain experience becomes a vital factor for children.

Elements of the trauma patients' individuality arrive with them in the ED at the time of the traumatic event. These elements relate to how well-developed their ability is in conveying social, cognitive, and emotional needs such as the expression of pain. The capacity to use language and social skills to convey or express pain is linked to developmental stages that progress as children grow older (Craig, 2009).

The social context of the trauma room is significant in providing a unique environment for patients' expression of pain. While less modulation of pain is evident in children with their parents than with strangers, there is enough alarm in the immediate context of the ED to elicit greater displays of facial expression of pain (Craig, 2009). Other emotions such as fear and anxiety may influence children's ability to modulate their expression of pain. It is unknown whether children feel constrained in their expression of pain when in the ED. The same factors

that affect patients' expression of pain also affect the caregivers' perceptions of pain.

Interpersonal factors, such as how a nurse may view the pain of a patient, and intrapersonal factors, such as a physician's own pain tolerance, apply to caregivers' perspectives on pain experiences of others. This is particularly true if they have had previous painful experiences as children. The juxtaposition of expression and interpretation highlight the complications inherent in assessment and management of pain and potentially comprise components of the weighted summary brought by all members to the trauma room.

Symbolic violence. An additional concept developed by Bourdieu (1989), the notion of *symbolic violence*, has applicability to this examination of potentially suboptimal pain assessment and management in children. Symbolic violence refers to having power over others, where that power is enacted discreetly and where actions are inferred and understood as having accepted legitimacy. A person with some kind of power over another (as for example, an adult over a child) will commonly convey disapproval to the one with lesser power, which then may alter the behaviour of the one with lesser power. The one with lesser power comes to accept this power over them as legitimate and the altered compliant behaviour is seen as part of a just and beneficial social order. Legitimacy is imposed on the dominant social order. This symbolic violence supports established power relations. Symbolic violence can be viewed as a means to accomplish social marginalization in a subtle and almost imperceptible process (Hall, 2004).

In relation to pain management of children in the ED, doctors and nurses are the adults the child is dependent upon to care for them (especially in the absence of the child's parents or guardians) and who potentially enact the dynamics of symbolic violence. An underlying implicit assumption typically associated with symbolic violence is that the best care possible is being provided by trusted and expert HCPs who have the child's best interests in mind always. It is not

known precisely what children think about the actions of their HCPs in the trauma room setting. It could be hypothesized that children would not entertain the notion that anything other than the best of care is occurring; although the HCPs are causing them pain by moving them, or performing painful procedures such as obtaining blood samples or establishing intravenous access. Interviews with children who have undergone such a trauma would verify or negate these assumptions.

Theory of Pain

Theories of pain are fundamental to the discussion of pain research and are considered well regarded, well established, and pervasive components in current discourse on pain assessment and management in adults and children. A brief review of the GCT (Melzack & Wall, 1965) suggests that pain patterns such as activation, modulation, and modification are expressions of neural plasticity, comprising a continuum of reactions of neurons in response to nociceptive input that is generated from the periphery but is maintained throughout the central nervous system. The summative effect determines the pain intensity felt by a person and whether that pain persists. GCT integrates physiological, sociological, and psychological conceptualizations of pain, acknowledging and accounting for cognitive responses to pain that are within an individual's control to a certain extent. Developmentally, the ability of children to perceive and react to pain is established late in gestation, when the neurochemical systems and pain pathways are known to be intact (Fitzgerald, 2015). Cortical and subcortical centres responsible for awareness and cognition of pain are active and relevant to the conscious child of any age, making theories of pain a fundamental backdrop to any discussion of pain assessment and management. Cognitive development has been directly related to the development of pain perspectives and age (Chan & von Baeyer, 2015). Kortessluoma and Nikkonen (2006) found that

expressions of pain in a group of 4-to-11-year-olds were more introspective and abstract with older children (10 to 11 years of age), than with younger children (4 to 9 years of age); nonetheless, all the children clearly communicated their pain experiences in qualitative child interviews.

The GCT posits a conceptualization of pain that accounts for and realizes input from an individual's conscious world. Through activation, modulation, and modification of pain signalling through the spinal cord to the cerebral cortex, cognitive awareness has been demonstrated to influence pain perception (Büchel et al., 2002; Lorenz, Minoshima, & Casey, 2003). Cognitive processes such as fear and anxiety that are known to accompany pain (Ochsner et al., 2006), along with the distress of a traumatic event, may exaggerate the child's perception of pain. Cognitive processes allow a crossing point between the cortical and subcortical centres of the brain and the open system of the social world, thereby creating a conduit to critical realism's real world.

The processes of activation, modulation, and modification are influenced by the pharmacological, physical, and psychological agents used to relieve pain. Critical realists suggest that an emergent relationship exists between one's state of consciousness and one's physical brain. Networks of neurons and the synaptic connections between them are conditioned by our experiences (see above, Weighted Summary).

The physiological response to tissue injury stimulates the sympathetic nervous system and mobilizes the nervous, endocrine, and immune systems (Chapman, Tuckett, & Wong, 2008). Acute wounds disrupt local tissue environment, trigger inflammation, constrict blood vessels, promote coagulation, and stimulate an immune response. Sympathetic responses at the injury site restrict blood flow, reducing hemorrhage and fostering platelet aggregation, thus keeping healing

factors within the wound. These responses are followed by a period of vasodilation that result in the erythema, edema, and heat that are often observed after tissue injury. C fibers interact with the injury, secreting proinflammatory peptides and signalling injury. Proinflammatory cytokines, neutrophils, and macrophages, and complement and acute phase proteins generate a systemic reaction that protects against microbial invasion, sensitizing the wounded area to protect and promote healing. (Chapman et al., 2008). Emotional arousal from the stress of the traumatic event increases sympathetic activity systemically, through autonomic and endocrine mechanisms.

The spinal cord demonstrates plasticity by shifting alternately between states of nociceptive inhibition and facilitation. Spinal nociceptive inhibitory mechanisms can be classified as (a) supraspinal descending inhibition; (b) propriospinal, heterosegmental inhibition; and (c) segmental spinal inhibition. The adaptive value of nociceptive inhibition is that pain must not impair flight or fight (Chapman et al., 2008). Through descending pathways, higher structures can facilitate or inhibit the pain experience. Frontal-amygdalar circuits may modulate the affective intensity of injury, playing a role in pain modulation. Cognitive variables such as interpretation, attention, and anticipation can influence amygdalar response through the frontal-amygdalar circuit. The amygdala, in turn, can influence the hypothalamo-pituitary-adrenocortical axis, a major organ of the stress response. Frontal influences also affect patterns of activity at the locus coeruleus (Chapman et al., 2008).

The key excitatory central neurotransmitter and regulator in the endocrine response to injury is corticotropin-releasing hormone. Locus coeruleus neurons increase firing rates in response to corticotropin-releasing hormone, and this increases norepinephrine levels throughout the central nervous system. Noxious signalling inevitably and reliably increases activity in the

locus coeruleus noradrenergic neurons, and locus coeruleus excitation appears to be a consistent response to nociception. The locus coeruleus heightens vigilance, attention, and fear as well as facilitating general defensive reactions mediated through the sympathetic nervous system. Basically, any stimulus that threatens the biological, psychological, or psychosocial integrity of an individual increases the firing rate of the locus coeruleus, and this in turn increases the release and turnover of norepinephrine in the brain areas having noradrenergic innervation. The locus coeruleus exerts a powerful influence on cognitive processes such as attention and task performance. In addition to directly receiving noxious signals during spinoreticular transmission, the locus coeruleus also responds to corticotropin-releasing hormone (Chapman et al., 2008).

The immune and nervous systems act together cooperatively at the wound. Tissue injury releases the immune-stimulatory neuropeptides substance P and neurokinin A. These activate T cells and cause them to increase production of the proinflammatory cytokine interferons. In addition, another proinflammatory cytokine, interleukin 1, stimulates the release of substance P from primary afferent neurons. The neurogenic inflammatory response helps initiate the immune defense response, and at the same time is in part a product of that response (Chapman et al., 2008). While nociceptor pathways are associated with pain it is well known that pain is the result of a complex interplay between signalling systems, modulation from higher centres, and the unique perception of the individual (Steeds, 2009).

The complex, physiologically rooted defense response to tissue injury involves a fight-or-flight response that is restricted when having to be immobilized on the ambulance stretcher for transport, and continues to be constrained through the physical assessment of the trauma assessment protocol. The physiology of pain is rooted in the actual layer of reality, in the critical realist standpoint.

Summary

Since we know that cognitive processes of fear and anxiety influence pain, it is likely that children are also able to consider other cognitive processes that allow an interface with the open system of the social world, creating a segue into a myriad of social influences. Causal powers, or generative mechanisms, provide discussion points for the consequences of these mechanisms as they play out in different settings. Social influences within the real world are part of the open system as posited by critical realism and require identification to explain and understand the dynamics inherent in current pain assessment and management practices for pediatric trauma patients. Child factors such as age and sex have been shown to bear upon pain practices and affect the way pain is regarded in the hospital by HCPs. Whether the patterns demonstrated in other patient populations foreshadow patterns in pediatric trauma patients requires exploration and verification. Regardless of the developmental stage of the child with pain from trauma, or the level of expertise of HCP caring for them, generative mechanisms within the realm of the real world constitute an entity of which neither party would likely be aware. How the effects of juvenile ageism and organizational culture impact on the treatment of pain are not easily evident.

Developmental theory helps explain the differences in interview data obtained from the children's interviews. The range of ages of the children interviewed spanned several of Piaget's developmental stages from concrete operational (8-11 years) to formal operational (12 years and up). Children in the concrete operational stage are just beginning to reconcile internal and external influences but they understand the world in a concrete and literal sense. Children in the formal operational stage are beginning to understand a more sophisticated sense of logic, reasoning and abstract thinking.

The gate control theory of pain and neuromatrix theory of pain describe pain as a sensory-discriminative, affective-motivational and cognitive-evaluative construct that captures the sensory, emotional and cognitive dimensions of pain (Moayed & Davis, 2013). These theories also help us to understand the abilities (or inabilities) of children to modulate their responses to pain especially in the distressing situation they have suddenly been thrust into in this trauma.

Critical realism assists analysis of this research by identification of generative mechanisms within the real layer of reality that may be elusively influencing the behaviours of both the children and HCPs. To the critical realist, developmental theory and the theories of pain would be a social representation or model of the human development and pain physiology. The theories are transitive and lay within the social world while human development and physiology lay within the actual layer of the critical realist's world.

Taking into account the tenets of critical realism, the GCT, and the underlying fundamental influences of developmental theory, this research examines and proposes generative mechanisms that may be at play in the assessment and management of pain in pediatric trauma patients in the pre-hospital and ED settings.

CHAPTER 4:

METHODS

In this chapter, the research questions and associated study designs, settings, samples, and procedures, as well as data analysis, are described. Procedures regarding the ethical conduct of the study are also outlined.

Overall Study Design

The overall design of the study is a mixed methods convergent parallel design (see Figure 2). A mixed methods convergent parallel design is characterized by the use of quantitative and qualitative data sets that are collected separately and concurrently (Creswell & Plano Clark, 2007). The two data sets are analysed separately and the datasets are then compared and related during integration or discussion. The main purpose of this design is to do triangulation which provides a fuller answer to the research question. The design is useful to obtain different but complementary data on the same subject matter. A convergent parallel type of design is used if each type of data (quantitative and qualitative) is thought to be of equal value for understanding the research problem. Benefits of the mixed methods designs are that the design complements the depth of understanding afforded by the qualitative methods with the breadth of understanding afforded by the quantitative methods (Palinkas et al., 2015) and draws upon the strengths of both qualitative and quantitative approaches (Guetterman, Fetter, & Creswell, 2015). Additionally, the philosophical and theoretical foundations of critical realism align with a mixed-methods approach (Shannon-Baker, 2016). Through analysis of the quantitative data from Phase 1 and qualitative data from Phase 2, results link to the causal mechanisms identified through critical realism and inform a path to a deeper understanding of treatment of pain in pediatric trauma patients.

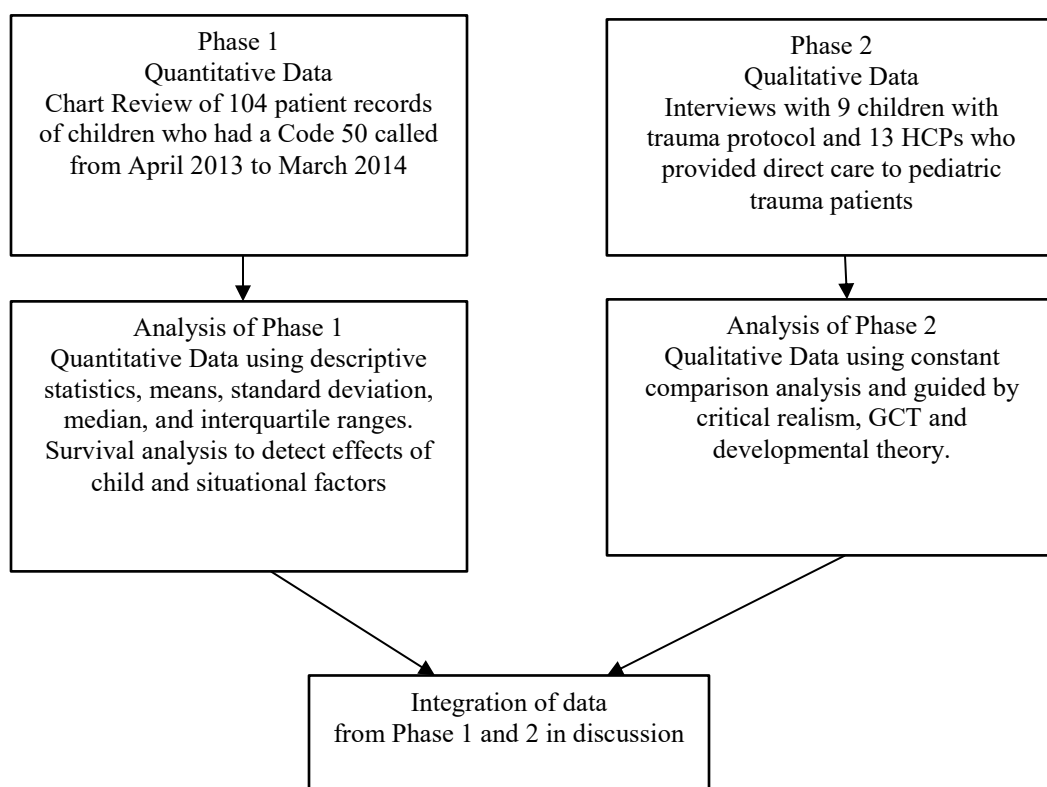


Figure 2. Mixed Methods Convergent Parallel Design. Source: Creswell & Plano Clark (2007).

Research Questions

Phase 1 Primary Research Questions

- 1(a) What is the nature and frequency of pain assessment and management practices for the pediatric trauma patient in the
 - (i) pre-hospital setting (including transport with EMS to hospital and from transferring institution); and
 - (ii) trauma room in the hospital ED setting (including in-hospital admission unit if first opioid not administered until admission unit)?
- 1(b) What child and situational factors influence these pain assessment and management practices in the pre-hospital and ED settings where

- (i) child factors include age, sex, number of injuries, mechanism of injury, severity of injuries and type of injuries; and
- (ii) situational factors include pre-hospital (transport to hospital), the hospital ED setting, and the transferring institution

Phase 1 Secondary Research Questions

- 2(a) What is the time (in minutes) from the occurrence of injury to the first administration of opioid analgesic?
- 2(b) What child and situational factors influence the administration of the first opioid analgesic?

Phase 2 Primary Research Questions

- 1. What is the child's perception of her/his experience of pain from the occurrence of injury in the pre-hospital setting and through the trauma room in the ED setting?
- 2. What is the HCP's perception of pain experience in pediatric trauma patients, from the occurrence of injury in the pre-hospital setting and through the trauma room in the hospital ED?

Phase 1

Study Design

A retrospective chart audit of pain assessment and management practices in pediatric trauma patients who have been admitted to the ED at the study institution over a recent 12-month period was carried out. This method is used most often in trauma research (Gilbert, Lowenstein, Kozial-McLain, Barta, & Steiner, 1996). An audit methodology allows for the examination of clinical practice without impinging upon or influencing delivery of care at the time of arrival of a trauma patient. This design has been recommended as a model for conducting research in difficult clinical scenarios (Cook et al., 2010).

Study Setting

Data were collected from medical records of children admitted to the ED at a large urban pediatric trauma center in a university affiliated hospital in Southern Ontario that serves metropolitan Toronto and central and northern Ontario. Data were accessed from the electronic patient charts (EPC) of eligible patients. EPC data can be accessed from any computer in the hospital with a secure password. Data in the EPC includes records of care from both the pre-hospital and the trauma room in the hospital ED settings. Additionally, when necessary, the search for administration of the first opioid extended into the admission unit.

Study Sample and Inclusion Criteria

The sample consisted of children who (a) arrived in the ED with a traumatic event over the one-year period; (b) were from 0 to 18 years of age; and (c) had a formal trauma protocol (Code 50) initiated upon arrival in the ED, requiring admission with the diagnosis of trauma. Children transferred from peripheral hospitals who met the inclusion criteria were also included. Many of the trauma cases at the study hospital had been stabilized at other hospitals within regional areas and then transferred via ground or air transport. All patients in the study samples for both Phase 1 were treated upon arrival in the trauma room at the study hospital with the trauma algorithm as the foundation for all health care they received.

Exclusion Criteria

Children who died while in the ED and children who arrived ambulatory to the emergency department at the hospital were excluded, since they were considered to have had considerably different pain management practices. Children for whom adequate records could not be found were also excluded.

Sample Size

Sample size was based upon (a) the number of eligible children admitted to the hospital after a trauma protocol during the one-year period between 2013 and 2014 and (b) the number of exploratory independent child and situational variables. Based on the suggestion that the optimal ratio of observations to an independent variable should not fall below 10 to identify relevant predictor variables (Halinski & Feldt, 1970; Bartlett, Kotrlik, & Higgins, 2001), we included at least 100 observations. Phase 1 was an exploratory enquiry based on feasibility and not meant to test hypotheses but rather to generate hypotheses.

Feasibility

The study hospital is a major Level 1 pediatric trauma center in southern Ontario, Canada. It has attended to between 119 and 173 Code 50 trauma cases every year since 2011 (see Table 1). Therefore, obtaining the required sample size of at least 100 charts for review was feasible. There are specific criteria for consideration of triggering a Code 50 for the study hospital (Appendix H).

Table 1

Number of Trauma Cases per Annum Over a Four-Year Period

Year	Number of admissions to ED	Number of Code 50s*
2011	61,898	141
2012	64,397	141
2013	64,687	119
2014	69,704	173

Note. *Code 50: the term used at the study hospital indicating that a patient meets defined criteria as a trauma patient and an official trauma protocol must be initiated. *Source:* the Hospital for Sick Children.

Data Collection Procedures

Pilot Study

A pilot test of the chart audit process was conducted and consisted of data collection and entry into the REDCap (Research Electronic Data Capture) electronic data capture tool hosted at the study hospital (Harris et al., 2009) of 30 charts. The primary investigator (GC, a PhD student) and a second data collector (VK) who was a research assistant trained by the primary investigator, independently conducted data collection for the same 30 charts to test for accuracy, completeness, and interrater reliability. Observations from the primary investigator and the second data collector were compared and the number of agreements were computed according to an equation that divides the number of agreements by the sum of the number of agreements and disagreements (Politt & Beck, 2004). Cohen's kappa was set at 0.90 and achieved with three separate sets of 10 charts at 0.90 for all three sets.

The data included in the chart audit tool were developed by the primary investigator and were based upon a tool used previously for a similar type of audit (Appendix I). Changes were made following the pilot study prior to the main data collection. Any additional data required for the pilot study patients were collected prior to the beginning of the main data collection. The database was reviewed and verified by a biostatistician to ensure comprehensiveness and alignment with the proposed analysis of the data to address the research questions. The pilot test and any necessary changes (to either the audit tool or database dictionary) were conducted by the investigator with the second data collector.

Study data for Phase 1 were collected and managed using REDCap. REDCap is a secure, web-based application designed to support data capture for research studies, providing (a) an intuitive interface for validated data entry, (b) audit trails for tracking data manipulation and

export procedures, (c) automated export procedures for seamless data downloads to common statistical packages, and (d) procedures for importing data from external sources.

Main Study

Charts for this retrospective chart review included those patients identified in the target population of children who met the eligibility criteria outlined above. Data on the nature and frequency of pain assessment and management administered during the time from the event occurrence until the patient was discharged from the ED were collected. Where pharmacological pain management was not administered in this time frame, it was necessary to search in the patient's chart to find out when and where (i.e., which in-hospital unit) the first opioid analgesic was delivered. A flow chart for data collection was developed. Data were collected by the investigator from EPC using the audit tool with support from the trained data collector as necessary and entered directly into the REDCap database described previously.

The investigator was given an identification number from the REB at the study hospital allowing access to the selected records electronically. Data were collected from patient records meeting the inclusion criteria and manually entered into the computerized REDCap database by the investigator or the investigator's assistant. An existing trauma database within the study hospital trauma unit contained much of the data required for the proposed research (e.g., age, gender, number of injuries, type of injuries, ISS, mechanism of injury). Access to this database became available once REB approval was obtained.

Measurement Tool

A measurement audit tool was modified from an existing tool used for a similar type of audit conducted at the study institution examining pain assessment and management practices in children with sickle cell disease crisis (see Appendix I). The dictionary of injuries used was that

of the trauma data base manager who collects injury data routinely for the trauma unit at the study hospital; these data were already extracted and considered to be accurate and comprehensive since the data were gathered and reported for the trauma unit at the study hospital on a regular basis.

Data Management

The database was password protected and accessible only by individuals approved for collecting and analyzing data, including my PhD supervisory committee members and any individuals employed for data collection or analysis (e.g., the biostatistician). Data were kept within the REDCap database recently adopted by the study hospital for the use of data capture for research. One master list that included subjects' coded identification numbers and medical record numbers (MRN) was kept in the investigator's computer in a file separate from the data, consistent with privacy legislation at the study hospital and its affiliated university. Approval from the study hospital, explained fully during the REB application process, was necessary for any data to be held outside of the study hospital.

Data were entered into the REDCap database and categorized by the VK and GC according to codes developed by the investigator. For a categorical variable such as the gender of a child, male subjects were entered as 0, and female subjects were entered as 1. For a continuous variable such as the date of the event, the number of year, month, day, and time were entered as numerical values.

To reduce the incidence of errors, the investigator collected some of the data with assistance from one research assistant (VK). Detection of errors was done by (a) closely examining outliers from the means and medians; (b) searching for empty fields and rechecking these for accuracy; (c) searching for inconsistent data values (Chapman, 2005); (d) direct data

entry to the electronic data base; and (e) setting up minimum/maximum values for each variable as well as logic checks.

Data Coding

A dictionary was developed specifically for this audit. It included data entry codes for (a) each type of injury, (b) gender, (c) age, (d) number of injuries, (e) medications, (f) year, date, and time of injury, including length of stay in the hospital ED, (g) mechanism of injury, (h) procedures conducted in the trauma room, (i) hospital unit where the patient was admitted, and (j) whether the patient arrived via the direct or indirect route to the study hospital (see Appendix J). The dictionary was used to enter data collected from the electronic patient chart (EPC) directly into the REDCap database. Utility of the dictionary for statistical analysis was verified by a biostatistician and was used in the pilot study to further test its utility. A unique identifier was used to prevent identification of any participants and all other data related to specific charts. The unique identifier (UID) naming system comprised a numbering scheme based on the year, month, day, and enrolment order of the study. The number of injuries was calculated by adding up each separate injury described by the trauma database manager; the abbreviated injury scale (AIS) was not in use at the study hospital at the time of the present research (see Appendix K for definition of terms).

Missing Data

In the emergency care environment, which is marked by urgency and time constraints, data may fail to be entered into the chart document and therefore be missing. In the database, data known to be missing were identified by a specific number (e.g., 999). If more than 10% of the data was missing, the medical record would have been deemed ineligible for inclusion in Phase 1 of the study. However, the pilot indicated there were no children affected by this missing

data criterion. Additionally, nonoccurring data (e.g., if the child did not suffer an eye injury during the traumatic event) were identified in the database with a different number (e.g., 0000).

Data Analysis

Descriptive statistics (i.e., frequencies, ranges, averages and standard deviations) were computed to describe (a) participant demographic data (i.e., age, gender, mechanism of injury, and types of injuries); and (b) the nature and frequency of pain assessment and management strategies. Specifically, the types and frequency of validated or nonvalidated pain assessment tools and narratives utilized, pain intensity scores, and the types and frequency of pharmacological, physical, and psychological pain interventions were reported. Tools considered as validated pain assessment tools for this research included the NRS (Berry & Huskisson, 1972), the Wong-Baker FACES Pain Rating Scale (Wong & Baker, 1988), and the Coloured Analogue Scale (Scott & Huskisson, 1976). Tools considered as validated pain assessment tools for children unable to verbally communicate their pain in this research were observational (behavioural). Validated pain assessment tools included the Face Legs Arms Cry Consolability Scale (FLACC; Merkel, Voepel-Lewis, Shayevitz, & Malviya, 1997); the composite Children's Hospital of Eastern Ontario Pain Scale (CHEOPS; McGrath et al., 1985), and the Premature Infant Pain Profile–Revised (PIPP-R; Stevens et al., 2014).

Multiple regression analysis was conducted to determine the influence of the child and situational factors on the nature and frequency of pain assessment and management. A survival analysis regression model was constructed with the dependent variable (i.e., average time to administration of first opioid analgesia) determining the relationship with child factors (i.e., age, sex, number of injuries, types of injuries, mechanism of injuries, ISS) and the situational factors

(i.e., whether a child was transferred from another hospital, admission unit upon leaving the ED, and whether pain treatment was provided in the pre-hospital or ED settings).

Ethical Considerations

Any research involving children is considered by research ethics boards to be highly sensitive in nature. All data for this audit were considered sensitive because they involved children in devastating and tragic situations. The use of unique identifiers and codes for these situations or events ensured maintenance of privacy. The data collection process was in accordance with Personal Health Information Protection Act (PHIPPA) legislation, required by the study hospital. The primary investigator along with the doctoral supervisor and committee members had completed the second edition of the Tri-Council Policy Statement (TCPS-2) (Canadian Institute of Health Research, 2010) training required by the study hospital.

Timelines

Arrangements for both scientific and REB approval at the study institution took place immediately following the proposal approval and took four months. A separate administrative ethical review was obtained from the University.

Significance

Pain measurement and management in this specific patient population has not been adequately researched. The knowledge generated from this study offers critical insight into the pain experienced by these children that has not yet been measured in a careful, focused, or meaningful way. While the severe acute pain of the pediatric trauma patient cannot be completely eliminated, a thorough examination of pain practices could potentially modulate the pain that is likely associated with much suffering in these children. From these data, intervention studies targeting children, parents, and HCPs could be developed to improve the status of pain

assessment and management in this patient population, with the ultimate outcome of relieving suffering and its associated consequences. Additionally, development of pain practice guidelines could be initiated and implemented for the pediatric trauma patient.

Phase 2

Study Design

Phase 2 was a prospective qualitative design within the critical social paradigm. Semi-structured interviews were conducted to capture the perceptions of the pain experience of pediatric trauma patients and the HCPs caring for these children. Interviewing individuals was the point of entry to their perceptions, according to the critical realist standpoint.

Study Setting

Children. Phase 2 took place at the same university-affiliated, urban, tertiary care hospital as Phase 1. The interviews of eligible pediatric trauma patients took place in-hospital on the admission unit of the study hospital. Pediatric trauma patients were commonly transferred to the same in-patient trauma unit in the study hospital, although they could be transferred to other in-hospital units. Aside from observation rooms that housed several patients requiring specialized close nursing observation, each child had a single room. The children were comfortable conducting the interviews in their room.

Health care providers. A convenience sample of HCPs from the hospital ED directly caring for pediatric trauma patients at the study hospital were interviewed. These health care providers consisted of a diverse group of professionals including (a) nurses; (b) physicians from several subspecialties (i.e., emergency physicians, anaesthetists, general surgeons); (c) chaplains; and (d) child life workers. Individual interviews with at least one person from each professional

group were conducted in a private setting (e.g., small offices at the study hospital) at the workers' convenience.

Study Sample and Inclusion Criteria

Children. Initial inclusion criteria included children who (a) were registered in the ED; (b) had the trauma protocol, or Code 50, initiated; (c) were English speaking; (d) were more than 8 years of age; (e) had a GCS score ≥ 12 at the time of initial injury; (f) had not experienced loss of consciousness at the time of initial injury; and (g) were deemed medically and surgically stable after their injuries by the responsible physician (two to seven days after admission to the in-hospital unit). Different age criteria were necessary for Phase 1 and Phase 2 given the different data collection methods. Children aged 0 to 7 years were not included in Phase 2 due to the difficulty interviewing children younger than the age of 8 years. Phase 1 age groups included a broader age of children that aligned with pre-school, school-age, and adolescent age groups. The ages of children in Phase 2 aligned with later school-age and adolescence to accommodate conduct of interviews. Children younger than 8 years of age have been shown to be cognitively and emotionally developmentally less capable of communicating their needs (Bieri, Reeve, Champion, Addicoat, & Ziegler, 1990; Reich, 2000; Stanford, Chambers, & Craig, 2005; Thompson & Varni, 1986) were not included in this study.

Due to the inability of recruiting a sufficient number of participants who met the inclusion criteria in a reasonable amount of time (e.g., no patients were recruited for the four months between October 2013 until February 2014), an amendment was successfully sought to broaden the inclusion criteria for children. The delay in recruitment was initially thought by the TPCC to be due to the seasonal pattern of Code 50 admissions observed at the study hospital. Commonly pediatric trauma patients are admitted more frequently during the summer and winter

(when there are more outdoor activities) and are admitted less frequently in the spring and fall. However, when the time period without patient recruitment became prolonged the investigator examined the detailed records kept of all excluded patients and a decision was made to change the inclusion criteria to increase enrolment. This change in criterion was made with the support of the dissertation committee. Additional revised inclusion criteria included children who (a) had the trauma protocol Trauma 1 (more severe injuries) or Trauma 2 (less severe injuries); and (b) experienced no, a brief period, or a questionable period of loss of consciousness at the time of initial injury. The trauma protocol at the study hospital changed during the course of the research period, from all trauma patients being classified as a Code 50 to their being classified as either Trauma 1 or Trauma 2. This change in classification reflected the inclusion of emergency physicians in the trauma management process; emergency physicians are now charged with leading the trauma team in management of Trauma 2 patients.

Health care providers. HCPs eligible for this research all attended to pediatric trauma patients arriving in the hospital ED as part of their employment, and had been employed as regular full- or part-time staff members for at least one year.

Exclusion Criteria

Children. Children with pre-existing cognitive impairment(s), defined for this research as any condition that would impede the child's ability to effectively communicate with the researcher during an interview, were excluded. Children with life-threatening conditions, defined in this research as any physical condition that rendered the child physiologically or psychologically unstable to withstand an interview, were excluded. The decision about whether to interview the child using these criteria was made by the TPCC. Additionally, children who did not speak English were excluded due to their inability to communicate during the interview.

Health care providers. Individuals who infrequently attended Code 50s at the study hospital (i.e., had attended to less than three Code 50s) were excluded, to ensure that only participants with a comprehensive understanding of how Code 50s transpire were interviewed. HCPs did not have to have cared for any of the children specifically taking part in Phase 2 of this research.

Sampling Approach and Sample Size

Children. A purposive sampling technique was used to ensure adequate samples of children who were older (12 to 18 years) and younger (8 to 11 years), with the intent of interviewing 10 in each age group. As the purpose of this study was to attain a new and deeper understanding of the pain experience of these children, sample size depended upon the quality of information obtained (Sandelowski, 1995). Sample size was guided by the principal of saturation, that is, when no new themes emerged from interview data, which is usually between 10 to 20 subjects (Morse, 2000; Rowan & Huston, 1997). Because there were 140 to 200 Code 50 trauma patients per year in the trauma room at this hospital ED, the timeline estimated to assemble enough participants was six to 12 months, recruiting one or two participants per month.

Health care providers. The same purposive sampling technique was used for the HCPs as with the children. A sample was sought of 10 to 20 subjects with at least one individual from each group of HCPs who cared for children in the hospital ED as part of their employment requirement.

Feasibility

Phases 1 and 2 took place at the same hospital. It is a major pediatric trauma centre, with an appropriate sample population. Similar types of qualitative studies, requiring in-depth interviews with bereaved parents who have lost children to suicide, malignancy, cystic fibrosis,

among other acute and chronic conditions, indicate high participation rates of 70% to 95% (Hynson, Aroni, Bauld, & Sawyer, 2006; Dyegrov, 2004). However, the acute nature of the medical, surgical, and psychological fragility of the patients resulting from traumatic injuries and their associated distress could have made conducting an interview a potentially challenging endeavour, depending on the clinical condition of the child. Based on the participation of similar types of qualitative studies, and taking into account the acute and recent nature of the ordeal trauma patients had endured, it was anticipated that it was reasonable to expect a participation rate of at least 25% (or two to five per month), given that the sample size would be smaller when younger children were excluded. Researchers often anticipate that children experience adverse effects when being interviewed about traumatic experiences, but evidence suggests that this is not so (Reich & Kaplan, 1994; Zahner, 1991). Additionally, the value of information children gave when questioned about sensitive emotional problems—specifically children aged 6 to 11 years—was found to be of very high quality (Zahner, 1991).

Data Collection Procedures

Once ethics approval for Phase 2 was obtained from both the hospital and university REBs, a working relationship with leadership staff on the inpatient trauma unit was established. Several information sessions were held with staff, outlining the objectives and purpose of the study. A general information letter was given to front-line staff members by the investigator (Appendix L).

Recruitment of children. In the initial REB proposal, it was stated that a neutral person, such as the trauma patient care coordinator, would approach patients and their parents using a letter with a brief standardized study explanation (Appendix M). Meetings with the trauma patient care coordinator (TPCC) and the social worker assigned to the trauma unit were arranged,

to define a process for identifying eligible study participants. A checklist with inclusion and exclusion criteria was developed for screening all trauma patients who came into the study hospital's in-patient trauma unit for eligibility for the study. All checklists were given to the investigator for analysis and record-keeping purposes.

If the parents agreed to learn more about the study, the investigator then fully explained the study procedure and its rationale to the parents and children, obtaining written consent and/or assent from the children after explanation of the study had been given, as well as getting consent for audiotaping the interview. The TPCC determined from the chart if there were any special considerations such as trauma to a family member during her screening for study participants. The TPCC acted as a liaison between the trauma patient's family and the hospital care providers, and coordinated all care related to pediatric trauma patients at the study hospital. No data were collected from the chart. Once patients were considered stable, according to recommendations from the TPCC on the unit, on approximately day two to seven after the traumatic event, the interview took place at a time convenient for the children and their parents.

It is now widely accepted that children do not reach full linguistic maturity until they are about 6 to 10 years of age, at which point they commonly use verb tenses, word order, and sentence structure in an appropriate manner. It has been found that cognitive development is directly related to the development of pain perspectives and age (Crow, 1997; Harbeck & Peterson, 1992; Stanford et al., 2005). These assumptions underlay the decision to ensure that younger children (8 to 11 years) and older children (12 to 18 years) were both included in the interview sample, thereby attaining a study sample representing both stages of development.

Interviews took place in the patients' rooms on the trauma hospital unit. Most of the patients had a private room, which provided quiet and privacy. Children were asked if they

wished to have a parent present. If they did not wish to have a parent present, the investigator was prepared to sensitively and diplomatically explain to the parent that sometimes children would be more honest and relaxed if they were interviewed alone. However, if the children wanted their parents to stay, or if the parents refused to leave, these requests were accommodated. Demographic data on all child factors from all study participants were collected by asking questions directly of the participants. Questions for the interview more based on several of the dimensions of narrative elaboration. Appropriate questions, relating to guidelines suggested by the narrative elaboration approach espoused by Saywitz and Snyder (1996), were used.

Narrative elaboration, a technique that enhances recall of events, is used to interview children in the legal system (Saywitz & Snyder, 1996). Retrieval strategies are organized to enhance recall of the event. A sequence of questions is posed about the event that addresses participants, settings, actions, affective states and/or conversations. The strategies can be aided by visual cues. For example, one strategy is to talk about all the people involved in the incident. Drawings have been used to better understand how children construct meanings and can be used to “talk” to others about their world (Angelides & Michaelidou, 2009). Thus, having younger children draw a picture may be used as a strategy to help the child feel more comfortable with the interview process.

To avoid fostering an attitude suggestive of juvenile ageism, a proposed generative mechanism for the present research, extra efforts were made to attenuate feelings of authority over children during the interview process. To minimize the power differential in a one-on-one interview, strategies such as engaging the child in role playing, taking turns interviewing each

other, and avoiding elicitation of the “correct answer” were used to help create more natural settings for the interviews (Eder & Fingerston, 2001).

Other strategies used to minimize the power differential included talking with children and their parents prior to the interview so they could get to know the interviewer in an informal way. Engaging children in conversation about subjects other than their trauma can help the researcher gain a level of trust with the child and their family. The children were also encouraged to try using the tape recorder with their parents and to play the recording back, thereby familiarizing themselves with the process for the interview. Finally, the children encouraged to turn the digital recorder on and off as the interview started and ended. If the parents were present during the interview, scaffolding was encouraged as a strategy to help enrich the interview. (Scaffolding is a technique whereby parents helped identify characters, words, or concepts for their child to help them communicate with the interviewer without directing the topic; Irwin & Johnson, 2005).

The interviewer ensured that the children were clearly aware that the interview was voluntary and that at any point they could stop the interview. It was emphasized that the children had total control over how and when the interview took place. In case the need for emotional support arose that was beyond the abilities of the parent and investigator to deal with during the interview process, the investigator and the trauma nurse coordinator on the unit arranged for psychological support by a professional who agreed to provide such counsel. This was a condition of REB stipulating that written and formal support be provided by senior management of the social work department at the study hospital if required. Written formal support was obtained before the interviews. In the event parents became very upset during the interview process (e.g., if a child described occurrences the parents had not been aware of), it was planned

that immediate assistance would be sought from the child's nurse and, if necessary, the TPCC. The patients and family were also asked if it was acceptable to them to come back for further inquiry in the event the interview was interrupted for medical procedures or if they required a break from the interview process.

The investigator made arrangements with the patients and their families to follow up the day after the interview to see whether the patients required further emotional or psychological support. It was understood that, should emotional or psychological support be required, it was the responsibility of the investigator to inform the trauma care coordinator immediately of any concerns. However, during the course of the interviews, emotional and/or psychological support was not necessary for any of the patient or parents.

Recruitment of health care providers. The investigator approached eligible HCPs individually, and explained all aspects of the research to them. Their written consent was obtained at that time. All interviews were audiotaped with permission and written consent was obtained for the audiorecording of the interviews. (see Appendices N, O, P, and Q for all consents and assents.) HCP interviews took place at a time convenient for the HCPs, who were informed that they could stop the interview at any time should they feel necessary.

Interview Guide. *Children.* It was anticipated the interviews would take approximately one hour. A semi-structured interview guide (see Appendix N) was used. The questions were organized to yield information within the *real* layers of reality and the generative mechanisms that lay therein that, according to the critical realist (Bhaskar, 1998), are related to the social concepts and social sphere that have an impact on behaviour in all humans.

Questions for the interview were developed with the aim of engaging the children in conversations about their pain experience from their recent trauma event in order to answer the

research questions of this study. The first question posed was “Tell me about your accident.” Several other questions related to organizational culture and provided answers that were meant to contribute to the culture within the trauma room of the study institution. One question, for example was “Can you tell me about how the pain was when you first arrived at the hospital?” This question was designed to draw the children’s attention to the initial encounter with the hospital environment, providing a sense of what it had been like for them to come into that environment from the scene of the traumatic event.

To address the theoretical concepts proposed as critical to understanding the pain experience of a child, questions were posed to explore the concept of how they felt they were treated by HCPs during their trauma journey (e.g. asking about the relationship with the HCPs they encountered in the pre-hospital or ED settings). One question, for example, was “Can you tell me about the time you first received some medicine to make the pain better?” Detection of interactions with an inattentive HCP that made the child feel they were not listened to could indicate the presence of attitudes indicative of juvenile ageism.

Several of the interview questions could address the theoretical concept of *habitus* (Bourdieu, 1988), by asking about attributes of HCPs which the children associated with their personal feelings about pain and injury; for example, “Who would you tell your friend helped you the most with your pain?” Some of the questions posed could provide answers that may detect power differences between patients and HCPs, and could draw out responses related to the concept of *symbolic violence*. One such question was “Can you tell me about the time you first received some medicine to make the pain better?” The intent of this question was to determine whether the children felt they were made to wait for help with their pain, thus inferring a sense of power being exercised over them in spite of their immediate need for pain relief.

Health care providers. It was anticipated that these interviews would take approximately one hour. As with the children, the questions in the interview guide for HCPs were organized to yield information within the *real* layer of reality that, according to critical realists, was related to the social concepts and social sphere that have an impact on behaviour in all humans. Interviews with HCPs were of a professional nature, with minimal need for particular techniques required to obtain information. Questions in the interview guide were framed to yield information pertaining to how the HCP perceived their patient's pain experience (e.g., do you feel children with multiple injuries experience a lot of pain?), whether the HCP felt their organization responded to pain care (e.g., how do you feel pain assessment and management practices at your institution are administered?) and what they felt about the approach to pain management during acute trauma care (e.g., how do you think trauma algorithms affect pain assessment and management practices for these children?). Many of the concepts that lay at the root of the interview questions, such as the generative mechanisms proposed (e.g., juvenile ageism), will not be within the realm of awareness of the children or the HCPs interviewed for this research. It will be necessary to abstract the concept from the interview data when analysing answers to the interview questions. Some abstraction will need further clarification through future research. For example, since only two of the nine children perceived inattentiveness of HCPs when they mentioned the children could not receive pain interventions until they got to the hospital or because they were not yet eighteen years of age, future research should pursue the notion of juvenile ageism as a generative mechanism.

Data Management

Audiotaped sessions were transcribed verbatim by a transcriptionist who was hired and trained by the investigator. The transcriptionist was required to sign a confidentiality agreement

as per hospital policy. After signing the contract, the investigator highlighted the sensitive nature and magnitude of confidentiality of the data to the transcriptionist, and indicated that any discussion should only take place with the investigator and her thesis committee. Electronically transcribed scripts and paper copies were then kept in a locked and secure office at the study hospital identical to conditions previously mentioned for the Phase 1 chart audit data, ensuring a two-lock procedure was in place. Each audiotape was duplicated and an electronic copy was made should deletion occur accidentally. Should any participant or parent of the participant refuse to be audiotaped, the investigator planned to write field notes at the time of the interview. Field notes are commonly written as close as possible to the time of observation but can be left up to the discretion of the investigator (Mulhall, 2003). A decision was made *a posteriori* to include the interview field notes as reliable data.

Data analysis. Fundamental differences about the nature of knowledge between quantitative and qualitative paradigms exist (Morse, Barrett, Mayan, Olson, & Spiers, 2002). Distinguishing features of qualitative data analysis concern explaining and interpreting data and require intellectual and conceptualization processes to transform the data into a meaningful understanding (Thorne, 2000). Constant comparison analysis generates thematic development, guiding the way to an understanding of the phenomenon under study—in this case the pain experience of the trauma patient—including the social processes involved in coping with it (Boeije, 2002; Thorne, 2000). After each interview, the investigator assessed the necessity of whether or not interview questions required changes depending upon the responses of the children and HCPs. If a particular question yielded answers that were rich in qualitative data, it was imbedded in future interviews. The generation of new descriptions and conceptualizations of a phenomenon comprise the major goal of and qualitative analysis. The cognitive processes in

qualitative research involve comprehending the phenomenon under study, compiling a picture of it that includes relations and theorizing about how these relations have evolved and function, and then putting the new knowledge back into the context of existing knowledge about the phenomenon.

The aim of descriptive content analysis is to attain a condensed and broad description of the phenomenon under study. The outcome of the analysis results in concepts or categories describing the phenomenon. Since this research was exploratory in nature all data were included in the development of categories; no data were left out of the description. Typically the purpose of articulating those concepts or categories is to build a model, conceptual system, conceptual map or categories (Elo & Kyngäs, 2007). In the present research the purpose of developing categories was to map data to generative mechanisms related to critical realism. Sandelowski (2000) suggests that qualitative content analysis moves into the domain of interpretation since there is an effort to understand both manifest and latent content of data. Sandelowski also proposes that variously hued, toned and textured studies are not to be confused with misuse of methods or techniques in qualitative content analysis. In order to provide a summary of events qualitative description was used in this research in order to stay close to the data.

From the qualitative description of the data, tenets of critical realism and the proposed generative mechanisms were used to draw out evidence of underlying causal structures that connected to the empirical observations. This approach differs from using critical realism as a methodology and was used in the present research to capture the essence of what the children and HCPs interviewed were attempting to express. Since very little is known about the subject of pain assessment and management in the pediatric trauma patient I felt a qualitative descriptive

approach was a necessary prelude to further inquiry and analysis. Additionally, I felt that use of one specific theoretical model would disproportionately influence data interpretation.

Another fundamental analytic process in qualitative research, differentiating it from quantitative research, is its reflexivity. Reflexivity in qualitative research begins with identifying the investigator's assumptions that may enter into the research. As an investigator, it is necessary to be aware of one's own views and assumptions of the research topic because these views constitute a lens through which she makes observations. Reflexivity also helps the researcher appreciate that the observations made are really interpretations of these observations (Hsiung, 2008). Reflexivity guards against shallow, overgeneralized writing that can be influenced by institutional, personal, epistemological and ontological factors that might overwhelm one's ability to gain insight into the data; it allows for the researcher to examine her preconceived perceptions. The steps used to conduct a qualitative constant comparison analysis for Phase 2 were, respectively: coding, development of meaning codes, grouping of subthemes, and development of themes.

In addition to data coding that aligns with qualitative data analysis processes in general, the critical realist is searching for demi-regularities in data coding. Demi-regularities are tendencies or patterns that emerge from the empirical data and are the beginning of abduction and reduction according to critical realist (Fletcher, 2016). Provisional codes were developed using a deductive coding process and subjected to three coding cycles that resulted in a reduced number of codes. The codes were then mapped to themes informed by critical realism. Critical realism is marked by engaging in existing theoretical constructs prior to coding. The coding for this project was directed and mapped to the generative mechanisms proposed as explanations for the pain treatment in pediatric trauma patients (see Appendix O). In this research I did focus on

the construct of pain, including the physiological and psychological aspects of pain, and the perceptions of the children and HCPs interviewed. The lens of critical realism was applied in order to further understand these perceptions.

All codes were vital in understanding the pain experience of the pediatric trauma patient and the HCPs who provided care to them. Dominant codes are often considered starting points for identification of demi-regularities. One important demi-regularity was the immediate severe pain expressed by the children (as they experienced movement through the transport process and procedures during the trauma assessment process) that was not efficiently addressed. This irregularity lay in contrast to the trauma algorithm of care that is widely accepted as the best approach to care but which lacks intent to manage pain from a possibly huge nociceptive event.

Another demi-regularity was the lack of awareness of the state of pain treatment for pediatric trauma patients on the part of the study hospital's organizational culture, a well-known international leading regional pediatric trauma center. That pain care has not been well addressed for these patients, as proven by qualitative interview data from both the children and the HCPs and further supported by the quantitative measurements of time indicating the overall sample of children in Phase 1 waited a median of 99 minutes to administration of first opioid analgesia, is not acknowledged as a clinical problem in the study hospital. It is clear the study hospital accepts the trauma algorithm of care as the optimal approach to care for their trauma patients. However, adoption of the algorithm is widespread and changes to it would require awareness, further research, and cooperation from many parts of the world and not just the study hospital. In this research, the participants' perceptions of pain assessment and management for pediatric trauma patients challenges the trauma algorithm in providing optimal care to this patient population. Identification of demi-regularities such as these paves the way to abduction

and retroduction processes which critical realists use to divulge generative mechanisms (Fletcher, 2016).

Coding. In Graneheim and Lundman's (2004) approach, selection of the unit of analysis is one of the most basic of required decisions. A meaning unit, commonly referred to as a code, refers to a constellation of statements that relate to some central meaning. Possibilities for units of analysis, other than interviews, include diaries, people, programs, classrooms, or anything that refers to the context for the meaning unit. Codes are tools that can be used to help the researcher think about the interview data. In this study, the unit of analysis was the interview, and the codes concerned the patient's experience as it related to their traumatic event with emphasis on their pain experience. Attempts were made to shorten the text while keeping the central meaning of the text. This process is referred to as *condensation* (Graneheim & Lundman, 2004). Further condensing these shortened texts, with an emphasis on description and interpretations at a higher level of logic, is labelled *abstraction*.

Meaning of code. Content areas are parts of the text that refer to a specific domain. These areas of topic or domains comprised attempts to get at the root of the children's thoughts and their inner experiences of pain.

Development of subthemes. The areas of topic or domains were further grouped into categories—i.e., subthemes—that shared a common thread. These common threads extended throughout the interview or an entire set of interviews and were general in nature (DeSantis & Ugarriza, 2000).

Development of themes. Themes were developed from commonalities that recurred throughout the different subthemes. Getting to the root of the children's thoughts by analyzing themes from interview data provided insight into the inner experience of pain or the encoding of

pain. In this study, both manifest and latent levels of analysis (Graneheim & Lundman, 2004) were conducted. Manifest content refers to the visible and obvious components of the data while latent content refers to a deeper interpretation of the underlying meaning of qualitative data. Analysis of the transcribed data was supported by NVivo 10.0 software and began immediately after the first interview. Using a constant comparative analysis approach, analyzed interview data were considered for subsequent interviews as the analysis was built; themes emerged with each interview conducted, and the interview guide was modified as necessary.

Abduction is a process in which empirical data are re-described using theoretical concepts (Danermark, 2002). A key finding of the empirical data from the interviews and chart review indicate that pain assessment and management is not optimal for pediatric trauma patients. Using the theoretical constructs of juvenile ageism and symbolic violence to get at the causal mechanisms transcends description and raises the level of theoretical engagement.

Juvenile ageism is evident by the overall actuality of longer periods of time to first opioid analgesia for children when compared to adults. A decade ago, Neighbor et al. (2004) cited the median wait time to first opioid analgesia for adults as 77 min. That time period in pediatric trauma patients in the present research is a median of 99 min to first opioid analgesia and, when compared to the 2004 data from Neighbor et al., is still indicative of a delay. That this delayed time period time period to first opioid analgesia is unchallenged is suggestive of juvenile ageism. Additionally, the delays in taking some of the children's injuries seriously shows that they were not listened to as closely as they should have been and possibly would have been if there were an adult.

Symbolic violence is manifest through the placement of pain assessment and management as a lowered priority within the trauma algorithm of care. Pain therefore assumes a

position of a reduced priority and delays in pain care become systematic and obscured.

Acceptance of the trauma algorithm of care as best practice and the primary approach to care for trauma patients brings with it inherent delays in pain management. The imperative use of this approach to care has obvious advantages in the provision of life saving priorities; however, incorporated within this approach is the potentially harmful lack of attention to pain.

Retroduction focuses on the causal mechanisms and conditions that allow the causal mechanism to take effect resulting in the empirical trends observed. Conditions that lead to the empirical trends seen in both the quantitative and qualitative data that both suggest oligoanalgesia for the pediatric trauma patient, originate within the larger societal realm of reality. Children are thought of in a certain way by adults (juvenile ageism) and the algorithm of care does not place pain as a competing priority (symbolic violence). The condition of the traumatic event that brings together these two causal mechanism paints the picture of pain assessment and management for the pediatric trauma patient. The weighted summary of each individual HCP and child within the trauma room carries the past experiences of each person thereby opening the instance of care to the myriad of influences seen in an open system. Organizational culture ensures the status quo for trauma care is maintained by adhering strictly to algorithm of care that requires re-certification every 2 years as a condition of employment at the study hospital. How the generative mechanism map on to the interpretation of findings can be visualized in Appendix O.

Analytic and Data Management Strategies

Integration and Triangulation

Integrating mixed methods data is the centerpiece of mixed methods study designs (O’Cathain, Murphy, & Nicholl, 2007). A well-established method to integrate is within a

discussion where the separate results of quantitative and qualitative data are discussed.

Integration of data in a mixed methods convergent parallel design describes the extent to which the qualitative and quantitative findings cohere (Fetters, Curry, & Creswell, 2013). Integration of data is accomplished in this research through a narrative merging of the databases during analysis and discussion.

Triangulation in research is the use of more than one approach to researching a question with the objective of increasing confidence in the findings through the confirmation of using two or more independent measures. The combination of findings from two or more rigorous approaches provides a more comprehensive picture of the results than either approach could do alone (Heale & Forbes, 2013). Methodological triangulation is the most common type of triangulation. Studies that use triangulation may include two or more sets of data collection using the same methodology, such as from qualitative data sources. Alternatively, the study may use two different data collection methods as with qualitative and quantitative. Triangulation may also include the use of multiple theories, data sources, methods or investigators (Archibald, 2016).

In this research both methodological triangulation and theoretical triangulation were used. Methodological triangulation was accomplished by using the mixed methods convergent parallel design using both quantitative data from Phase 1 and qualitative data from Phase 2 with the intent of each phase to provide a picture of pain assessment and management for the pediatric trauma patient. Theoretical triangulation was accomplished using three theories to aid in analysis of the qualitative data. The three theories included critical realism, gate control theory of pain and developmental theory.

The goal of qualitative analysis is to derive interpretations and understand the meaning of participant's experiences (Warren, 2001). Warren reminded interviewers to constantly be aware of the perspectives of the interviewer and the respondent; both would be gendered and aged, and each would be thinking about different worlds. The interviewer might be thinking about the research topic, questions, rapport, consent forms, and whether the tape recording was working; and feeling nervous. I experienced anxiety about being a novice researcher. Although comfortable with interviewing parents and children from previous pediatric nursing experience, the research interview process is fundamentally different. Since the children interviewed for this research had just recently endured a traumatic event, emotional stress from the interview process was in the forefront during the interviewing process. Fear about whether the children would become upset with the interview process was always a concern, albeit, in hindsight, unfounded. Participants might be thinking about relationships outside of the interview, or getting help; or they may be feeling pain or hunger. Probing for details and depth of experiences can have an emotional cost, causing stress for the individual (Warren, 2001).

The transcribed interviews for both children and HCPs were loaded into the NVivo 10.0, a computer-assisted qualitative software program. My own process included line-by-line coding with the research questions in mind; I made no attempt to generate themes at the outset. Transcripts were read and reread to ensure completeness of coding. Once codes were identified, Excel spreadsheets were used to organize the data. Several worksheets were created as the coding process moved towards a focused development of subthemes. The worksheets were printed, spread out, and put together in broad thematic groups. Thematic issues were developed using the coding and subthemes as building blocks. In this part of the analysis, process condensation (shortening of the text while keeping the central meaning) from the interview data

was carried out. The final step was to further condense these shortened texts, describing and interpreting the data in a process called abstraction (Graneheim & Lundman, 2004).

Methodological Considerations

Reflexivity as it relates to qualitative research refers to the ability to consider critical relationships that are part of how we write about others (Doucet, 2008). Doucet suggested that three critical relationships require consideration when reflecting on conducting, writing up, and reflecting back on one's research: the relationship with oneself, with the research respondents, and with the audience.

The relationship with oneself and the research is about being haunted by something that, when it appears, instills the necessity to do something about it. Having worked for many years as a pediatric ED nurse, I have always felt that the essence of emergency nursing was caring for the trauma patient. However, I did not often administer or witness the administration of opioids to the many children with trauma. I understood that this was due to an unspoken uneasiness about untoward physiological effects or consequences of administration of opioids that seemed to pervade the staff working in the trauma room setting. Questions about whether the child had received analgesia were rarely stated out loud.

The relationship between the researcher and researched might have been affected by the researcher's assumption that the event the children had endured, or the HCPs borne witness to, was rooted in devastation. But with children, the developmental ability to completely comprehend the seriousness of the traumatic event may not be fully developed. More importantly, the power differential between adult and child in our society dominates the relationship. While the researcher was aware of the power inequality and took measures to minimize this affect, the research participants could not be expected to undergo the same

reflexive process (Doucet, 2008). Despite attempts to mitigate power disparity and being conscious of power imbalance, the researcher had no control over how the researched would feel.

Children and families are approached frequently for research requests at the study hospital; when leaving the room of one of the children interviewed for this research two other researchers were waiting outside that patient's door to see if the family would be interested in other research occurring in the study institution. Numerous requests for research participation could result in fatigue for patients who are already experiencing a significant disruption in their lives, and fatigue from the traumatic event and subsequent hospitalizations. Responses to the research questions posed and interpretation of interview data was undeniably affected by the world view of the researcher being a Caucasian female who, although a parent, had not experienced being the parent of a child who had experienced a traumatic event.

Tension between the audiences this research was intended for might affect the analysis and discussion of its results. The trauma unit staff at the study hospital, the trauma unit itself, the national trauma community at large, and the academic community will receive, evaluate, and perhaps act upon the findings from this study (Doucet, 2008). Anticipation of how the research would be received influences, guides, and changes the way research was written; however, one cannot control how it will be received.

Other assumptions from the investigator's own experience include the notions that children (a) experience intense, acute, severe pain that may emotionally and physically overwhelm them during the pre-hospital and in-hospital experience; (b) experience powerful guilt because they feel the traumatic event may be their own fault; and (c) are less able to articulate these feelings. These assumptions could only be confirmed or challenged through awareness that they might have influenced interpretation and careful analysis of interview data.

The process of reflexivity involves making a deliberate effort to scrutinize the investigator's own self in relation to the research subject (Hsiung, 2008) and taking responsibility for one's own situatedness within the research and the effect it may have on the setting, study participants, questions posed, data collected, and interpretation (Berger, 2015). During the interview process, it was difficult for me to not take into account parent comments, given that they were present during the interviews. Being a parent of a child who has endured a traumatic event appears to be incredibly stressful and, having worked with the pediatric population in the ED for many years, I was aware of the difficulty of separating parent and child in these stressful moments. It was difficult to not take into account the parents' comments during the interview process and I struggled with not including their observations within analysis of data. I was able to set aside my own biases when collecting and interpreting my findings in Phase 1 and 2 by realizing the importance of separating oneself emotionally from the patient and family. From my professional experience working as an emergency nurse for many years I developed the ability to emotionally separate from the situation in order to provide effective care while maintaining empathy for the family. Assumptions that parents would be inextricable from their children was something I was aware of during the design of the project and ethical permission was obtained to have the parents present with the child during the interview if the child so desired; however, the strong bond between the parent and child in reality was difficult to negotiate in terms of parent participation during the interview process. Removal of parent comments during analysis and focusing only on the children's and HCPs interview data allowed me to manage the tension arising from the child and parent dyad; however, given the crucial role parents play in children's lives future research should include analysis of their comments

Practical measures to maintain a balance between the researcher's own experience and that of the participants as suggested by Berger (2015) and used for this research were use of a log to track coding, repeated review of the interviews, and seeking peer consultation.

Trustworthiness, Rigour, and Quality

In any research, there needs to be confidence in the findings (Golafshani, 2003). Reliability and validity in quantitative research are measures of the quality of the research. In qualitative research, comparable terms would be trustworthiness, rigour, and quality. Rigour in qualitative research is addressed by ensuring that the research sample is carefully chosen. In this research, inclusion and exclusion criteria for both Phases 1 and 2 ensured that the patient population selected for study truthfully illustrated the picture of pain management in the pediatric trauma population. To test dependability and trustworthiness in qualitative research triangulation is used. In this research project triangulation took the form of (a) interviews with children with trauma, (b) interviews with the HCPs caring for these pediatric trauma patients, and (c) the chart audit data. All three approaches were credible tactics to use when painting a picture of how children with trauma are treated for pain. Another way to establish credibility was to illustrate analysis and development of themes via charts (Graneheim & Lundman, 2004). Charts outlining how codes, meaning of the codes, subthemes, and themes were developed have been provided in the analysis of the two sets of interviews for this research.

Ethical Considerations

With experiential subjectivity and emotion as the hallmarks of qualitative inquiry, it is emotion that shapes the risk as participants reconnect with the traumatic event. Interviews with children after a major traumatic event may potentially be considered high-risk research because (a) the topic of the interview may be highly distressing; (b) the interview may occur in the midst

of a difficult crisis situation; and (c) the pediatric participant constitutes a vulnerable population (Morse, Niehaus, Varnhagen, Austin, & McIntosh, 2008). Some supports were put in place to avoid harm. They included (a) allowing a parent to attend the interview if the child wished; (b) developing a relationship with the researcher beforehand; (c) having a counsellor on the in-hospital unit in the event one becomes necessary; and (d) giving control over the interview to the child, by allowing him or her to stop at any point. In the review by Morse et al. (2008), most researchers found that the benefits derived from an interview process usually outweighed any risks for the participants, by affording participants the opportunity to talk freely about their experience for the first time. This may help to integrate the experience into their lives. A caveat to Morse et al.'s proposed benefits is that that review referred to an adult population. Caution needed to be the operative in the proposed research because of working with children's pain from traumatic injuries.

Additional considerations to protect the rights of study participants included (a) using a third-party approach informing potential participants of the nature of the study, to gain initial permission to interview them; (b) using informed consent and assent when appropriate; (c) ensuring confidentiality, anonymity, and privacy; (d) proceeding through appropriate review processes including formal ethical review processes at the study hospital and university; and (e) emphasizing that children or parents could stop the interview at any time they wished, and that this would have no impact on the care they received.

All information obtained during the study was kept anonymous by using subject code numbers, as well as by storing all raw data forms in a locked filing cabinet in the investigator's office located at the study hospital. One master list, containing the patient's coded identification numbers, MRNs, is being kept in the investigator's computer, separate from any data. That

computer is password protected, encrypted, and accessible only by individuals approved for collecting data including the investigator's PhD supervisory committee members and any individuals employed for data collection. All consents and data are to be kept for seven years, as per institutional policy for descriptive studies, and then shredded. Participants have been assured that study reports would contain no identifying information. All interviews with children were audiotaped with permission, and written consent for the audiorecording of the interviews was obtained (see Appendixes P, Q, R, and S for consent and assent letters). Audiotapes were clearly labelled with the subject code number and duplicated in case of accidental deletion. Audiorecordings and written consents are kept in a two-lock cupboard at the study hospital.

Timelines

Phase 2 was expected to take approximately one year to complete, since the number of trauma patients was unpredictable and seasonally affected; more trauma events occurred in the summer months. Additionally, an attempt was made to stratify the interview subjects (i.e., obtain equal numbers of younger and older participants), to ensure a fair representation of the younger and older age groups previously discussed. As expected, since consent for interviews with children who met study criteria were difficult to obtain, Phases 1 and 2 of the study were conducted concurrently.

Overall Significance

Currently there is negligible knowledge available to clinicians concerning the nature and frequency of pain assessment and management practices for pediatric trauma patients from the time of injury and in the ED. While it is essential that life-saving efforts hold primacy over pain management at the time of initial injury assessment and treatment, results from this research were designed to determine precisely when pain is addressed in this patient population. It is

possible there may be a prolonged period before pain interventions are offered, potentially prolonging the suffering of these children.

The pain experiences of pediatric trauma patients have not been well addressed in the research previously; nor have the perceptions of the HCPs caring for them. This study has generated new knowledge for this patient population and will inform theory, research, and clinical practice (including education). It is important to know the impact of this type of pain event on children, their families, their future function and development, and any long-term effects that could possibly be identified early that may be associated with this impact. It is equally imperative to tap into the insights of HCPs, as this has provided vital information about how pain assessment and management practices for pediatric trauma patients in the initial stages of care are managed.

CHAPTER 5:

RESULTS

In this chapter, the results from Phase 1 and Phase 2 are reported.

Phase 1:

Nature and Frequency of Pain Assessment and Management Practices

Demographic Characteristics of Pediatric Trauma Patients

The sample consisted of 119 patient records for children admitted to the ED at the study hospital between April 1, 2013 and March 31, 2014 who met the study criteria for inclusion (see Figure 3 and Table 2). Two patients' records of the 119 (1.6%) were excluded due to their traumatic injuries resulting in death, leaving 117 patients; 13 of the 117 (11%) were excluded as they were transported to their local ED by their parents and were ambulatory at the time of arrival to hospital. The remaining 104 children were brought to the nearest hospital via ambulance from the scene of the accident and were assessed for the outcomes of interest; pain assessment/reassessment and pain interventions (see Figure 3). There were two possible trajectories for children to get to the ED at the study hospital; direct and indirect. Children in the direct trajectory ($n = 47$; 45%) were brought from the accident site directly to the ED at the study hospital via the local EMS crew. Children in the indirect trajectory ($n = 57$; 55%) were brought to the nearest local hospital, stabilized, and then transported via a second EMS crew to the ED at the study hospital.

Of the children admitted to the ED at the study hospital for trauma care, 15/104 (14%) were discharged home after assessment and a short period of observation. Median (IQR) length of stay for the remainder of the sample was 4 (2 to 8 days) days and the total length of stay in the hospital ranged from 1 to 67 days.

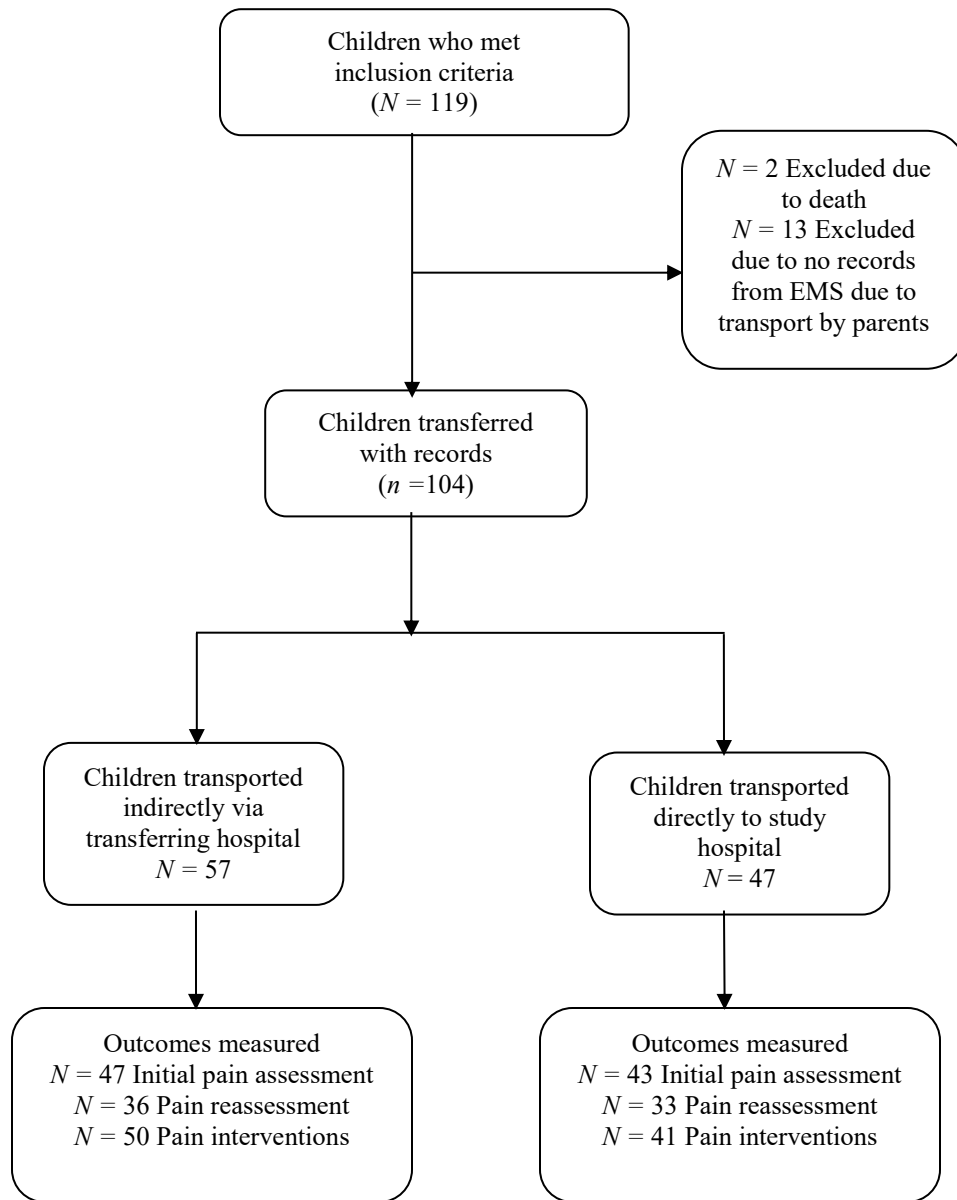


Figure 2. Flow diagram for Phase 1.

The time period (*SD*) from trauma to discharge from the ED at the study hospital ranged from 51 minutes to 1,280 minutes while the average length of stay for the period of time in the ED was 324.4 minutes (*SD* = 173.2 minutes).

The mean age of children was 9.15 ($SD = 4.59$) years (range 1 to 16 years). There was a slightly larger number of females with the trauma protocol triggered ($n = 59/104$, 56.7%) compared to males ($n = 45/104$, 43.3%). The median ISS score was 10 and ranged from 1 to 42; a score of 10 to 15 is considered an indication of moderate injury.

Table 2
Demographic Characteristics of Pediatric Trauma Patients

Characteristic	Overall ($n = 104$)	Direct ($n = 47$)	Indirect ($n = 57$)	Test Statistic	p -value
Gender				$\chi^2 (1) = 0.44^*$	0.51
Female	59 (56.7)	25 (53.2)	34 (59.7)		
Male	45 (43.3)	22 (46.8)	23 (40.4)		
Age group in years, n (%)				$\chi^2 (2) = 0.16^*$	0.92
0 to 5	29 (27.9)	13 (27.7)	16 (28.1)		
6 to 12	46 (44.2)	20 (42.6)	26 (45.6)		
13 to 16	29 (27.9)	14 (29.8)	15 (26.3)		
Age in years, mean (SD)	9.15 (4.59)	9.34 (4.62)	8.99 (4.59)	$T (102) = 0.38^{**}$	0.70
ISS, median (IQR) [min, max]	10 (2 to 17)	5 (1 to 11)	13.5 (9 to 19)	$T (97) = -3.44^{**}$	0.001***
	[1 to 42]	[1 to 35]	[1 to 42]		
Number of injuries, median (IQR) [min, max]	4 (2 to 7)	3 (1 to 6)	5 (2 to 8)	$Z = -2.66^\dagger$	0.009***
	[0 to 13]	[0 to 13]	[0 to 13]		
Mechanism of injury, n (%)				$\dagger\dagger$	0.24
Fall	35 (33.7)	18 (38.3)	17 (29.8)		
MVA	52 (50.0)	24 (51.1)	28 (49.1)		
Struck by object	12 (11.6)	2 (4.3)	10 (17.6)		
Assault	5 (4.8)	3 (6.4)	2 (3.5)		
Type of injuries					
Head/neck/spine	81 (77.9)	39 (83.0)	42 (73.7)	$\chi^2 (1) = 1.29^*$	0.25
Extremities	56 (53.9)	25 (53.2)	31 (54.4)	$\chi^2 (1) = 0.01^*$	0.90
Abdomen	41 (39.4)	15 (31.9)	26 (45.6)	$\chi^2 (1) = 2.02^*$	0.15
Chest	30 (28.9)	10 (21.3)	20 (35.1)	$\chi^2 (1) = 2.39^*$	0.12

Note. SD = standard deviation; IQR = interquartile range; min = minimum; max = maximum; MVA = motor vehicle accident; *Chi-square test of association; **Equal variance two-sample t -test; \dagger Wilcoxon Rank-Sum test; $\dagger\dagger$ Fisher's exact test; *** $p < 0.005$.

There were significant differences in ISS and number of injuries between the pediatric trauma patients in the direct and indirect trajectory groups; children in the indirect group had higher ISS scores (ISS, mean (IQR) = 13.5 (9 to 19), $T (97) = -3.44$, $p < 0.001$) and a greater number of injuries (Mdn (IQR) = 5, (2 to 8), $Z = -2.66$, $p = 0.009$). Using the ISS as a covariate for this research is worthwhile since, if a high ISS is found to be associated with a specific level of pain, then patients with a specific score could serve as an objective indicator around which to

begin providing pain interventions. However, results need to be interpreted with caution (a) given the small sample size and (b) the gate control theory of pain has clearly demonstrated that there is not a direct relationship between the amount of tissue damage and pain intensity. The majority of the children (85%) had suffered more than one injury; they were most frequently involved in an MVA (50.0%). The most common type of injury was head injury.

Nature of Pain Assessment in Pediatric Trauma Patients

From the time of the traumatic event through to discharge from the hospital ED, a pain assessment was recorded for 90/104 (86.5%) children while a pain assessment was not recorded for 14/104 (14%) children. Information about pain assessment and management was found in the formal trauma record written by the trauma team. There were two approaches to pain assessment in the children: validated pain assessment measures and narrative notations. Of the 90 children with a recorded pain assessment, 60 (67%) had an initial pain assessment recorded with a narrative notation, 26 (29%) had an initial assessment done with one of two validated pain measures: the NRS (Downie et al., 1978); or the FLACC (Merkel, Voepel-Lewis, Shayevitz, et al., 1997).

Four children (4%) had an initial pain assessment done with a combination of a validated pain measure and a narrative notation (see Figure 4). The NRS is recommended for children older than 10 years of age; thus, for the 39 (37.6%) children who were less than 10 years of age, it was not an appropriate tool. The FLACC tool was used much less often; however, it was appropriate for the children less than 10 years of age (e.g., critically ill patients; Voepel-Lewis, Zanotti, Dammeyer, & Merkel, 2010).

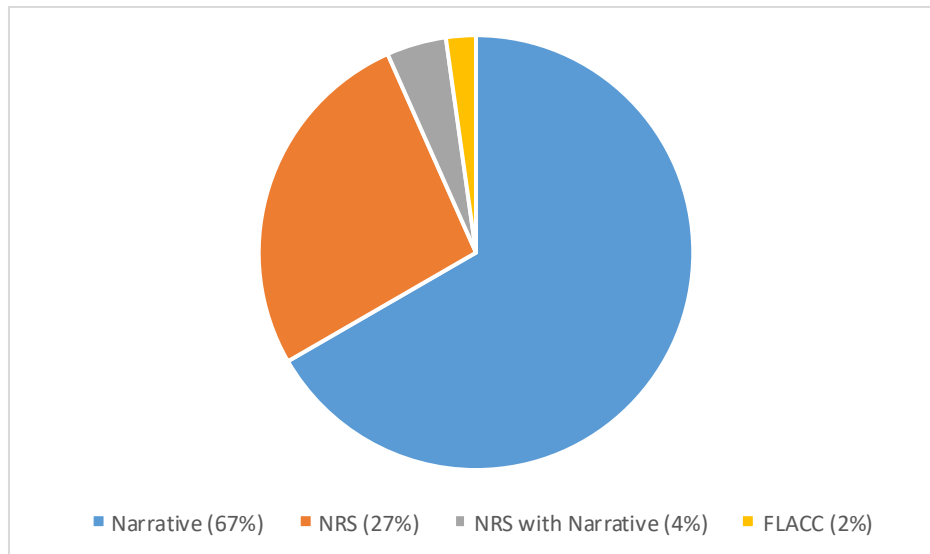


Figure 3. Initial pain assessment measures.

Of the 60 children whose initial pain assessment was recorded using narrative notations, 43 (72%) described only whether pain was absent or present in a specific location. The location of pain assessed or noted most often was the head/neck/spine area and pain in the chest was assessed or noted least often (see Figure 5).

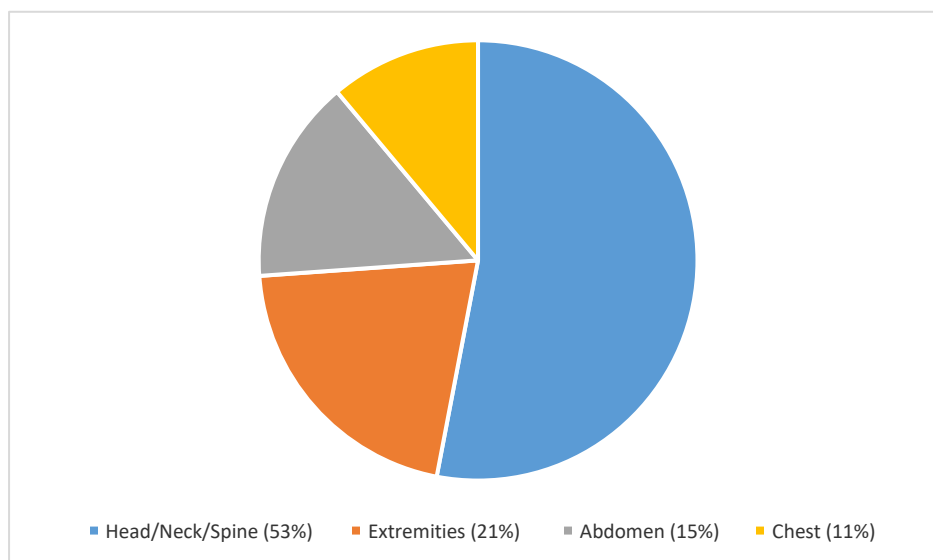


Figure 4. Distribution of pain locations in pain narratives.

Of these 60 narratives, nine included a reference to pain severity or intensity, as a descriptor of the nature of the pain, in combination with its location. Pain intensity and location of pain were noted in two notations: *severe* and *a lot of pain*. The nature of pain was described in one narrative as *radiating*. Three patient narratives were related to movement and pain indicating that pain *increases with breathing*; two of the narratives indicated that pain *increases with respiration* and *increases with movement*; and one narrative reported the patient to be *unable to take a deep breath* due to pain.

Eight of the 60 narrative notations did not identify a location of pain. Pain severity only, without a location of pain source, was noted in one notation: *hurts a whole lot*. Changes in pain intensity only were referred to in four of the notations—*decreased pain*, *partial pain relief*, *pain decreased once splint applied*, *increases with deep inspiration*—with no location of pain specified. Physical expressions of pain without pain location were noted in three notations: *unable to sit or lie sideways*, *agitated and in pain*, *screaming in pain*.

Initial pain intensity scores in the direct trajectory group were higher en route (mean (IQR) = 6.62 (3.10), $p = .035$) and upon arrival at the study hospital (mean (IQR) = 6.78 (3.90), $p = .039$). Clinical guidelines at the study hospital suggest an assessment be done within 15 minutes of arrival to the ED including a pain assessment. With this guideline as a reference children in the indirect trajectory were significantly less likely to receive a pain assessment within an appropriate time; 37/47 (64.9%, mean (IQR) = 70 (27 to 180), $p < 0.001$) children did not have a pain assessment done within 15 minutes of contact with HCP. The time from the trauma event until the initial pain assessment was greater in the indirect trajectory group (median (IQR) = 70 (27 to 180) minutes) than in the direct trajectory group (median (IQR) = 26 (12 to 48) minutes ($\chi^2 (1) = 14.44$, $p < .001$). (see Table 3).

Table 3
Nature of Pain Assessment (PA) in Pediatric Trauma Patients

	Overall	Direct	Indirect	Test Statistic	p-value
Children with PA, <i>n</i> (%)	90 (86.5)	43 (91.5)	47 (82.5)	$\chi^2 (1) = 1.80^*$	0.18
Children with PA en route, <i>n</i> (%)	77 (79.4)	36 (87.8)	41 (73.2)	$\chi^2 (1) = 3.08^*$	0.079
Children with PA at study hospital, <i>n</i> (%)	73 (70.2)	37 (78.7)	36 (63.2)	$\chi^2 (1) = 2.98^*$	0.084
PA with pain tool en route, <i>n</i> (% of those with a pain assessment)				$\chi^2 (1) = 0.48^*$	0.49
FLACC/NRS	31 (40.3)	13 (36.1)	18 (43.9)		
Narrative	46 (59.7)	23 (63.9)	23 (56.1)		
PA with pain tool at study hospital, <i>n</i> (% of those with PA)				$\chi^2 (1) = 2.32^*$	0.13
FLACC/NRS	30 (41.1)	12 (32.4)	18 (50.0)		
Narrative	43 (58.9)	25 (67.6)	18 (50.0)		
Pain intensity en route (initial pain score) mean (<i>SD</i>)	5.17 (3.37)	6.62 (3.10)	4.00 (3.20)	T(27)=2.22**	0.035
Pain intensity at study hospital (initial pain score) mean (<i>SD</i>)	4.56 (3.79)	6.78 (3.90)	3.31 (3.20)	T(23)=2.41**	0.039
Time to PA from trauma, median (IQR) in minutes among those with PA	43 (17.5 to 84.5)	26 (12 to 48)	70 (27 to 180)	$\chi^2 (1) = 14.44^{\dagger\dagger\dagger}$	< 0.001***
Received PA within 15 min of HCP contact				$\chi^2 (1) = 12.72^*$	< 0.001***
Yes	53 (51.0)	33 (70.2)	20 (35.1)		
No	51 (49)	14 (29.8)	37 (64.9)		

Note. PA = pain assessment; FLACC = Faces, Legs, Activity, Cry, Consolability scale; NRS = numerical rating scale; EMS = emergency medical services; HCP = health care provider; SD = standard deviation; IQR = interquartile range; *Chi-square test of association; **Equal variance two-sample t-test; † Wilcoxon Rank-Sum test; †† Fisher's exact test; ††† Log-Rank Chi-square test; *** $p < 0.001$.

Child and Situational Factors Affecting Pain Assessment in Pediatric Trauma Patients

Multivariate analysis was conducted to examine the predictors of time to first pain assessment. Children who (a) had a high ISS, (b) had been struck by an object, or (c) had arrived at the study hospital via the indirect route waited significantly longer to have a pain assessment (see Table 4).

Table 4
Predictors of Time from Trauma to First Pain Assessment

Child factor	Hazard ratio	95% CI	χ^2 (1)	<i>p</i> -value
Age (years)				
0 to 5	0.82	0.39 to 1.69	0.30	0.58
6 to 12	1.05	0.58 to 1.89	0.02	0.88
13 to 16	1.00 (Ref)			
Gender				
Male	1.00 (Ref)			
Female	0.84	0.51 to 1.38	0.45	0.50
Number of injuries	1.04	0.92 to 1.18	0.46	0.50
ISS	0.93	0.90 to 0.97	13.54	0.001**
Mechanism of injury				
Fall	0.58	0.30 to 1.10	2.77	0.096
Struck by object	0.22	0.08 to 0.61	8.71	0.003**
Assault	0.95	0.21 to 4.23	0.01	0.94
MVA	1.00 (Ref)			
Head and spine involved				
Yes	0.86	0.40 to 1.84	0.16	0.69
No	1.00 (Ref)			
Chest involved				
Yes	1.84	0.91 to 3.73	2.85	0.092
No	1.00 (Ref)			
Abdomen involved				
Yes	1.62	0.95 to 2.77	3.10	0.07
No	1.00 (Ref)			
Extremities involved				
Yes	1.6	0.8 to 3.34	2.18	0.1
No	1.00 (Ref)			
Route to hospital				
Direct	1.00 (Ref)			
Indirect	0.42	0.26 to 0.70	11.17	< 0.001**

Note. ISS = injury severity score; MVA = motor vehicle accident; *significant at $p < 0.05$; **significant at $p < 0.005$; χ^2 = Chi-square test of association.

Differences in the times are further demonstrated in the time to first pain assessment graph (see Figure 6). In the Kaplan-Meier curves in Figure 6 the lengths of the horizontal lines along the X-axis of serial times represent the survival duration (time to event) for that interval. The interval is terminated by the occurrence of the pain assessment. The main focus is on the entire curve rather than on the traditional clinical concern with rates at fixed periodic intervals (Rich et al., 2010).

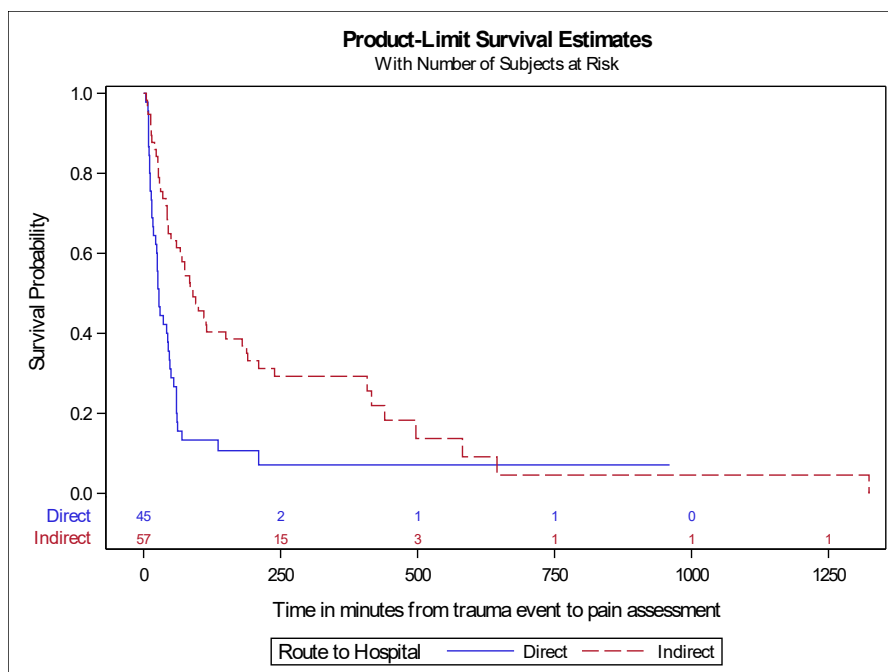


Figure 5. Time to first pain assessment from trauma.

Frequency of Pain Reassessment in Pediatric Trauma Patients

For 10 of the 90 patients with an initial pain assessment, only one pain assessment was recorded, and no record was made of any pain reassessment from the time of the trauma through to discharge from the ED at the study hospital. Of the 80 children with recorded pain reassessments, the median (IQR) number of reassessments was 2 (0 to 4). The median (IQR) amount of time between pain assessments was 15 (9.5 to 40) minutes.

Of the recorded pain reassessments of 80 patients, 42/80 (52.5%) used a combination of validated pain tool and narrative notation. The pain reassessment approach was most frequently combined with NRS (Downie et al., 1978)) alternating with narrative notation; this particular combination was used in 36/80 (45%) of the patients. A singular approach, using one of NRS (27.5%), narrative notation (16%), or the FLACC tool (2.5%), was also recorded. Other combinations used less frequently include varying combinations of NRS, the FLACC tool, the FACES Pain Scale, and narrative notation (see Figure 7).

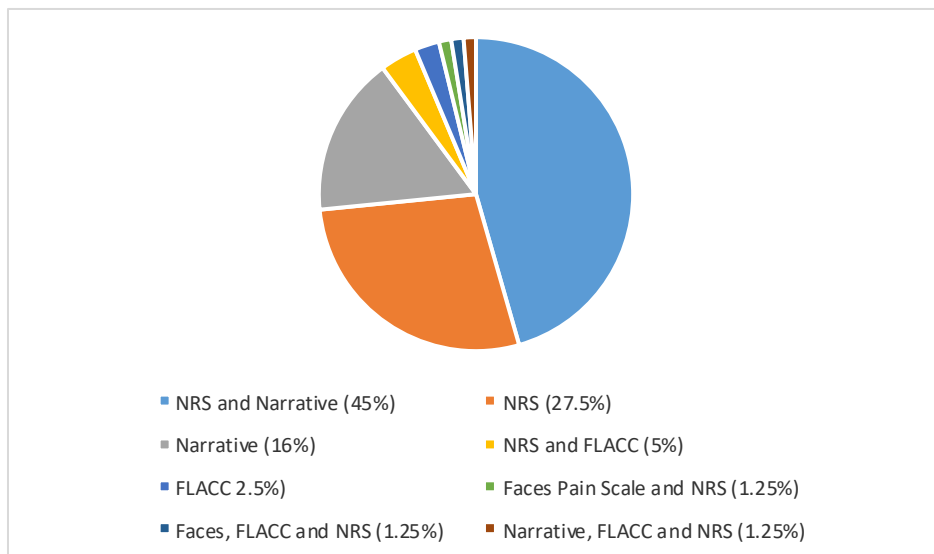


Figure 6. Pain reassessment measurement approach.

In the narrative pain reassessments of 36 patients, the focus continued to be on presence or absence of pain in specific locations of pain; 18/36 (50%) of the narratives noted location of pain only. Five of the 36 described changes in pain along with location of pain, such as: *increasing leg pain, headache not settling, abdo pain still persists, head pain comes and goes, moderate abdo pain which is increasing*. Three patients stated that their pain was changing, without naming the location, in terms such as *slightly better, pain improving, decreased pain*. In the pain reassessment data set of narratives one patient was recorded as *asking for pain med*. The quantity of pain was noted by nurses for three patients, who stated *a little*, three patients who stated *medium*, and one patient who stated *a little headache* when asked about their pain on reassessment. Two reassessments noted that the patients had behavioural reactions to pain, such as *patient crying and in a lot of pain*, and *patient flinching*.

Pain intensity scores en route were noted to be significantly higher in the direct trajectory group of patients (mean (*SD*) = 6.76 (2.10) than in the indirect trajectory group of patients (mean (*SD*) = 3.86 (3.00), $p = .002$) (see Table 5).

Table 5
Frequency of Pain Reassessment in Pediatric Trauma Patients

Outcome	Overall	Direct	Indirect	Test Statistic	<i>p</i> -value
Number of pain reassessments, median (IQR)	2 (0 to 4)	2 (0 to 5)	2 (0 to 4)	$Z=0.46^{\dagger}$	0.65
Number of pain reassessments en route, median (IQR)	0 (0 to 1.5)	0 (0 to 2)	0 (0 to 1)	$Z=-0.49^{\dagger}$	0.62
Number of pain reassessments at study hospital	0 (0 to 2)	1 (0 to 3)	0 (0 to 2)	$Z=1.06^{\dagger}$	0.29
Pain intensity en route (reassessment), mean (<i>SD</i>)	5.14 (2.98)	6.76 (2.10)	3.86 (3.00)	$T(32)=3.18^{**}$	0.002
Pain intensity at study hospital, mean (<i>SD</i>)	2.58 (2.89)	2.84 (3.32)	2.32 (2.44)	$T(42)=0.59^{**}$	0.56
Correlation b/w pain intensity score and number of pain assessments, Spearman's r (<i>p</i> value)					
En route	-0.20 (0.26)	-0.03 (0.91)	-0.09 (0.71)	-	
At study hospital	0.10 (0.54)	-0.08 (0.73)	0.34 (0.12)	-	

Note. IQR = interquartile range; SD = standard deviation; *** $p < 0.005$. **Equal variance two-sample t-test; † Wilcoxon Rank-Sum test.

The influence of several child factors was indicated in the number of pain reassessments. Children in the 6 to 12 years age group were significantly less likely than the other age groups to have had a pain reassessment (RR = 0.48, CI, 0.35 to 0.65, $\chi^2(1) = 21.08$, $p < .001$). Females were more significantly more likely to have had pain reassessments done (RR = 1.56, CI, 1.18 to 2.06, $\chi^2(1) = 10.54$, $p = .002$). Children who had been involved in an MVA were significantly more likely to have their pain reassessed than children with falls (RR = 63, CI, 0.44 to 0.90, $\chi^2(1) = 5.66$, $p = .011$), children who had been struck by an object (RR = .49, CI, 0.30 to 0.80, $\chi^2(1) = 6.83$, $p = .004$), and children who had been assaulted (RR = 0.20, CI, 0.08 to 0.47, $\chi^2(1) = 11.78$, $p < .001$). Children with head and spine injuries were significantly less likely to have their pain reassessed (RR = 0.67, CI, 0.46 to 0.98, $\chi^2(1) = 3.56$, $p = .037$). (see Table 6.)

Table 6
Multivariable Poisson Model Examining the Relationship of Number of Pain Assessments on Child Factors

Child factor	Relative risk of additional PAs	95% CI	χ^2 (1)	p-value
Age (years)				
0 to 5	0.78	0.56 to 1.09	2.05	0.15
6 to 12	0.48	0.35 to 0.65	21.08	< 0.001**
13 to 16	1.00 (Ref)			
Gender				
Male	1.00 (Ref)			
Female	1.56	1.18 to 2.06	10.54	0.002**
Number of injuries	0.98	0.91 to 1.05	0.08	0.59
ISS	0.98	0.96 to 1.00	3.33	0.090
Mechanism of injury				
Fall	0.63	0.44 to 0.90	5.66	0.011**
MVA	1.00 (Ref)			
Struck by object	0.49	0.30 to 0.80	6.83	0.004**
Assault	0.20	0.08 to 0.47	11.78	< 0.001**
Type of injury				
Head and spine				
Yes	0.67	0.46 to 0.98	3.56	0.037*
No	1.00 (Ref)			
Chest				
Yes	1.34	0.93 to 1.93	1.01	0.11
No	1.00 (Ref)			
Abdomen				
Yes	1.25	0.95 to 1.65	3.47	0.11
No	1.00 (Ref)			
Extremities				
Yes	0.85	0.60 to 1.20	0.76	0.36
No	1.00 (Ref)			
Route to hospital				
Direct	1.00 (Ref)			
Indirect	0.98	0.98 to 1.29	0.07	0.90

Note. ISS = injury severity score; MVA = motor vehicle accident; * $p < 0.05$; ** $p < 0.005$.

Pain intensity was related to gender; females had a greater decrease in pain intensity score than males (-2.70, CI, -4.83 to -0.57, $T(1) = 2.48$, $p = .013$). Pain intensity was also related to ISS; children with higher scores experienced a significant change in pain intensity (-0.18, CI, -0.36 to 0.003, $T(1) = 1.98$, $p = .053$). Pain intensity was significantly more likely to increase with an abdominal injury (2.53, CI, 0.02 to 5.04, $T(1) = 1.99$, $p = .048$). (see Table 7).

Table 7
Multivariable Linear Model Examining the Relationship of Pain Intensity and Child Factors

Child factors	Change in pain intensity	95% CI	T(1)	p-value
Age (years)				
0 to 5	-1.31	-4.59 to 1.96	0.79	0.43
6 to 12	-0.21	-2.41 to 1.99	0.17	0.85
13 to 16	0.00 (Ref)			
Gender				
Male	0.00 (Ref)			
Female	-2.70	-4.83 to -0.57	2.48	0.013*
Number of injuries	0.50	-0.11 to 1.11	1.61	0.11
ISS	-0.18	-0.36 to 0.003	1.98	0.053*
Mechanism of injury				
Fall	1.76	-0.99 to 4.51	1.26	0.21
MVA	0.00 (Ref)			
Struck by object	0.29	-3.37 to 3.94	0.14	0.88
Assault	-0.42	-5.23 to 4.39	0.17	0.86
Type of injury				
Head and spine				
Yes	-1.55	-5.72 to 2.63	0.73	0.47
No	0.00 (Ref)			
Chest				
Yes	1.27	-3.60 to 6.14	0.51	0.61
No	0.00 (Ref)			
Abdomen				
Yes	2.53	0.02 to 5.04	1.99	0.048*
No	0.00 (Ref)			
Extremities				
Yes	-0.75	-3.60 to 2.09	0.52	0.60
No	0.00 (Ref)			
Route to hospital				
Direct	0.00 (Ref)			
Indirect	-1.77	-4.78 to 1.24	1.15	0.25

Note. ISS = injury severity score; MVA = motor vehicle accident; * $p < 0.05$; ** $p < 0.005$.

Nature of Pain Management in Pediatric Trauma Patients

Ninety-one out of 104 (87.5%) pediatric trauma patients received an analgesic agent when they were being transported by EMS, when they were at the transferring hospital, or during their stay in the ED at the study hospital. Of the 91 patients receiving analgesia, 76 (73%) were given an opioid analgesia, either fentanyl or morphine, intravenously; one opioid was administered intra nasally; and one was administered orally. Seven patients received opioid infusions along with intermittent intravenous bolus doses of opioids; one patient received only an

opioid infusion with no record of having received any other opioids. All opioid infusions consisted of morphine infusions, along with bolus doses of opioids, except for a midazolam infusion that was given to one patient. Nonopioid analgesic agents—acetaminophen and ibuprofen given by mouth—were administered to 15/91 (20%) patients. Additionally, one patient received a topical anaesthetic. (see Figure 8).

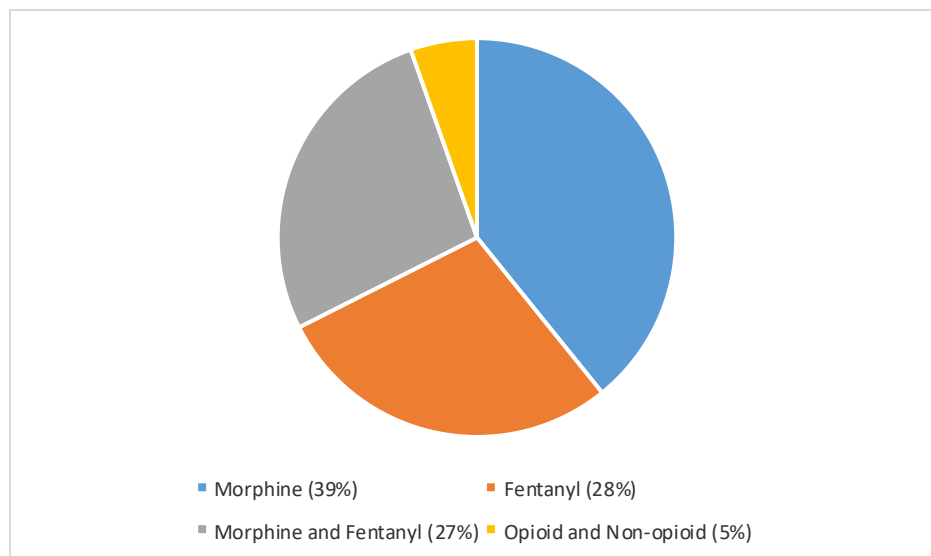


Figure 7. Distribution of opioid analgesia by type.

Differences were noted in how any pharmacological interventions were administered en route to the study hospital with children in the indirect trajectory group receiving significantly more pharmacological interventions. Only three of the 40 (7.3%) children in the direct trajectory group received any kind of pharmacological intervention compared to 37/40 (64.9%) ($\chi^2 (1) = 32.75^*, p < .001$) who received any kind of pharmacological intervention in the indirect trajectory group. The indirect trajectory group also received fewer pharmacological interventions ($n = 41$ (87.2%)) once they arrived at the study hospital than the direct trajectory group ($n = 38$ (66.7%)) ($\chi^2 (1) = 5.97^*, p = .02$). Non-pharmacological interventions were recorded in 14/104

(13.5%) cases; these included splinting for seven patients, blanketing for five patients, and application of ice for two patients. (see Table 8).

Table 8
Nonpharmacological and Pharmacological Interventions in Pediatric Trauma Patients

Pain intervention	Overall	Direct	Indirect	χ^2 (1)	p-value
Nonpharmacological, <i>n</i> (%)	14 (14.0)	7 (15.2)	7 (13.0)	0.10*	0.75
Pharmacological					
Any intervention, <i>n</i> (%)	91 (87.5)	41 (87.2)	50 (87.7)	0.01*	0.94
Any intervention en route, <i>n</i> (%)	40 (40.8)	3 (7.3)	37 (64.9)	32.75*	<0.001***
Any pharmacological intervention at study site, <i>n</i> (%)	79 (76.0)	41 (87.2)	38 (66.7)	5.97*	0.020**
Pharmacological intervention type en route, <i>n</i> (%)					
Opioid	40 (100.0)	3 (100.0)	37 (100.0)	-	
Nonopioid	0 (0.0)	0 (0.0)	0 (0.0)	-	
Topical	0 (0.0)	0 (0.0)	0 (0.0)	-	
Pharmacological intervention type in hospital, <i>n</i> (%)					0.011**
Opioid	64 (81.0)	28 (68.3)	36 (94.7)	-	
Nonopioid	14 (17.7)	12 (29.3)	2 (5.3)	-	
Topical	1 (1.3)	1 (2.4)	0 (0.0)	-	

Note. *Chi-square test of association; ** $p < 0.05$; *** $p < 0.005$.

Frequency of Pharmacological Pain Interventions in Pediatric Trauma Patients

For 56 of the 79 pediatric trauma patients who received an opioid, the average number of subsequent opioid interventions was 2.88 ($SD = 2.05$) and ranged from one to nine doses during the time of the trauma through to discharge from the ED at the study hospital; 23/79 (29%) received only a single dose. The median (IQR) time between administrations of each subsequent bolus dose of opioid analgesia for the 56 patients who were administered a repeated dose of analgesia was 34.5 (15 to 68.8) minutes.

In the direct trajectory group, 41/47 (87%) patients received analgesia; 19 received only one dose and 22 received subsequent doses of opioid analgesia. Median time (IQR) between administrations for each subsequent bolus dose of opioid analgesia for these 22 patients was 27 (14.3 to 56.3) minutes and ranged from 1 to 280 minutes.

In the indirect trajectory group, 50/57 (87.7%) patients received analgesia. Of these, 21 received only one dose and 29 received subsequent doses of an opioid analgesia. Median time (IQR) between administrations for each subsequent bolus dose of opioid analgesia for these 29 patients was 39 (18.3 to 80) minutes and ranged from 2 to 420 minutes.

Time to Administration of First Opioid Analgesia

For the 79 pediatric trauma patients who received an opioid analgesic, the median (IQR) time from the traumatic event to administration of first opioid analgesia was 99 (77 to 180) minutes. There were no significant differences between children in the direct and indirect trajectories when measured from time of the traumatic event to administration of the first opioid analgesia ($Mdn = 85$ minutes, IQR [60 to 97] and 145 minutes, IQR [90 to 300] respectively; $\chi^2(1) = 1.22$; $p = 0.27$). The longer time period to administration of the first opioid for the children in the indirect trajectory group does not include the time required to transfer the patient to the study hospital. Although the time difference from traumatic event to administration of first opioid analgesia between direct and indirect trajectory groups was not statistically significant, the period of time for the indirect trajectory group was almost twice as long as that for the direct trajectory group so was considered a clinically important difference. The minimal clinically important difference (MCID) is defined as the smallest change in difference of an outcome measure that is perceived as beneficial and would lead to a change in the patient's medical management (Wells et al., 2001). No literature identifying a MCID for the time period from injury to first opioid analgesia could be found.

To determine the MCID for the time to first opioid analgesia it would be necessary to take a predictive or data driven approach to gather information on the times to first analgesia possibly utilizing clinical opinion as a standard for the occurrence of what is an important

change. Statistical modeling would need to be used to see what amount of change is most predictive of that meaningful changed state (Beaton, Boers, & Wells, 2002).

There were differences between children in the direct and indirect groups who received appropriate doses of opioids as per dosing guidelines for the study hospital, based according to weight. Children in the indirect group received a less than optimal dose of opioid more often than children in the direct group (see Table 9). The appropriate doses of intravenous opioids for acute pain used for the analysis were fentanyl 0.5 mcg/kg/dose and morphine 0.1 mg/kg/dose (MacKenzie, Zed, & Ensom, 2016). Children receiving an opioid dose below these doses were considered to not have received an appropriate dose. Recommended doses for oral acetaminophen and ibuprofen used for this analysis were acetaminophen 10 mg/kg/dose and ibuprofen 10 mg/kg/dose. (see Table 9)

Table 9
Time to Administration of First Opioid Analgesia in Pediatric Trauma Patients

Outcome	Overall	Direct	Indirect	χ^2 (1)	<i>p</i> -value for difference
Time to opioid administration from trauma, median (IQR) in minutes among those with opioid administration	99 (77 to 180)	85 (60 to 97)	145 (90 to 300)	1.22†††	0.27
Received appropriate dose of pharmacologic intervention				4.02*	0.045
Yes	31 (40.8)	16 (55.2)	15 (31.9)		
No	45 (59.2)	13 (44.8)	32 (68.1)		

Note. IQR = interquartile range; EMS = emergency medical services; *Chi-square test of association; **Equal variance two-sample t-test; ††† Log-Rank Chi-square test.

The time to pain intervention graph demonstrates the differences in time (minutes) to first analgesia from the time of trauma comparing direct and indirect trajectories. (see Figure 9).

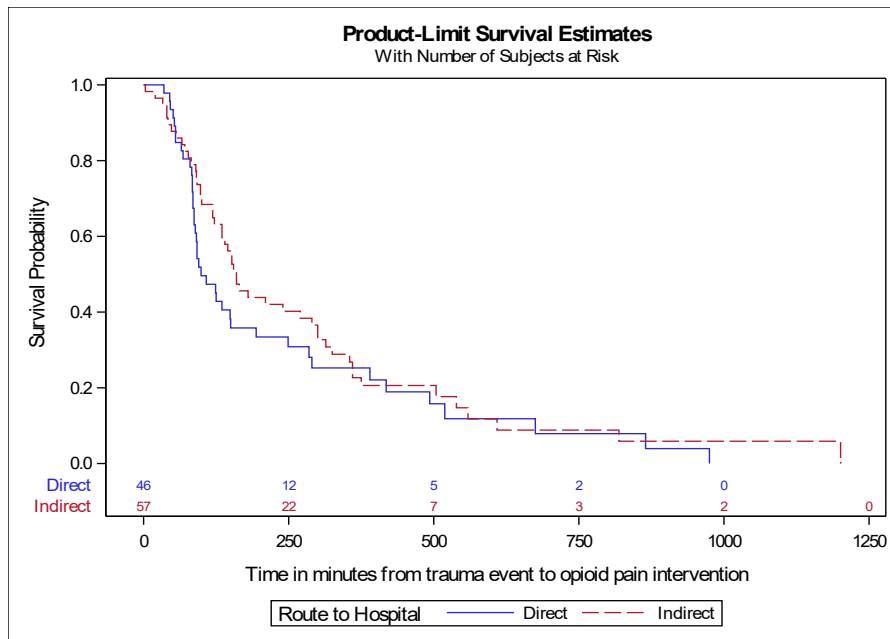


Figure 8. Time to pain intervention from time of trauma.

Child and situational factors in time to first pain intervention. Child factors identified as affecting time from trauma to first opioid analgesia included the number of their injuries, the mechanism of injury, and the type of injury. Children with injuries from an assault waited longer to receive an initial opioid analgesia than children with other mechanisms of injury (HR = 0.25, CI, 0.07 to 0.87, $\chi^2(1) = 4.78$, $p = .029$). Children with more injuries waited longer to receive an initial opioid analgesia than children with fewer injuries (HR = 1.18, CI, 1.03 to 1.35, $\chi^2(1) = 5.50$, $p = .019$). Children with head or spine injuries waited longer than children without head injuries for administration of the first analgesia (HR = 0.42, CI, 0.21 to 0.83, $\chi^2(1) = 6.14$, $p = .013$).

Situational factors identified as affecting time from trauma to first opioid analgesia indicated that children arriving via the indirect trajectory to the study hospital waited significantly longer than children in the direct trajectory to receive the first opioid analgesia (HR = 0.53, CI, 0.33 to 0.87, $\chi^2(1) = 0.01$, $p = .013$). (see Table 10.)

Table 10

Multivariable Cox Proportional Hazards Model of Time to First Opioid Administration on Child Factors

Child Factor	Hazard ratio (95% CI)	Test statistic: χ^2 (1)	<i>p</i> -value
Age (years)			
0 to 5	0.81 (0.42 to 1.56)	0.40	0.81
6 to 12	0.59 (0.33 to 1.06)	3.15	0.076
13 to 16	1.00 (Ref)		
Gender			
Male	1.00 (Ref)		
Female	1.53 (0.94 to 2.48)	2.97	0.085
Number of injuries	1.18 (1.03 to 1.35)	5.50	0.019*
ISS	0.94 (0.94 to 1.01)	2.74	0.098
Mechanism of injury			
Fall	0.67 (0.35 to 1.25)	1.58	0.21
MVA			
Struck by object	0.47 (0.22 to 1.04)	3.45	0.063
Assault	0.25 (0.07 to 0.87)	4.78	0.029*
Head and spine involved			
Yes	0.42 (0.21 to 0.83)	6.14	0.013*
No	1.00 (Ref)		
Chest involved			
Yes	1.07 (0.55 to 2.07)	0.04	0.84
No	1.00 (Ref)		
Abdomen involved			
Yes	1.34 (0.79 to 2.28)	0.27	0.27
No	1.00 (Ref)		
Extremities involved			
Yes	1.27 (0.65 to 2.49)	0.49	0.49
No	1.00 (Ref)		
Route to hospital			
Direct	1.00 (Ref)		
Indirect	0.53 (0.33 to 0.87)	0.01	0.013*

Note. ISS = injury severity score; MVA = motor vehicle accident; * $p < 0.05$; ** $p < 0.005$.

Phase 2:

Children's and Health Care Providers' Perspectives of Pain

Perspectives on the pain experience of pediatric trauma patients were gained in the interviews with them and the HCPs. In this section, both perspectives are linked to critical realism, the overarching conceptual framework for this research project (see Chapter 3).

Qualitative and quantitative results are integrated in Chapter 6.

Demographic Characteristics of Children Interviewed

Eleven children were eligible for this phase of the research; however, only nine were approached for consent. Two eligible participants were missed by the trauma patient care coordinator (TPCC) during the recruitment process after the amendment, due to admission and discharge of the patients over a long weekend where no recruitment was possible. The other nine children consented to be interviewed for the research project (see Figure 10). The children were recruited from the in-patient trauma unit at the study hospital by the TPCC with seven children interviewed over a period of 10 months from August 2013 to May 2014 and another two children interviewed over the three-month period between October 2015 and January 2016. A gap in the interviewing period was due to unavailability of the interviewer (i.e. away from the study due to an approved leave).

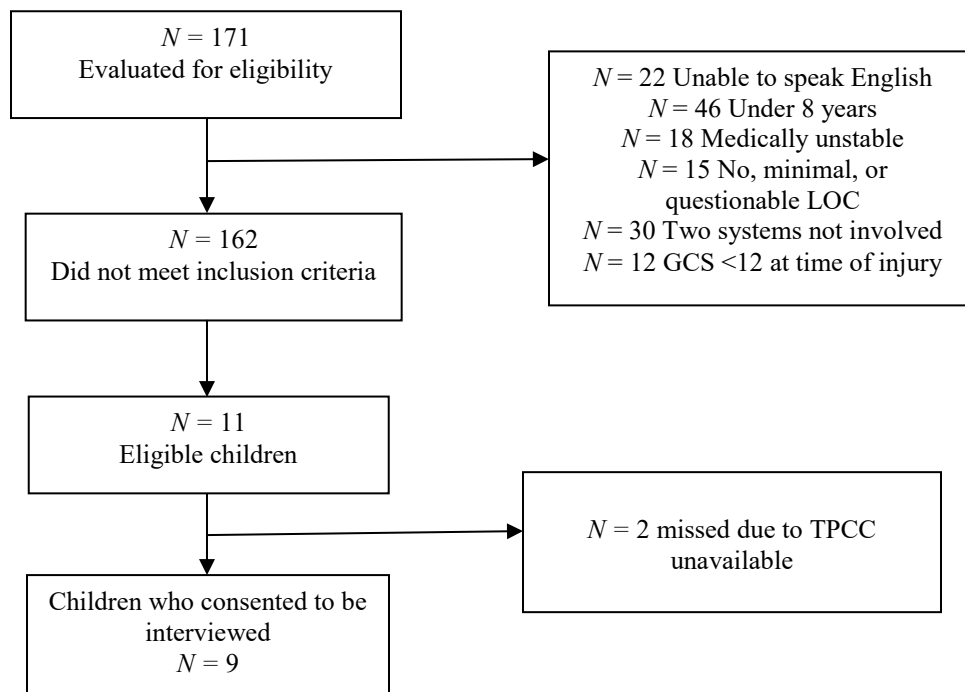


Figure 9. Flow diagram for recruitment of children interviewed.

Note: LOC = loss of consciousness; GCS = Glasgow Coma Scale; TPCC = trauma patient care coordinator.

Figure 10 summarizes the reasons for why children were excluded from the study. A change in inclusion criteria was necessary (see Chapter 4) to account for the high number of exclusions aside from the age limit of 8 years (which could not feasibly be adjusted).

The average age of the participants was 10.8 ($SD = 2.3$) years with six of the nine children (67%) involved in an MVA; the remaining three patients (33%) experienced a fall. There was an almost equal number of males and females in the group. No other demographics were reported on in Phase 2. Five of the nine children (56%) were brought in via the direct route and four (44%) by the indirect route.

The Interview Process

Although the original intent was to conduct the interviews in a private, quiet space, in reality three of the children were in acute-care rooms housing several other patients, to more carefully monitor them due to the severity of their injuries. Thus, moving them to a different space was not possible. Furthermore, all nine of the children had painful injuries (such as fractures) requiring stabilization. They were visibly uncomfortable with movement, often resting in bed in specific positions. It would have been inappropriate to induce pain by moving the patients requiring closer monitoring to a different location, and therefore it became necessary to pull the curtains around these three children in the acute care rooms and conduct the interviews while attempting to be as discreet as possible. It was necessary to do the interviews at this specific time in spite of the discomfort of the patients because of their imminent discharge home. Although several patients and parents were in the room while the interviews were being conducted, the interviews maintained an aura of privacy since the noise level was not high and the other patients were busy with their own clinical tests and activities.

All of the children interviewed wanted a parent present and all parent(s) agreed and were very helpful. The role of the parents during the interview was to support their child and to assist by scaffolding to recall events. Although parents frequently spoke out during the interview about the child's pain experience from their vantage point, at no point was the parent's viewpoint sought by the investigator or used in the analyses. To the best of my ability I put aside influences from parents' comments particularly during interview data analysis. The children appeared very comfortable with their parents present and frequently looked to them for encouragement in answering the interview questions. Even the older children sought support from a parent during the interview.

All the children agreed to be audiotaped. They controlled the digital recorder during the entire interview by holding it near their own mouth and in turn near whoever was speaking at that moment. Children in the younger age groups enjoyed this task and there were only a few mishaps (e.g., tape recorder accidentally but momentarily turned off). The mean (*SD*) length of time of the children's interviews was 20.7 (*SD* = 4.9) minutes and ranged from 8.55 to 29.03 minutes. The shorter interviews were often interrupted by hospital procedures (e.g., arrival of surgical consult, diagnostic imaging, and/or a meal). Most interviews were interrupted by the arrival of a meal although some were interrupted by hospital procedures. In spite of the shorter interview period, the quality of the information obtained was considered very rich. Children were interviewed one to two days prior to the expected date of discharge. Table 11 outlines details about the interviews for each child.

Table 11
Summary of Interview Details for Children

Pseudonym	Age (years)	Gender	Mechanism of injury	Length of interview (min:sec)	Number of pages in transcript
Child #1 (Peter)	12	M	Hit by car crossing street	19:06	12
Child #2 (Alexander)	8	M	Fell in gym at school	15:16	10
Child #3 (Jack)	13	M	Fell while skiing	12:46	8
Child #4 (Jennifer)	12	F	Hit by car crossing street	16:42	12
Child #5 (Kaitlin)	12	F	Fell onto blunt object	29:03	23
Child #6 (Arjun)	8.5	M	Hit by car while riding bike	14:38	10
Child #7 (Amanda)	14	F	Passenger in car	26:22	17
Child #8 (Chin)	10	M	Hit by SUV	08:55	5
Child #9 (Lisa)	8	F	Hit by car	17:23	12

The Children's Stories

Children used storytelling to give an account of what had happened to them. The following excerpts from the interview transcripts are the accounts of each child with their pseudonym, to be used throughout the analysis, and the age of the child at the time of the traumatic incident. Telling the story from the child's perspective provides contextual detail for the reader to bear in mind during discussion and analysis of the interviews. Those children who were hit by a car recounted their stories as follows:

No, I was riding (my bicycle) across the road . . . A car hit me. (Arjun, 8.5 yrs.)

I was crossing the street and then I got hit by a car and I tumbled to the ground. (Lisa, 8 yrs.)

Well I was actually on my way to class or to school and I . . . I usually cross the street right at the end of my street instead of going down to the crosswalk and I came . . . there were two cars coming from the other side and I thought I had time to cross but I didn't look in the other direction and a car came from that way and hit me there. (Jennifer, 12 yrs.)

OK. So what happened was I was going to . . . I was going to the st . . . I was going to the subway station. And I was going across the street. I pressed the

button . . . the bus came to a stop . . . I couldn't see past another car and I didn't see there was a car driving by and then the bus honked at me as soon as I got across. I didn't see anything so I kept walking and then bam . . . it hit me. Well I didn't actually see it hit me 'cause I blacked out before it happened. (Chin, 10 yrs.)

OK. . . I wanted to do fund-raising for my school . . . um . . . but then my Mom said no . . . She just wanted to give me two dollars . . . but then I wanted to . . . so I went and I crossed the street, past the crosswalk. No past this small street where there's no crosswalk and then. I remember just taking a couple of steps. That's all I remember after that . . . and the next thing when I woke up I was in a small street with no cross light. (Peter, 12 yrs.)

Well, I got into a car accident with one of my friends and . . . umm . . . we were turning into a recreational centre . . . we were making a left-hand turn . . . and we didn't time it right and then a guy hit us on my side . . . t-boned us on my side and umm . . . that's all I remember. Actually, I don't even remember him hitting us, I just remember the lights getting closer. And then umm I blacked out for a bit and then when I . . . uh . . . when, like, I didn't black out, all I remember after that is uh . . . the . . . what's it called . . . the ambulance, or not the ambulance . . . the firefighters trying to . . . using the cloth thing to rip the car off. (Amanda, 14 yrs.)

Children involved in a fall recounted their experiences as follows while offering an explanation as to the cause:

OK, I was um . . . I was at gym class and I was on a balance beam that my gym teacher flipped over a lawn chair and um . . . he, he flipped it over and we were all taking turns walking on it and I was walking over it and I . . . um . . . In the middle of it, I . . . um . . . I lost my balance and I . . . uh . . . then I ran and then I fell. (Alexander, 8 yrs.)

Well I was skiing and I went on a jump and on . . . while I was in the air there was a big gust of wind . . . um . . . and the gusts were enough to close the chair lifts . . . probably about 60 or 70 kilometres and it blew me past the landing and I landed . . . um . . . on the flats and broke my leg and my arm. (Jack, 13 yrs.)

Mhm. And I was carrying it . . . and I was walking down my driveway. I have a pretty steep driveway, but . . . I was at the top and it had ice. And I was with . . . um . . . my two friends . . . and one of my friend's moms. And I slipped on the ice and I fell onto the pump. (Kaitlyn, 12 yrs.)

The children did not hesitate to tell their stories with quite vivid recall although the younger children's accounts were very brief; they relayed their events in a concrete manner.

From a developmental perspective, children have an automatic egocentric default in perspective

taking that improves, but does not disappear, with the approach of adulthood (Epley, Morewedge, & Keysar, 2004). Egocentric tendencies are evidenced by consideration of only objects that are visible to them, which in examination of children's perspective of the traumatic events they have just experienced, was evidenced by the inability to anticipate an oncoming vehicle. As children mature into adulthood the ability to correct this egocentric tendency develops (Epley et al., 2004). The account of the traumatic event by the older children was more sophisticated relative to the younger children's versions. The abrupt accounts given by the youngest children (Arjun and Lisa) as compared to the more detailed accounts given by the older children (Peter and Amanda) demonstrate the difference in development within the sample group. The older children were able to correct their account of the event, providing less egocentric and more sophisticated interpretations of the accident scene.

Development of Themes

Development of codes, code meanings, subthemes and themes arising from the data are illustrated in Tables 12 to 15. Discussion of themes and subthemes include quotes to support the coding schema. Themes derived from the children's interviews include their perceptions of (a) underlying assumptions about pain management, (b) pain, (c) the trauma experience, and (d) presence of parent and importance of support individuals.

Underlying Assumptions About Pain Management

There was evidence that initially some of the traumatic events were not taken seriously by both parent and HCP caregivers. Children assumed their parents' assessment of the situation was accurate and were dependent upon their parents and upon HCPs to provide sufficient care for their injuries.

Table 12

Development of Assumptions About Pain Management Theme for Children's Interviews

Theme	Subtheme	Code
Assumptions about pain management	Apparent acceptance of poor pain treatment	Initial minimization of pain by adults with child
		High levels of pain intensity accepted
		Delays in pain management expected

Falls, in particular, were not perceived by parents as serious. For example, Alexander reported that his mother was not worried when she heard about his fall: “She was going to take me home and say suck it up sista!” (Alexander, 8 yrs.).

After Alexander’s mother observed him for about an hour, she did realize that he was not acting like himself; he was pale grey in colour and was very quiet. She then brought him to the hospital where he was diagnosed with a lacerated liver. Similarly, Kaitlyn was injured when she fell while holding a heavy object. She fell such that she landed on this object and suffered a lacerated liver. Her father waited several hours before taking her to the hospital:

Well I was lying on the couch . . . and my dad and xxx and xxx and . . . they just had dinner,, like, they were just eating dinner. And my dad said after dinner to go to the hospital. (Kaitlyn, 12 yrs.)

Even later, when Kaitlyn went to the hospital, she was sent home: “Yeah, he gave me Advil. And . . . umm I went to the hospital and I got an x-ray and they said that nothing was . . . really wrong. Like, nothing was broken” (Kaitlyn, 12 yrs.).

After sending Kaitlyn home, her father brought her back in because she had fainted several times. The hospital still attempted to send her home:

And then I fainted and my dad caught me. (Kaitlyn)

One assumption about pain management in the pediatric trauma patient was that pain medication would not be administered immediately after the traumatic event. Jennifer accepted that she could not receive pain medication because she had to wait until she was at the hospital.

When asked what her pain level was during her interview, Kaitlyn stated: “Well, I’d say if I had to put it in a number, I’d say it’s like a 6/7. Yeah but if it really hurts it’s like a 7/8” (Kaitlyn, 12 yrs.). Stratifying pain intensity into the levels of mild (1 to 3), moderate (4 to 6) and severe (7 to 10), it is apparent that Kaitlyn’s resting pain state at a level of 6 or 7 was within the moderate to severe range. These levels of pain are unacceptably high, because treatment is commonly provided for pain levels above 4 out of 10 (Twycross & Crollis, 2013; Twycross, Forgeron, Chorne, Backman, & Finley, 2016) and there should not be delays in pain management.

Another assumption expressed by many of the children was that there would be delays in receiving pain interventions because they were not old enough. When Jack was asked if he received anything for pain in the ambulance on the way to the hospital, he overheard that he was too young to get anything for pain: “No not in the ambulance because I’m under 18 I can’t . . . couldn’t get it or something” (Jack, 13 yrs.). These assumptions conveyed by children—that they were not old enough to be given pain medication or that they had to wait till they got to the hospital—are rooted in the concepts of juvenile ageism.

The approach to care provided to Kaitlyn contradicts what is known about the relationship between pain and tissue damage; namely, that there may be no tissue damage associated with pain or, conversely, there may be no pain associated with tissue damage (Bear, Phillip, Hill, & Mundell, 2016; Loeser, 2000).

After Amanda's MVA, which required extraction from the vehicle she was trapped in with the Jaws of Life, she was cared for in the transferring institution for six to seven hours in the hallway of the emergency room, where no identifiable staff member cared for her nor was she provided any pain relief during that long period of time: "No, we were just out in the hallway . . . [When asked whether there was a nurse specifically caring for her:] . . . Oh, not taking care of me. No" (Amanda, 14 yrs.).

Children's Perception of Pain

Most children interviewed indicated they experienced immediate pain in several areas at once, and the pain was often made worse by the movements necessary to be transported to the hospital. From the interviews it was evident that pediatric trauma patients were paying close attention to their pain during the time spent with EMS and in the trauma room in the ED. These children also indicated the pain from trauma assessment procedures was an additional source of pain. (see Table 13.)

Immediate pain. Although the relationship between injury and pain is variable (Melzack, Wall, & Ty, 1982), several children reported immediate, severe pain after their traumatic event. For example, immediately after being hit by a motor vehicle, Peter described extreme pain in multiple places:

OK, my head! My head, my leg, my back and my arm and my shoulder. (Peter, 12 yrs.)

Table 13
Development of Theme for Children's Perception of Pain

Theme	Subtheme	Code
Children's perception of pain	Immediate pain	Emphatic account of pain right away after being hit by car or falling upon recall of event Specific areas of injury such as head, arms, legs causing the most pain
	Pain with movement	Bumpy ambulance rides making pain worse Discomfort having to move from stretcher/gurney for x-rays or to bed
	Vigilant awareness of pain treatment	Statements about specific time frames of pain treatment administration
	Procedural pain	Catheterization worse than pain from injuries Frequent mention from several patients of having intravenous cannulation started Having pain with diagnostic imaging procedures such as CT

Jack talked about immediate pain with a skiing accident:

Yeah. As soon as I landed I could feel, like, pain shooting up my leg and my arm.
 (Jack, 13 yrs.)

And when asked what his pain level at that time was he stated:

It was eleven. (Jack, 13 yrs.)

Chin stated that he felt intense levels of pain immediately as well as fear:

I was scared . . . it started off at a few seconds being zero and then it just went right up to 10. (Chin, 10 yrs.)

Alexander stated the worst pain was right away, along with some dyspnea, an indication of the seriousness of his fall:

Yeah right away when I fell . . . right away . . . I couldn't breathe . . . I got the wind knocked out of myself. (Alexander, 8 yrs.)

Not all the children reported immediate pain. Many could not recall the moment of the traumatic event, likely due to a brief loss of consciousness.

Pain with movement. Amanda, who had been trapped in a motor vehicle and had to be extricated from it, stated:

I was in more pain when they were taking the car off, I guess with, like, the way that the car was pushed up against me. It didn't, like, hurt or anything. I guess when, like, the car was moved it was, like, . . . rubbing everything together.
(Amanda, 14 yrs.)

When the car was moved, Amanda's pain was exacerbated. During transport, Amanda experienced pain on movement from the potholes during which her father stated she was "moaning and groaning a lot" and she reported:

Yeah,, like, it hurt when we hit . . . all the bumps and everything and, like, it did hurt when they had to, like, switch me from the gurney into, like, the ambulance gurney or whatever thing they had to use but . . . (Amanda, 14 yrs.)

Upon arrival to the study hospital Amanda had to again be moved:

But . . . uh . . . yeah, they had to switch me into another . . . but, like, they couldn't . . . like, I knew that they were going to switch me . . . I wasn't really that prepared, but it still hurt a lot. (Amanda, 14 yrs.)

Pain on movement was expressed by many of the children and was often not only associated with moving from stretcher to bed, particularly in early stages of trauma. During transport in the ambulance to hospital after being hit by a car, like Amanda, Peter stated:

I was in pain . . . because there was all those bumps and they jumped a little bit.
(Peter, 12 yrs.)

And later Peter mentioned pain when moved at the hospital:

Yeah they moved me to, like, a bunch of different beds and it hurt. (Peter, 12 yrs.)

Jack experienced pain on movement during transport to hospital from the ski hill where he was hurt:

Well during the . . . it was . . . it hurt a lot especially on the drive there because they were . . . it was really bumpy and there were a lot of potholes so I kept

bouncing around in those and the driver was driving really slow . . . I couldn't really tell though and he was, like, driving really slow and I was, like, bouncing around in the back and it really hurt, and (I was) in a lot of pain. (Jack, 13 yrs.)

Kaitlyn was not experiencing pain from her abdominal injury but movement from bed to bed for scans and transport to the study hospital was painful:

It (the injury) didn't really hurt. The only part that hurt a little bit was when they were taking me . . . they had to put me on a bed and then take me off the bed. (Kaitlyn, 12 yrs.)

Pain on movement has been identified by Crandall and colleagues (2007) as an issue for adolescent patients with blunt trauma and was evident in the children interviewed for this research. From working in the ED with pediatric trauma patients, I am aware that patients are moved a minimum of four times in the first one to two hours after the traumatic event. Patients are first moved from the scene of the traumatic event to the EMS stretcher; they are then moved from the EMS stretcher on to the trauma room stretcher. More movement would be required if they arrived at the study hospital via the indirect route. The trauma room stretcher is a hard bed used for diagnostic imaging purposes, and is uncomfortable. Once stabilized, patients are moved from this hard bed onto a hospital stretcher that has a soft but thin mattress. Finally, when the patient is admitted to the in-hospital unit, patients are moved to a hospital bed.

Several diagnostic images are required in the course of trauma assessment, which also necessitates movement into different positions. The model of care for pediatric trauma patients involves transportation to a specialized institution to obtain the best care and an optimal outcome. Efforts to streamline compassionate care for pediatric trauma patients with a focus on comfort could be influenced if the organizational culture of the study hospital attempted to focus on this issue. The power imbalance between patients and necessary hospital protocols is vast and is discussed in more length in the Chapter 6.

Vigilant awareness of injuries and pain management. Children expressed a keen awareness of whether pain was treated or not. Jack, when asked if he received anything for pain in the ambulance on the way to the hospital, overheard that he was too young to get anything for pain:

No not in the ambulance because I'm under 18 I can't . . . couldn't get it or something . . . (Jack, 13 yrs.)

Jack was also aware of the sequence of events prior to receiving pain treatment:

I know they put me on a bed and they had a lot of people looking at me . . ., like, checking my vitals and stuff and back . . . and then they knocked me out so they could . . . do x-rays and things. (Jack, 13 yrs.)

Amanda was aware of when she received pain treatment when asked whether the pain in her hips from a pelvic fracture was treated:

Not until, like, the last hour that we were there. We were in there for . . . [looking to father] seven hours? (Amanda, 14 yrs.)

Amanda did remember receiving medication very shortly after arrival at the study hospital although she did not relate whether the medications were effective in relieving her pain:

I don't know what it was but they put it in the IV so . . . we were there for maybe 15 minutes. (Amanda, 14 yrs.)

Jennifer remembered receiving medication en route to the hospital:

Yeah they gave me . . . it was on the ride to xxx when they gave me morphine. (Jennifer, 12 yrs.)

Alexander remembered receiving pain medication while en route via helicopter to the study hospital:

When I was in the ambulance they gave me a sleepy thing, they made me goofy, that's when I got all, that's when I started telling comedies. (Alexander, 8 yrs.)

The children's attentiveness to their pain management was mirrored in their own pain assessment. Even as EMS staff and trauma team members were conducting their assessment for injuries, the children were conducting their own assessment. Peter sustained a fractured femur

and shoulder along with a head injury; however, he was most keenly aware that one of his teeth was chipped:

Yeah I asked if my tooth was broken . . . yeah, like, if I had all my teeth then she . . . and the girl was, like, yeah but then I realized there was, like, a chip at the back of my mouth. (Peter, 12 yrs.)

The nervous system plays a strong role in defence by detection of threat in the external environment; cognition (anticipation, appraisal); signalling of incurred tissue injury; and through motor responses geared to escape or fighting (Chapman et al., 2008). This is the actual layer of critical realism coming into play.

Chin was also aware of mouth injuries that had not yet been identified by the HCPs in attendance:

Um, I was feeling for if anything was broken. My leg was killing me and also I had two teeth that were very loose. (Chin, 10 yrs.)

An unusual hyperawareness of mouth injuries could be rooted in physiologically based responses to the acute stress of the traumatic event, which can result in patients desperately attempting to locate their injuries. Initial stages of experimentally induced acute stress response were found by van Marle, Hermans, Quin, and Fernandes (2009) to result in a surge of vigilance originating in the amygdala, augmenting detection of threats in the environment. Excitation of the locus coeruleus in response to stress and trauma exerts a powerful influence on cognitive processes such as attention and task performance (Chapman et al., 2008).

Children who experience trauma are caught within the interplay between the biological reality of tissue damage (actual) causing pain (empirical), the socially constructed constraints of the trauma process or algorithm of trauma care that influences pain management (real), and the reality of experiencing the effects of juvenile ageism in a society that condones it.

Procedural pain. The sudden onset of severe pain from trauma and the ensuing journey through the trauma management process includes a detailed physical exam, insertion of intravenous lines, taking of X-rays, placement of urinary catheter and/or nasogastric tube, and possible intubation. All of these may occur without sufficient anaesthesia. Kaitlyn clearly remembered the urinary catheter placement upon arrival to the study hospital:

Yeah, they put a catheter. I didn't, like, it. (Kaitlyn, 12 yrs.)

To check her hemoglobin, Kaitlyn had to have several IVs, and blood samples were frequently drawn. The discomfort and pain from the catheterization, multiple IV insertions and multiple blood sampling at times was perceived as being worse than her injury. Kaitlyn stated: "Well the pain from that took away from my stomach" (Kaitlyn, 12 yrs.).

Amanda had several tests done prior to receiving pain medication and recalled pain throughout: "They did an X-ray and a CAT scan on my head. It was really painful" (Amanda, 14 yrs.).

Children's Perceptions of the Trauma Experience

Along with the pain from injuries suffered during the traumatic event children expressed distress and a sense of the surreal as they found themselves suddenly in the chaotic scene of the trauma itself and subsequent hospital admission. (see Table 14.)

Table 14

Development of Theme for Perception of Trauma Experience

Theme	Subtheme	Code
Perception of trauma experience	Trauma experience is surreal and distressing	Disbelief about being in a traumatic event
		Finding oneself in an unusual circumstance such as having underwear removed in a crowded room or being extricated from a car
		Patient feeling convinced he was going to die
	Tripartite of fear, distress, uncertainty	Higher pain intensity due to uncertainty of injury extent
		Distress over pain to the point of not clearly remembering painful procedures
		Fear of being trapped in vehicle and crossing street
	Stimulus overload	Crowds gathered at scene of traumatic event
		Sudden exposure to large number of strangers (e.g., trauma personnel
		Questions from multiple care providers

Surreal sense of trauma. The sudden and unexpected nature of the traumatic event encompassing the event itself, transport to the hospital, and then the assessment, admission, and procedural requirements encountered upon arrival in the hospital, are unfamiliar and frightening (Mohta, Sethi, Tyaga, & Mohta, 2003). The children in this study found themselves in situations that were highly unusual, possibly disturbing, and consisting of activities such as removal of clothing or touching in private areas. The children had been coached throughout their life that these activities are very much forbidden and inappropriate. Peter remembers having to have his clothes cut off upon arrival to the hospital:

Oh, like, when . . . OK . . . yeah . . . they cut my underwear . . . and that felt weird but I knew it was for a good reason. (Peter, 12 yrs.)

Alexander remembers the moment his clothes were removed during assessment in the trauma room:

Yeah they pulled my pants down . . . and I got a little stage fright. (Alexander, 8 yrs.)

An unknown extent of injuries gives rise to the threat of body image changes or even bodily mutilation. A dissociative emotional state could be due to a physical injury or an emotional response to the trauma (Mohta et al., 2003). Some children described an altered sense of reality around the time of the traumatic incident. An altered sense of reality was evidenced by Peter who had remained convinced until the following day that he was going to die:

Yes, I was scared, really scared because I thought I was going to die. I don't know . . . , like, when the surgery happened . . . , like, the day after . . . before . . . the day of the surgery because I was still alive . . . because if I was gonna die there was no point into putting time into doing the surgery so . . . (Peter, 12 yrs.)

Chin conveyed a similar sense of unreality after being hit by a car: "I thought it was a dream . . . Um I was feeling for if anything was broken. My leg was killing me and also I had two teeth that were very loose. I was scared" (Chin, 10 yrs.).

Amanda and her father were in the transferring hospital for so long after a horrific MVA that they couldn't remain oriented to time. Her father stated that when Amanda was asked how long they had waited in the trauma unit at the study hospital. After waiting for about eight hours at a transferring institution, she thought it was about an hour and a half: "I don't think it was even that long sweetheart. You know we sort of lost track of time . . . yeah it was two o'clock in the morning" (Amanda's father).

Dissociative reactions to a traumatic event can include a sense of emotional numbing or detachment, reduced awareness of surroundings, and/or distortion in reality, body, and time, or seeing events as if in a dream (Bryant, 2007; van der Velden & Wittmann, 2008). Reports of longer-lasting effects of painful medical events in childhood have been associated with high levels of fear of medical procedures (such as vaccine-related pain) and fear of future medical treatment into adulthood (McMurtry et al., 2015). Children who have endured a traumatic

experience may potentially need to deal with the fear related to both the pain and the invasiveness of medical procedures.

Tripartite of fear, distress, and uncertainty. Fear, distress, and uncertainty comprise the affective dimension of pain (Price, 2000). These emotions were evident in many of the children as they recounted the traumatic events. Amanda found herself in the distressing and unfamiliar situation of having to be extracted from the vehicle in which she was trapped:

Yeah, because when they were taking it apart they had to put a blanket over my face because they were scared that the glass would have broken in . . . the windshield would have broken in . . . because all I heard was, like, the crushing of the car and every, like, . . . apparently every time that the car would, like, move, I would, like, scream . . . (Amanda, 14 yrs.)

Use of the Jaws of Life for the extraction further heightened Amanda's level of anxiety. Fear and anxiety have been shown to exacerbate the pain experience (Boerner et al., 2015).

Jack was so worried about the pain he didn't remember some of the procedures done at the trauma centre. When asked whether he remembered having an IV inserted he said:

I think . . . not really because I was worried about the pain . . . , like, once I was at the hospital . . . they put, like, needles and blood things in my arm. (Jack, 13 yrs.)

Peter anticipated profound anxiety related to crossing the street when he quietly stated at the end of the interview:

I don't even want to cross the street anymore . . . Oh my god. I'm scared too because when I was crossing the street I didn't even see the car coming so I know I can just get hit anytime because if I don't look in every direction every second then I can get hit. (Peter, 12 yrs.)

Drendel, Brousseau, and Gorelick (2006) found a higher documentation of pain intensity scores for pediatric patients in EDs where there was diagnostic uncertainty. Gaffney and Dunne (1986) explained that uncertainty of duration of pain emerged as a major theme in their research, in which they examined developmental aspects of children's perceptions of pain. Uncertainty has

been shown to have a potent hyperalgesic effect correlating with activity in the periaqueductal grey (Yoshida, Seymour, Koltzenberg, & Dolan, 2013).

Kaitlyn expressed higher levels of pain when the traumatic incident happened because she was uncertain of what was occurring around her:

I would say it was, like, uh . . . 8 or a 9 cause I didn't know what was wrong.
(Kaitlyn, 12 yrs.)

A review on illness uncertainty in adults by Wright, Afari, and Zautra (2009) reported that uncertainty about pain outcome and pain intensity were related to increased pain sensitivity, attention to pain, and pain intensity. Crombez, Viane, Eccleston, Devulder, & Goubert (2013) reported that fear was a central component of acute pain in both children and adults; they posited that pain demanded vigilant attention as to its source and possible means of relief from it.

Stimulus overload. Stimulus overload is often encountered by children at the scene of the traumatic event, where they find themselves in a vulnerable position in the eyes of the general public; similarly, upon arrival at the hospital, they may be surrounded by the large group of HCPs making up the trauma team. Kaitlyn and her mother expressed feeling overwhelmed upon arrival in the trauma room after transfer from an outside institution:

Well, I got . . . well, there was a bunch of things happening at once. There was, like, 20 people in there. They were, like, [to mother] what did they do? I couldn't really see . . . it was kind of . . . Yeah, cause I was, like, trying to pay attention to everything I'm doing. So, I was, like, "look at me here, over here. (Kaitlyn, 12 yrs.)

Jennifer was overwhelmed upon arrival to the ED: "Um . . . that's where there were people everywhere . . . there was a lot of people asking me a lot of questions and um . . ." (Jennifer, 12 yrs.).

The overwhelming position of being in an exposed condition in the public eye was difficult for some of the children. Jack suffered multiple injuries while skiing:

I got to the bottom and I could see people out of my peripheral. Everyone was standing on two sides because you had to go through the lift line to get to the ski patrol shack . . . and everyone was watching . . . and, like, the pain in my leg . . . and I was, like, . . . I was crying . . . and then they, like, took me off and just brought me towards the ambulance . . . (Jack, 13 yrs.)

Such stimulus overload is based in physiology and from the critical realist perspective is situated in the *actual* layer of reality. The capacity to quickly respond to threats to homeostasis in the environment is critical for survival. The initial stages of the stress response consist of a surge in vigilance to detect and assess the threat (van Marle et al., 2009). This state of hypervigilance at the initial onset of stress is accompanied by sensory processing that allows for prioritization of real threats. An increased alertness to threat combined with a decrease in specificity necessary to prioritize real threat can be maladaptive if there is a continued demand for response to innocuous stimuli, resulting in indiscriminate hypervigilance (van Marle et al., 2009).

Presence of a supportive individual. Several children found that one person stood out as very helpful throughout the trauma experience. While it was understandable that a parent was seen as important to each of the children many of them also looked beyond parental support to the support of the caregivers involved in their care. (See Table 15.)

Table 15
Presence of a Supportive Individual

Theme	Subtheme	Code
Presence of support	Important relationships between HCP and child can be made at this critical time	One person stands out as helpful even in the presence of parents Strong relationship with child during time spent in hospital

Peter found that in the trauma room experience there was one person who he remembered as being particularly helpful or memorable:

Yeah . . . and there was this one person telling me, like, . . . um . . . whenever I needed to ask questions she answered it, she's, like, every couple of minutes, she was, like, do you have any questions . . . she was, like, talking with the other people but then after a couple of minutes she'll come back and ask me if there's anything wrong. (Peter, 12 yrs.)

Arjun remembered the police officer in the back of the ambulance with him, and Peter had a favorite nurse on the in-hospital unit: "Yes. Oh yes. One notable person was xxxx . . . she was a nurse . . . my favourite nurse!" (Peter, 12 yrs.).

These support individuals, who stood out to the children as being helpful in the absence of a parent, clearly gave comfort to the children, who authentically received it.

Children's Perspectives of Pain: Summary

In summary, interviews with pediatric trauma patients revealed that the pain they experienced as part of a traumatic event was marked by patterns of immediate severe pain, accompanied by chaos, fear, and uncertainty. The pain was persistent through to admission to hospital even to the point when the interview was conducted; most of the children were experiencing pain during the interviews. Children had many erroneous assumptions about pain management that need to be addressed by HCPs and corrected. The delays were perceived by children to be because they were young and that it was normal to have to wait for pain interventions. Pain with movement was identified by many children. Movement is a necessary part of being transported to the hospital from the accident scene and again for many of the trauma assessment procedures, such as being moved for X-rays, or rolling over for assessment of the spine. Pain and distress with procedures were identified by the children. Procedures such as intravenous establishment and/or urinary catheter placement are critical for trauma management; however, preparation with a topical anaesthetic for intravenous insertion was not reported in Phase 1 of this research, and one of the children interviewed for Phase 2 was clearly distressed over the insertion of a urinary catheter. In the early stages after the traumatic event, the children

appeared to be hypervigilant for pain; appearing to be conducting their own assessment, they attempted to identify their own injuries. Many of the children were keenly aware of their pain interventions including when they received them and if they helped the pain. The children's awareness of their injuries and pain was not always evident to trauma staff who, as is evident in the next section, were preoccupied with identifying injuries and ensuring hemodynamic stability, which are the most pressing concerns in the initial moments of trauma care.

The trauma experience was viewed as being surreal. The children were overwhelmed by being surrounded by strangers and the unusual circumstance they found themselves in, often without a parent. This unusual circumstance was cause for distress amid a chaotic scenario where there was still a space for trauma staff to connect with a vulnerable child and provide meaningful support that would make an enduring impact on the child and family.

Health Care Providers' Perceptions of Pediatric Trauma Pain

Demographic characteristics of HCPs. Thirteen HCPs across several disciplines who were working in the ED in the study hospital agreed to be interviewed for this research (see Table 16). The average length of time for each interview was 21.9 (*SD* 5.0) minutes, ranging from 14 to 30 minutes. All interviews were digitally recorded with permission, transcribed, and subjected to qualitative analyses.

Table 16
Demographic Characteristics of Health Care Providers

Demographic characteristic	<i>N</i> = 13 (%)
Gender	
Male	1 (8%)
Female	12 (92%)
Years of experience	
1-2	5
3-7	4
>10	4
Profession	
Emergency room nurses	3 (23%)
Physicians	2 (15%)
Allied Health Professionals	1 (8%)
Administrators	1 (8%)

The interviewees were recruited from a group of 287 hospital staff who met eligibility criteria consisting of 19 full-time and 6 half-time position physicians, 46 casual staff members and 20 fellows; 100 nurses, including full- and part-time positions; 56 full- and part-time position social workers; 26 child life staff; and 14 chaplaincy staff. A flow diagram outlines the recruitment process (see Figure 11).

Interviews were conducted in a private office space, with the exception of one interview that took place in a secluded space in the hospital cafeteria during off hours. The interviewee group was predominantly female, reflecting the professional dominance of women in the nursing, social work, child life, and the pediatric physician groups within the ED setting of the study site. Development of codes, subthemes, and themes are illustrated in Tables 17 to 22.

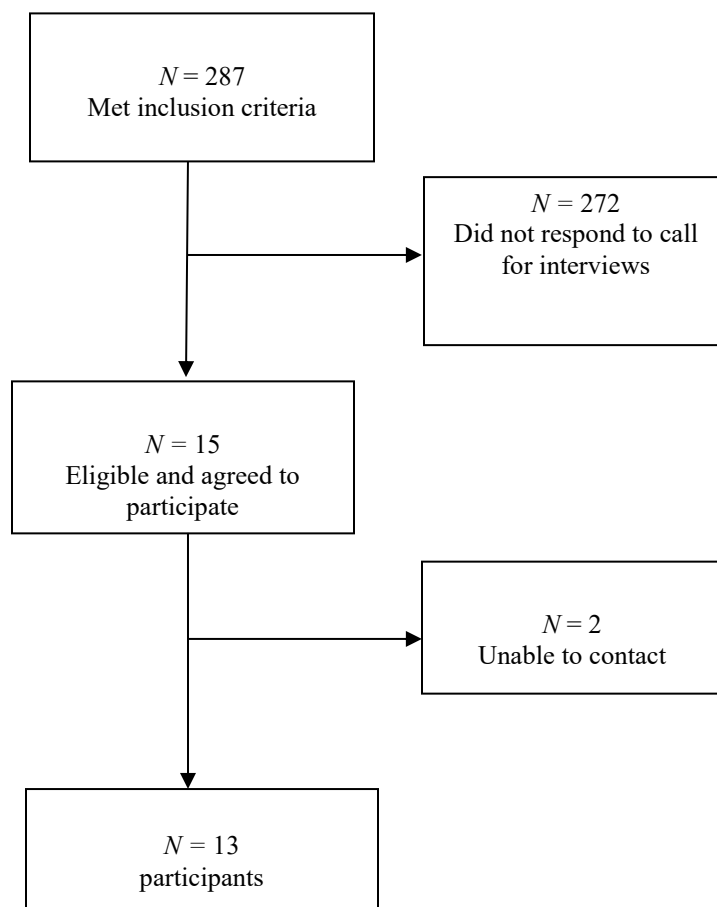


Figure 10. Flow diagram for recruitment of health care providers interviewed.

The themes derived from the interview data include (a) primacy of physiological stability; (b) differentiation between pain and anxiety in the child; (c) differences in educational preparation between disciplines; (d) fractured approach to pain management in trauma care; (e) underlying assumptions about pain management in trauma patients; and (f) acknowledgement of unique experience of trauma and pain.

Primacy of Physiological Stability

One of the resounding themes for HCPs throughout their interviews was the concern for establishing physiological stability for the pediatric trauma patient. (see Table 17.)

Table 17
Primacy of Physiological Stability

Theme	Subtheme	Code
Primacy of physiological stability	Pain is not the priority initially	Blood pressure must be stabilized Pain management not what is initially addressed

The importance of stabilizing the patients' physiological status was the overriding reported concern across disciplines. While this is the priority in all medical and surgical scenarios within any hospital, in the trauma patient this concern is abruptly and immediately brought into focus due to the urgency to identify injuries quickly and clarify injury severity. Many of the HCPs interviewed, such as one of the ED physicians below, expressed the desire to treat pain while first ensuring physiological stability:

. . . so with multiple injuries you do sometimes have to consider how the rest of their physiology is working so if they're having problems with their blood pressure and so forth then a lot of the pain medicines are . . . uh . . . are . . . are only going to make that worse so . . . so sometimes you have to make a decision about keeping their cardiovascular status supported as well as treating their pain. But in general, we do try to get their pain . . . uh . . . painkillers into them early on.

Another physician stated the following when asked about pain management in the trauma patient:

I'm not . . . we're not . . . surgeons are not thinking about the aspect of pain. At least until we're sure we're not . . . there's no life threatening uh . . . imminent . . . threat to the patient . . . anything that hasn't been addressed with regards to threat to the life or limb.

Advances in trauma care have commonly occurred during warfare where large numbers of serious injuries are encountered. In 1978 the Advanced Trauma Life Support (ATLS) program was developed to provide a structured approach to less-experienced clinicians in the recognition and intervention of life-threatening injuries. The Airway, Breathing, Circulation, Disability, and

Exposure (ABCDE) approach has since been widely adopted (West & Dawes, 2015). There have been adaptations as there is a Pediatric Advanced Life Support (PALS) courses however pain remains as a delayed priority.

Differentiation Between Pain and Anxiety of Children

Another theme arising from data was whether children were experiencing pain from their physical injuries or from the fear and distress from the intense traumatic experience they had endured. (see Table 18.)

Table 18
Differentiation Between Pain and Anxiety

Theme	Subtheme	Code
Differentiation between pain and anxiety	Ability to discern pain and anxiety poses difficulty across all disciplines	Cannot tell whether screaming and crying is indication of pain or anxiety Inability to discern between fear, anxiety and pain

Treatment for pain is provided or withheld according to the personal judgement of the attending staff, as this ED physician suggests:

So sometimes something that looks, like, pain is actually is anxiety and it's relieved . . . um . . . with some nonpharmacological measures.

Tension between the identification of fear or anxiety and pain due to tissue injuries is evident throughout several of the interviews, crossing professional boundaries. As one of the allied health professionals expressed:

Oftentimes my observation is the child . . . um [hesitates] . . . and it's important to discern the difference because they're all anxious and terrified when they come in, they're beside themselves . . . but there are many, many times when physicians are doing something, to examine and to assess and whatever and the children are screaming and it seems, like, they're in pain.

An ED nurse stated similar sentiments, albeit with more acknowledgement of an amplification of pain in the presence of fear and anxiety rather than a separation:

. . . and the children are very anxious because of the trauma setting which also increases their pain further.

Delays in pain treatment that accompany the delayed attention to pain management in the trauma algorithm are amplified by the hesitation to treat pain that accompanies the failure to distinguish pain and anxiety.

Differences in Educational Preparation

The profession with the most capacity to influence and drive delivery of pain interventions to pediatric trauma patients, the physician group, surprisingly receives the least amount of pain education (Watt-Watson et al., 2009). The physicians need to be certified with the Pediatric Advanced Life Support (PALS) course. As opposed to the deficiency of pain education in the physician group, education for emergency nurses, PALS and Emergency Nursing Pediatric Course (ENPC), includes an algorithm indicating when to treat pain along the continuum of care specifically designed for trauma patients. (see Table 19.)

In this study, one of the ED physicians who had relatively recently completed the ATLS course stated there was no mention of a trauma algorithm in the teaching sessions or any instruction regarding pain assessment or management:

Yeah, not the specific algorithm, but definitely, from what I understand, the traditional style of teaching is that you manage the ABCD and pain came right at the end. And even . . . so two years ago I did an ATLS, the adult trauma course, and I don't think that pain management was mentioned once in the two-day course.

Table 19
Differences in Educational Preparation Between Disciplines

Theme	Subtheme	Code
Differences in educational preparation between disciplines	Diverse focus on pain education between RNs and MDs with no efforts being made to change	Pain not mentioned in trauma care education for physicians for adult or pediatric patients
		Nursing protocols do address pain but later
		Little attention paid to pain in trauma care

The majority of the physicians were not aware of the placement of pain treatment in the trauma algorithm taught to emergency nurses. This ED physician was unaware of this approach to care in the trauma room, stating:

Physician: I'm not sure what algorithm you're talking about. Because pain doesn't have a separate . . . I've not heard of it that way actually . . . that it's ABCDEFG . . . I . . . certainly you would tend to the life threatening injuries first and then your primary survey but once a child, you know is stabilized and you're able to, you know, pain control is usually given. At least that's how I practice. You stabilize somebody and then you address their pain.

Interviewer: OK. No, it's just the way that . . . um . . . ABCD is the primary survey and then you would repeat that as many times as necessary, but there is an algorithm that talks about environment, family and then it's g-give comfort.

Physician: Oh well that's not the one I learned.

The absence of pain assessment and management during formal teaching for trauma care providers may provide a subliminal message that diminishes the importance of this aspect of trauma care. Furthermore, in the broader organizational context, trauma care is not considered a focus of improvement within the study hospital, as evidenced by this ED nurse's comment: "Um . . . trauma seems to be . . . you know . . . valued in kids but yet in the hospital it's not really one of the big projects you could say".

Having highlighted the disconnection between pain education of the ED physicians and nurses, the senior nursing staff indicated they were aware of this disconnect and often took on the role of pain advocate when necessary.

This physician discussed the sum of his pain education in general:

It was both . . . um . . . with regards to training for pain management . . . we have annual CV requirements uh . . . in the States . . . so . . . I can't remember the frequency but I think it's at least twice yearly our educational half days during residency we had to have . . . certain things were mandated, like, sleep deprivation and or a talk on sleep a talk on cultural sensitivity and then I think a talk on . . . two times a year we had to have talks on pain management and so that's incorporated into our curriculum. You know often there's informal discussions about pain management, obviously we spend a lot of time a big part of our day with anaesthesiology in the operating room and you know . . . they treat pain uh . . . and there are experts in pain and so we always discuss things . . . certain patients we treated together on an informal or formal basis. And then every now and then we get surgical patients that are chronic pain patients and those patients we learn from . . . or read up about . . . pain management . . . we learn from those sources as well.

The entirety of education with regards to pain management with trauma patients appeared to be even less, in this same physician's discussion of the advanced life support course content:

. . . you know it's basically institution-dependent. For example, where I trained you had to have a certain base in life support advance . . . cardiac life support ALS for adults . . . the PALS for pediatrics . . . but none of those really address pain. There may be a paragraph in thereafter, you know, you make sure that the patient is stable then you can also address the pain.

Health care providers working within the organizational culture of a regional pediatric trauma centre have adopted the ATLS as the approach to trauma care. The ATLS is not only widely accepted throughout the study institution but is widely used and adopted throughout Canada and the United States. In the PALS guidelines (Kleinman et al., 2010) pain is addressed three times. It is noted (a) with conducting procedures such as intubation; (b) as a symptom that can cause tachycardia and is treated as tachycardia relates to shock; or (c) as presenting a confounding symptom when ascertaining cardiac conditions. Use of the trauma algorithm moves

far beyond the organizational culture of the study hospital. Changes to care are possible; however, these changes must be highly organized, with expert stakeholders engaged. The specific considerations of pediatric pain management appears to be a gap unless tied to procedural pain.

Fractured Approach to Pain Management in Trauma Care

All disciplines highlighted some elemental inadequacies in the management of pain for children with trauma. None of the interviewees specifically felt that pain management was optimal. (see Table 20.)

Table 17
Fractured Approach to Pain Management in Trauma

Theme	Subtheme	Code
Fractured approach to pain management in trauma	Pain not a competing priority in trauma care	Several different disciplines admitting inadequate pain treatment
		Differing opinions about how pain should be treated
		Candid statements that pain treatment was not a high priority in trauma room
	Lack of clarity in approach to pain treatment in trauma room	Tension between documentation and what individual wants to administer for pain
		Differing perspectives on approach to pain management
		Individual physicians treat pain their own way and do not know what other physicians are doing
		Hectic attempts to bring attention to patient's pain
	Changing approach to trauma care	Experienced staff more likely to advocate for pain treatment
		Current shift from general surgery to ED physicians caring for trauma patients

Several dimensions of the approach to pain management for pediatric trauma patients were recognized as problematic including (a) inadequate pharmacological treatment of pain for the pediatric trauma patient, (b) pain not being the priority in trauma, and (c) a fractured

approach to pain management in trauma. A fractured approach to pain management refers to the inconsistent manner in which clinicians provide pharmacological, physical, and psychological pain interventions to pediatric trauma patients.

Inadequacy of pain treatment in trauma. It was evident from some of the interviews with HCPs that pediatric trauma patients frequently did not receive therapeutic levels of opioids.

This ED admitted:

Um. . . but I don't know if I can accurately tell you if I feel, like, they're probably getting what they need . . . um . . . in order to be comfortable as much as they could, I guess you would want to say tolerate. But I would say the majority of the time, somebody's addressing their pain. I just don't know if it's really addressed well.

This narrative illuminates that, even when given, doses of analgesia are often subtherapeutic and therefore have the potential to provide ineffective analgesia. The same sentiment was expressed by an ED nurse who held the opinion that, in spite of recent attention paid to pediatric pain management in the ED, suboptimal treatment of pain persisted. In the early stages of trauma, when pain is likely the most intense, recommended doses of opioids were often not provided:

Well I think, you know, in the last couple of years there is an improvement in management of trauma pain. Uh but it's still not well managed in that initial, let's say 2 to 3 hours after the trauma. So . . . what people don't want to give are opioids to patients with head injuries. Or possible head injuries, even though the child might be awake and crying, they say oh we better get a scan first if it's a multiple trauma . . . OK . . . so . . . now they do use morphine better or fentanyl but uh . . . it's not an infusion, it's maybe . . . not even . . . the recommended dose . . . it's often less than the recommended dose for the child's weight . . . just in case . . . I'm not sure what this 'case' means . . . you know . . . and that's a child that's awake and alert and that has an IV access that could have opioid pain management.

Similarly, an allied health professional, who regularly attended when a trauma protocol was triggered, was asked about her perception of how pain is managed for patients in the trauma room. She felt there was room for improvement:

I think it's generally OK . . . I think there's lots of times it's not because I'm not a medical person but I do know they need them conscious and I do get all of that . . . I think they experience a lot of pain just you know the nature of the accident and examinations . . . um . . . afterwards . . . yeah . . . I think so . . . I think they . . . yeah but I think at the scene and the experience in the trauma room where all the trauma actually happens . . . evidence shows it and the kids say that it's really difficult.

Perceptions of the situation from different professionals can offer a fresh perspective to the trauma scenario. In this last quote, the social worker infers that the trauma room experience almost equals the traumatic event. From the critical realist standpoint, this dual perspective can be explained as emergence of social and natural circumstances combining together in the reality of the child's traumatic experience. Injuries from the trauma are situated in the actual world while the execution of the trauma assessment process by all the HCPs in the trauma room are situated in the real world. The generative mechanism of juvenile ageism proposed as resulting in delays in pain treatment was augmented by the constraints of ATLS guidelines culminating in inadequate pain management for the pediatric trauma patient.

Differing perspectives in approach to pain management. Many of the clinicians emphasized the necessity of, but the differing perspectives on, delivering pain treatment. One physician spoke to how the ideal pain medication protocol (when applying traction for a fractured femur in the emergency department) differed from written ED protocols:

You want just enough so it's titration to affect, so it's just enough. For the opiates that are prescribed, usually for example the morphine IV, you might but you give the dose, you see how the child responded just, just wait five minutes, like, we do in the recovery room and repeat the dose again or even just give half the dose again until they start to get comfortable.

In some professions pain care can mean divergent approaches to pain management. One allied health professional invoked a different approach to pain management, one that is infrequently considered in the trauma room setting:

Um, one of the things I've noticed is that for example, each belief system or each religious affiliation with that particular family . . . some families, for example a Hindu family would not want the child to really be given a lot of (pain medication) because it's a period of time in their life when they're not conscious about what's going on. And if the child is 15 years old or 16 or, like, that, they want the child to be aware of what's going on so too much of medication will not give them an insight of what's going on in their surroundings. It can be a selfish motive for the family as well and they may not understand the child's pain. So I think there's a thin line there, right? Because it involves, like, in Hinduism there's a lot of karma philosophy in there. Some individuals would like to leave the body in an awareness of god. So, when they are in that realm of an awareness of body, of mind, their surroundings, their family . . . they want their last thoughts to be on that . . .

The ED physician pointed to the following approach to pain management:

. . . there isn't sort of a cookie cutter sort of way for me to say "Everybody gets so and so" when they come into the trauma room . . .

Since accepted care within the trauma room of the ED is guided by strict adherence to trauma care guidelines that lack formalized plans for pain treatment of trauma patients, it seems there is a reactive approach to pain management dictated by the individual child and family as well as the HCPs involved in the care. The approach to pain management within the trauma room of the ED stands in contrast to well-defined pain assessment and management protocols in place for the broader ED setting at the study hospital.

Pain is not a competing priority in trauma care. Pain management was not a high priority in the trauma room for many of the HCPs interviewed. This physician related her/his philosophy on the priority of pain management in trauma patients:

It's really . . . it's pretty . . . it's not . . . it's not . . . uh . . . it's not high up there. Trauma is one of the few things in surgery that is very protocolized. And um . . . you get into your trauma mode when you're in the resuscitation room and it's very strict and there's very little that deviates from it. Trauma is about A airway, B breathing, C circulation, D disability, E exposure and in kids sometimes we say T for temperature. There have been some that added P for pain somewhere but really you're not . . . I'm not . . . we're not . . . surgeons are not thinking about the aspect of pain. Though I know that it's a little contradictory but the culture usually in surgery is to resuscitate, stabilize, get a good exam and then deal with

pain and so . . . I guess . . . the reflex instinct is to minimize the use of pain medication before we do all those things.

Organizational culture relates to management of pain in trauma patients, in that the broad organization at the study hospital has adopted general surgeons as the lead providers in trauma care, and existing trauma algorithms as the best practice in the management of pediatric trauma patients. The effect of organizational culture on the behaviour of individual HCPs in the trauma room transpires in a subconscious manner. The culture of the surgical specialty focuses very pointedly on the surgical issue and it is the general surgeons who frequently acted as TTLs within the study hospital. Organizational culture is responsible for shared solutions of which the trauma algorithm of care is one; principles of organizational culture suggest that if a shared solution is working well enough, it will be taken for granted, drop from awareness, and become an unconscious assumption. The unconscious assumption is then taught to new members coming into the study hospital and becomes the correct way to do things (Schein, 1996). Pain treatment for the pediatric trauma patient is affected by the two factors combined, namely, trauma care being in the charge of general surgeons, who have fine-tuned focus on injuries; and the use of the trauma algorithm, which does not place pain as a high priority. Organizational culture is shaped by its leaders (O'Reilly, Caldwell, Chatman, & Doerr, 2014), which places an onus on leadership at the study hospital to influence clinical practices and address inadequately addressed aspects of care such as pain treatment in pediatric trauma patients.

The powerful influence of organizational culture is frequently underestimated, particularly where phenomena such as pain management in pediatric trauma are not clearly understood. The critical realist notion of the temporal relationship of society to the individual is evident; the critical realist emphasizes that individuals enter into a society with social structures already in place. Surgeons are thus a part of a larger group that does not place pain as a

competing priority; they must adapt into a broader culture that lies outside of the study institution.

Lack of clarity in approach to pain management in trauma room. Unlike the highly structured approach that the trauma algorithm brings to trauma care, it appears that each clinician acts independently when it comes to pain management. When this physician was asked how she felt pain was managed in the trauma room in general, it became apparent that there were no guidelines for this aspect of care. However, like many other HCPs interviewed, she indicated there was an undefined but informally organized drive and personal desire towards improving pain management for trauma patients:

Well I can't really speak generally,, like, I could speak to the situations I'm involved in., like, I don't actually know how the others work or how that works. And there's a fairly large pool of people that function in the TTL role so and it's multi-disciplinary so sometimes it's Emergency Medicine, sometimes it's General Surgery, and I think there are different ways of practicing so I don't know generally how it happens at xxx. Um . . . but I do think there's certainly been a . . . a . . . like, a movement towards addressing pain earlier in the resuscitation than there was previously . . . so.

Pain management was often left until somebody spoke up and advocated for the child. The reason for the lack of attention to pain interventions was unclear but seemed embedded and could be because most of the HCPs interviewed perceived that there were more important things that needed to be done. Below, this allied health professional spoke to the silence of pain advocates when asked whether she had ever advocated for pain treatment in the trauma room:

. . . sometimes they don't hear because you know, there's organized mayhem down there but I do . . . and very often somebody will say to somebody else . . . "When was the last time he had whatever?" . . ., like, medicine and they'll get on that and we can say to the child, or to the parent that they've just had pain medicine. So, it eases the parent's anxiety too right when we say we've given pain medicine and they'll be better soon. And then the children generally calm down too when we say it shouldn't take long.

The onus of advocating for the child's pain management is often felt to belong to the nurse; however, the nursing group may lack the necessary assertiveness and experience to bring pain treatment forward in the trauma situation, as this ED nurse suggested:

Well I think that an experienced nurse you can really advocate for the child and say now come on . . . let's be realistic here right? . . . uh . . . but nurses in general in our department aren't as experienced as I am so really more nervous around making sure they have . . . the patient is stable, assessed frequently and documentation and sort of looking to others for guidance on that kind of stuff . . .

The trauma room is a part of the ED that has demonstrated improvement in pain assessment and management in recent years; yet it is separated from the rest of the ED in many ways and has not yet reflected improvements, as noted by this ED nurse:

In emerg we use nasal sedation and pain management but in trauma they haven't even thought of that yet . . . it's way beyond . . . I think it's another few years coming but maybe we could speed that up somehow . . . uh . . . ED Because nasal as well is very helpful.

Both Ali and colleagues (2014) and Chafe and colleagues (2016) have demonstrated that improvements in pain assessment and management is challenging and complex in the busy environment of the ED. There are no protocols, established practices, or benchmarks specifically tailored for pain treatment of the trauma patient. The part of the algorithm of trauma care for the nursing profession referring to "giving comfort" near the end of the algorithm was recently unofficially moved to "full set of vital signs," with the advent of pain assessment as the fifth vital sign.

Changing approach to care. While most of the Code 50 trauma cases in the study hospital have historically been managed by senior surgical residents, the current trend is for the ED physicians, who work within the broader unit where the trauma room is situated, to manage some of the cases. Two of the three study ED nurses expressed confidence for an improved pain assessment and management process with adoption of this new practice. Several senior ED staff

nurses felt ED physicians had the experience and assessment skills necessary to better deal with children in distress. One nurse expressed this notion clearly:

But most of the people we work with in trauma,, like, our emerg doctors are starting to manage the trauma patients so it's better but most are general surgeons that come from a lot of institutions that are just adult focused and they have no experience with managing a child's anxiety and pain or assessing a child's pain so . . .

The presence of head injuries and the necessity to assess any deterioration in the level of consciousness was frequently mentioned as a barrier to providing pain treatment in the trauma room. The nurses indicated that ED physicians could better discern the nuances in various levels of consciousness in children generally, and that this important skill could transfer to the trauma room.

Yeah . . . because they are more comfortable at assessing the level of consciousness to get the idea of the head injury type perspective and then give the pain medication . . . um . . . just because of their assessment skills. Also, if they do it more frequently they will be more likely to have that experience to say no this kid can have this pain medication and we're OK with that . . . we know it's safe.

Within the ED, changes to pain assessment and management are beginning to be made (Drendel et al., 2006). Patients with head injuries or those who are nonverbal or non-English speaking are difficult to assess due to the difficulty in identifying pain through behavioural pain scales, and are at greater risk of inadequate analgesia (Herr et al., 2006). Data from the ED nurses interviewed indicated that there was a preference for the ED pediatricians, with their expertise in assessment in general, to assess pain in the pediatric trauma patient. Additionally, trust has been built between ED nurses and ED physicians, that ED physicians would be responsive to the child's need for pain management.

Underlying assumptions about pain management in trauma

Many assumptions about pain management arose during the interviews with HCPs. These assumptions underpinned the actions of staff members in the trauma room (see Table 21.)

Table 21
Underlying Assumptions About Pain Management in Trauma Care

Theme	Subtheme	Code
Underlying assumptions about pain management in trauma care	Assumptions about pain management	EMS has provided pain medication en route
		Transferring hospital has provided analgesia prior to arrival at study hospital
	Assumptions about trauma protocol	Trauma protocol is based on current research
		Trauma protocol is best practice
		Trauma protocol would be very difficult to change

Assumptions about pain management. One of the assumptions that arose was the belief that most children had received a pain intervention prior to arriving in the ED. When asked if it would be considered worrisome for children to have pain medication on board upon arrival to the ED, this ED physician was confident that it was the norm for children to have received prior pain interventions:

No not at all in fact, that would be the norm, that EMS have given, have already given the child some analgesia. And I think most of us would, unless it's an obvious head injury, you something that's not going to mask . . . so . . . um. No, I think that's the norm that the child has had something . . . EMS is pretty good. We often get their reports to us are that . . . you know they've had, they've either had morphine, several times sometimes before they get to us. Some of the delay, if you were to go back and look at the charts I wonder . . . I think you're doing that . . . you're looking at EMS . . . some of the delay, if you just looked in the emerg and the trauma room to delayed analgesia is often because they're given a dose right before they arrived or right as they're pulling in. So, I have noticed that, you know, right as they're pulling in. You know analgesia may not be given in that 30 to 40 minute period but they had received something when they came so . . .

An ED nurse was also under the assumption that pain interventions were generally provided en route to the hospital:

If they've been transferred from another facility, they have been treated. And we're more and more likely to treat them more quickly because they've already done the primary assessment. If they're coming from the field, hopefully what they gave is adequate to kind of take the edge off at least . . . which means they probably won't be treated until we're done our primary.

The same ED nurse echoed the belief that children would be given pain interventions en route:

Unless the kids are completely oriented and if they are and quiet and oriented and are able to verbalize what's going on with them, I think, you know if they say, you know my arm is hurting terribly and there able to assess their neurological status they probably would treat them in the field. I think they have a protocol for that.

None of the staff interviewed overtly stated whether they checked EMS documentation to see if a dose of pain medication had been given.

Several HCPs had assumptions about expression and verbalization of pain by the children they cared for in the trauma room. One of the nurses felt that pain was not what children were most concerned about when they arrived in the trauma room, but that they were more overwhelmed with fear. Additionally, the impression was that children who were younger were treated sooner for their pain than older children:

So, I think kids are really overwhelmed really when they come into the trauma room. So, I think pain is not at the top of their minds whereas if they were in more of a settled environment and they had say a fractured arm . . . they would focus in everything that's going on with them . . . but there's just so much chaos . . . and so many people and so much noise and all this is happening. I think with the older kids . . . the little kids are in so much pain and they'll just scream and they get treated. I think the older kids wince and they are fearful and they put guard but they're not as verbal about it so I kind of feel their pain treatment is not as quick as the younger kids who just scream. Or some kids just scream and it's just scary and we can't tell what they're doing right? And those kids might actually get medicated even though they're not really in pain but because they're so little we can't really tell the difference.

The children interviewed did not indicate they were aware of an association between their pain expression or verbalization and their pain treatment, as suggested by the above statement by the ED nurse. The oldest child interviewed, Amanda, age 14 years, did appear that she was

putting up her guard when it came to verbalizing her pain experience. Furthermore, she stated she waited for several hours before her pain was treated at the transferring institution. Peter, age 12 years, was screaming out loudly in pain but he still had to wait a long time for pain treatment.

Although children may have received some form of pain treatment prior to arriving to the trauma room it cannot be assumed, as many of the HCPs noted. Although there is a medication record that can be checked to see if medications have been administered, the perception is that there is no time to examine these medication records since the priority is to care for the child's immediate physiological and hemodynamic stability. Hennes and colleagues (2005) found significant disparities between what EMS providers thought they had given to patients for their pain and what they had actually given. Few pediatric patients received pre-hospital analgesia in the research by Swor, McEachin, Seguin, & Grall (2005), who described the frequency of analgesia administration to pediatric patients during EMS transport. The assumption that children had already received analgesia prior to arriving in the ED appears not to be supported by practice. Organizational cultures of both the pre-hospital and trauma room are implicated in making changes to pain assessment and management practices for children with trauma.

Assumptions about trauma protocol. Assumptions regarding the benefits of the trauma protocol were apparent. The protocol was commended by the ED nurse below, who was grateful for the international nature of the protocol. When a TTL was new to the hospital and not familiar with hospital policies and procedures, it was likely that person was at least familiar with requirements in the trauma room:

I mean I think the research still supports the one we use. And I think they're consistent, because they're consistent everywhere, then when we get fellows from other places then we know that certain aspects of the trauma will be consistent, so for us that's good because we have people coming from all over the place.

Whether the new staff have come from an adult health care professional background or have specialized in pediatric trauma, the protocol used would be the same. While the trauma protocol is known world-wide, and viewed by some as advantageous, the international nature of the trauma protocol can also make the ability to change it even more problematic. As one of the ED nurses notes:

Yeah, yeah. The best practice for pediatric trauma . . . it's not something that we work on here.

A comment by an allied health professional reflects the same sentiment—it is difficult to effect change within the trauma room:

I think if we moved pain management, upped as a priority, it would be really good for, not just the child but for the parents who are . . . you know . . . observing their child in pain so I think that might help . . . but within the context of the trauma room . . . it's kind of wishful thinking but . . .

However, the broad range of physicians familiar with the trauma protocol only serves to continue to entrench the place of pain assessment and management near the end of the trauma management process. Unquestioning acceptance of the trauma protocol by trauma room staff is an indication of how deeply embedded and not amenable to question or change the current protocol is. The critical realist would suggest the knowledge of the protocol is part of clinicians' weighted summary that they bring with them to the provision of care of pediatric trauma patients. Many clinicians were conscious of the difficulty of making change to the protocols of care for trauma patients. Changes to the trauma algorithm would transcend organizational change, and require challenges to the broader discourse of trauma care. This type of challenge is beyond the scope and ability of most trauma room staff.

Tenets of behaviour change theory (Prochaska, 1979) suggest that a shift such as a change in the trauma algorithm is possible. Openness to change depends upon the stage of change one is situated in. Stages of change identified in the transtheoretical model of behaviour

change (Prochaska, 1979) include: precontemplation, where one is not open to change; contemplation, where there is an awareness there is a problem with the status quo; preparation, where one is setting the stage to take action; action, where behaviour is modified; and maintenance, where behaviour change is stabilized (Kirk, MacMillan, & Webster, 2010; Prochaska, DiClemente, & Norcross, 1992). When change is based upon the stages of behaviour change theory the process can begin. Successful change interventions identified by Johnson and May (2015) in an overview of systematic reviews examining professional behaviour changes (were reported to be audit and feedback, educational outreach visits, and reminders).

Unique Circumstance of Trauma and Pain

Many disciplines concur that the children in this study were undergoing a very unique and alarming experience of trauma and pain. Anxiety and fear were acknowledged to exacerbate the children's pain. (see Table 22.)

Table 18

Acknowledgement of Unique Experience of Trauma and Pain

Theme	Subtheme	Code
Acknowledgement of unique experience of trauma and pain	Awareness of impact of trauma experience	Statements of how patient is dealing with experience of trauma
		Questioning whether HCPs are aware of the impact of assessment process on patients

This ED physician conceded the exacerbation of pain by fear and anxiety that is present in the trauma room:

. . . you know there's a lot of factors that go into how much pain that person . . . it depends on what your level of consciousness is and I really do think that the pain experience is influenced by fears, influenced by stress, like, all of that stuff can like, exaggerate.

ED nurses expressed the same awareness. The children were going through a disturbing experience that has caused a disruption in their lives:

Because if you have a calm child you can distract them better but if you have all that motion going on in the trauma room and everyone's heightened anxiety, then their pain levels and anxiety are going up as well. These are the kids that need the pain management the most.

Social workers dealt with the aftermath of the trauma with the patient and their families. They were cognizant of the long-term effects the family may encounter after such an experience:

There is . . . there are so many people in the trauma room it's frightening . . . it's very, very frightening for them and um . . . also having all their clothes taken off and examined and the rectal thing because children have spoken to me about the accident wasn't as bad as what happened in the trauma room . . . uhmmm . . . so all of those things are another layer of distress for these kids because they don't understand why all of this is being done and depending on the age of the child . . . um . . . very humiliating for them. The teens have a harder time having everyone looking at them and examining them. So, it's all the fearful things . . . the needles, the number of people, the intensity of the situation . . .

One of the senior ED nurses spoke to the horror that children and family members might have endured prior to arriving in the ED:

She fell (water) skiing and then somehow I don't know how her arm got stuck in a motor or something. The grandfather had to reach in and pull her out of the water . . . he got some kind of adrenalin rush but he was able to get her up in . . . the motor fell off and it somehow hit her . . . but he got her to safety though . . . but she lost her arm . . . part of her hand . . . somehow it just went chunk chunk . . . but it doesn't happen often though, for sure. Do I feel children feel a lot of pain? . . . no question . . . yeah. And then all these strangers are looking at them . . . and asking questions . . .

The scenario described above occurred several hours prior to arrival in the ED and represented a situation that was unusual and stressful for all involved. The unimaginable pain the child endured, and that a loved one may have borne witness to, required another level of sensitivity from the HCPs in the trauma room.

Health Care Providers' Perspective of Pain: Summary

In summary, HCPs offered insight into the empirical and real layer of reality for the critical realist. Actions of the staff members in the trauma room were based upon attitudes and the current discourse of their disciplines, which represented the real layer; socially developed and accepted algorithms of care and any tension in relationships between staff members and between staff and patients influenced care provided to the pediatric trauma patient. Their perceptions offered insight into the observations of behaviours related to patient pain or distress that comprise the empirical layer.

Interviews with HCPs who cared for pediatric trauma patients indicated that primacy of physiology and efforts to ensure hemodynamic stability drove trauma care; this was a dominant theme. The approach to care for the HCPs pointed toward a dependency upon the trauma algorithm felt to be the best model of care for these patients.

All HCPs felt that the representation of children's pain was confusing and that the differences between pain and anxiety needed to be identified. Many HCPs stated they could not tell whether children were in pain or extremely distraught due to the chaos of the trauma assessment process.

Stark differences in educational preparation for pain management for pediatric trauma patients emerged as a surprising finding; physicians stated that they had received minimal or no pain education during their training for trauma care. For their part, nurses indicated that they had guidance from their profession to address pain during the trauma/resuscitation process, albeit near the end of the secondary survey of the trauma algorithm which occurs after stabilization of airway, breathing, circulation, and disability. The secondary survey encompasses attention to the

environment and the family, and it gives comfort and a more comprehensive head-to-toe assessment.

The study revealed quite fractured approaches to pain management, and no specific guidelines. Lack of official procedures or protocols for pain management resulted in (a) each physician treating pain within their own philosophy, which at times proved to be difficult; (b) pain treatment being relegated to a lower priority; and (c) opioid analgesia being dosed at suboptimal levels. The lack of clarity about pain treatment and a changing formation of staffing within the trauma room in the study ED combined to describe an unorganized approach to pain management that was palpable.

Underlying assumptions regarding the care of trauma patients included two main points: that children had already been provided with adequate analgesia prior to arriving at the study ED, and that the trauma algorithm of care represented the best evidence. HCPs expressed understanding of the pediatric trauma unique experience of trauma and pain.

Through analysis of the quantitative data from Phase 1 and qualitative data from Phase 2 the next chapter will examine the linking of results described in this chapter to the causal mechanisms identified through critical realism and inform a path to a deeper understanding of treatment of pain in pediatric trauma patients. For example, delays in delivery of pharmacological pain interventions reported were supported by comments by the HCPs who stated they were unaware of pain guidelines for the pediatric trauma patient. Lack of guidelines for pain management resulted in hesitancy in administration of opioid analgesia by the HCPs as well as titration with lower doses of analgesia. These patterns of opioid analgesia administration link to organizational culture as a generative mechanism because there are no clear efforts by the organization to address the lack of guidelines. Persistent delays in the period of time between the

traumatic event and delivery of pain interventions for children as compared to the same time period for adults, as reported in the literature, links to juvenile ageism as a generative mechanism.

CHAPTER 6:

DISCUSSION

In this chapter, knowledge claims from the results are discussed, based on inferences drawn from the research questions and the results from Phases 1 and 2. The results shed light on pain assessment and management practices in the pediatric population dealing with acute pain as a result of trauma; the child and situational factors influencing the pain; and the perception of the pain experience from the child's and the HCP's viewpoints. Phase 1 and 2 results are integrated, discussed in relation to critical realism, and compared to related extant literature.

Summary of Findings

Nature and frequency of pain assessment and management. Almost all (86.5%) of pediatric trauma patients had a recorded pain assessment; a narrative notation was used in about two thirds (67%) of the cases. The narrative commonly indicated only the location of pain to determine injury, and minimal pain descriptors were used. The NRS (Downie et al., 1978) and the FLACC (Merkel, Voepel-Lewis, Shayevitz, et al., 1997), validated pain tools, were used to record pain just over a quarter (27%) of the time. Pain management interventions were predominantly pharmacological and were provided to 91/104 (87.5%) pediatric trauma patients; opioid analgesic agents morphine and fentanyl were administered intravenously.

Influence of child and situational factors. Children with a higher ISS and those who had been struck by an object waited a significantly longer period of time for their first pain assessment. Children who had more injuries, who suffered an assault, and who had a head or spinal injury waited a significantly longer time to administration of the first opioid analgesia.

Situational factors that influenced pain assessment and management related to differences in whether children arrived at the study hospital via the direct or indirect route. Pain intensity

scores were higher in the direct trajectory group, both en route to and in the trauma room at the hospital ED, than in the indirect trajectory group. The time from the traumatic event until the first pain assessment was longer for the indirect trajectory group than for the direct trajectory group. A significant number of opioid analgesia doses were suboptimal for children in the indirect trajectory group.

Children's interviews. Most children reported that they had experienced immediate severe pain from their injuries and by the procedures making up the trauma assessment process. They also indicated they had been overwhelmed by the traumatic event but had valued the supportive people who communicated with them throughout, helping them manage their anxiety and deal with the uncertainty of their circumstances.

HCP interviews. HCPs revealed that there was ambiguity regarding the pain treatment for children with trauma. The absence of guidelines specific to the trauma patient left each clinician to decide upon their own approach. The ambiguity of pain management guidelines lay in contrast to the required adherence to the trauma protocol that places pain as a lower priority than establishment of physiological stability (see Appendix B). There were differences in educational preparation of pain management between nurses and physicians. However, changes were on the horizon, since management of trauma patients was to shift to emergency staff physicians, who have expertise in assessment of children and are comfortable treating their pain. HCPs expressed hope that good pain practices currently within the broad ED would begin to percolate into trauma care.

Phase 1:

Pain Assessment and Management Practices in Pediatric Trauma Patients

Nature of pain assessment in pediatric trauma patients. The principal method of pain assessment for these patients was narrative notation, used primarily to note absence or presence of pain and location of pain. Pain descriptors including indicators of the quality of the pain (e.g., dullness, pressure) and word qualifiers (e.g., pain intensity, temporal comparisons of pain states) identified in previously examined pain narrative notations in hospitalized children (Rashotte, Coburn, et al., 2013) were infrequently reported in the pediatric trauma patient records in the present study. Structure (e.g., pain summations or intervention plans) and content (e.g., pain declarations with quality, intensity, and temporal descriptors) of the narrative notations, previously reported in pain narratives for hospitalized children (Rashotte, Harrison, et al., 2013b), were seldom recorded for these pediatric trauma patients. The study population eluded to by Rashotte (Rashotte et al., 2013a; Rashotte et al., 2013) differed from the patient population in the present research in that their sample included children who were hospitalized on medical, surgical and critical care units across Canada as compared to the trauma patients of the same age group in the study hospital in the present research. Drendel et al. (2006) examined pain score documentation in the ED and found that 44.5% of children had a pain score documented. The use of pain scores is lower in the present study than pain score documentation noted by these authors.

More substantive appraisals of pain states recorded in hospitalized children lay in stark contrast to the appraisal of pain states in pediatric trauma study patients whose pain was reported in terms of absence/presence of pain and pain location only. The general intent of pain assessment in hospitalized children points to an assessment of effectiveness (or ineffectiveness)

of pain management strategies, whereas the intent of pain assessment in the initial stages of trauma care points only to identification and severity of injuries. The absence of documented pain descriptors in trauma pain narratives suggests the multidimensional pain experience of traumatized children is of a lesser importance to HCPs than their injuries in the trauma scenario.

During interviews for Phase 2, the children did not verbalize an awareness of their pain having been assessed. During interviews of HCPs, injury identification was noted as an imperative activity while pain assessment was not. Between optimal pain assessment practices and the documented pain assessment practices noted in this research lies a gap in pain assessment for pediatric trauma patients. This gap is possibly due to the beliefs and attitudes of the HCPs caring for these children and the trauma algorithm of care, which does not consider pain a competing priority.

Of the 90 children who had a pain assessment recorded, 24 (27%) had the assessment done with a pain tool (e.g., the NRS; Downie et al., 1978). Of the 24 children who had their pain assessed with a validated pain tool, nine (37.5%) children were eight years of age or younger. Goodenough, Addicoat, et al. (1997) cautioned that the NRS (Downie et al., 1978) was not an appropriate self-report pain measurement tool for children under the age of eight, since they have difficulty discriminating between pain intensity and distress, fear, and/or anxiety. Additionally, these children do not have the cognitive ability to understand seriation or estimation of quantity, both necessary concepts when using a numerical scale. According to Piaget (1964), a concrete operational stage is reached at around eight to 11 years of age; children in this stage attain the ability to understand seriation and classification according to size.

The FLACC tool (Merkel et al., 1997) was used in the present research for children who were not capable of verbally responding or were developmentally delayed. Given the broad age

range of children who may experience a traumatic event, a variety of validated pain assessment tools must be used. As location of injury is fundamentally important in the identification of injury, HCPs must provide a brief narrative description of the pain location; but they may perceive no need to ascertain pain intensity. However, inadequate use of pain intensity tools was not specifically alluded to in the interviews with HCPs conducted in Phase 2.

Clinical utility in the pediatric trauma patient population is an important contextual factor to include when ascertaining the best pain assessment tool in the trauma scenario. Trauma room and EMS staff are likely more familiar with the NRS (Downie et al., 1978) or narrative notations as indicated in Phase 1 results, where the NRS and narrative notations were noted to be the methods of pain assessment recorded most frequently. Additionally, the NRS was the only option for recording pain on trauma documentation charts at the study hospital.

There has been no validation research to determine which pain assessment tool(s) would best assess the specific pain state of pediatric trauma patients across the various age groups. We do not know if there is a difference between the acute pain experienced by pediatric trauma patients and other types of pain-inducing clinical scenarios (e.g., postoperative or procedural pain). Therefore, pain assessment and management practices outlined in the ED unit policies should prevail. The unique circumstances of pediatric trauma patients and the potential for experiencing increased fear and anxiety could suggest that a specialized approach to pain assessment may be necessary; however, given the wide range of ages, injuries, and conditions one pain tool will not suffice. With clinical utility first and foremost in the urgent scenario of the pediatric trauma patient the pain assessment tools reported in Phase 1, the NRS (Downie et al., 1978) and FLACC (Merkel et al., 1997) pain assessment tools, are likely best suited.

That children who had a high ISS waited significantly longer for the first pain assessment is likely due to the longer period of time required in the early stages of assessment and management of injuries. The children who had been struck by an object and also waited significantly longer for their first pain assessment may not have been recognized as seriously injured in the initial stages of assessment and management. Children in the indirect trajectory waited longer than children in the direct trajectory for an initial pain assessment. This longer period occurred despite a negligible difference in the time spent under the care of EMS during initial transport. The indirect trajectory group came from community hospitals with a combined pediatric and adult ED; these combined EDs have been reported to lack appropriate pain protocols for the pediatric patient population (Ali et al., 2014; Chafe et al., 2016). Findings from the present research align with these observations.

Findings from this research address gaps in literature related pain assessment for children with trauma. To address the gap in literature regarding pain assessment for the pediatric trauma patient the present research includes an analysis of pain narratives not found in the current body of trauma research. The use of specific pain tools were identified in this research while the assessment tool is frequently not identified in other research. For example, pain assessment data were not reported by Anantha et al. (2014) who examined pain management in pediatric trauma patients in the primary survey. Izsak et al. (2008) reported how frequently pain was assessed for pediatric trauma patients associated with mechanism of injury as well as identifying the pain tool used. Devellis et al. (1998) and Neighbor et al. (2004) examined pain management in pediatric trauma patients however, there were no reports of pain assessment. The pain assessment approach used most commonly in this research was narrative notation while the pain assessment tool used most commonly was the NRS.

Pain reassessment in pediatric trauma patients. In the direct trajectory group, pain intensity was significantly higher on initial pain assessment, on pain reassessment, and while in the ED as compared to pain intensity scores for children in the indirect trajectory group. Although there was a significant delay in conducting the initial pain assessment with the indirect trajectory group as compared to the direct trajectory group, the differences between the two groups in the time from the traumatic event until administration of the first opioid analgesia were not statistically significant. However, while the difference between the time periods to first opioid analgesia between direct and indirect trajectory patients was not statistically significant, it was clinically significant. It is possible that clinicians in outer-lying hospitals were not as familiar or comfortable with administration of opioid analgesia to children. The difference in pain intensity between the direct and indirect trajectory groups on route to the study hospital may have been because children in the direct trajectory group spent less time in the prehospital setting since they were picked up locally by EMS. The total amount of time spent in the prehospital setting for the direct trajectory group was 32.8 ($SD = 15.3$) minutes while the median time prior to arriving at the study hospital was 66 (IQR = 54-95) minutes for the indirect trajectory group. Additionally, children in the indirect trajectory group had been stabilized for transport; opioid administration during transport to the study hospital took place under monitored, safe conditions which could result in lower pain intensity scores. These children were under the care of HCPs and EMS staff long enough for opioids to take effect, compared to the direct trajectory group. Existing literature examining pain assessment in the prehospital setting indicates that suboptimal pain assessment for pediatric patients is widespread (Murphy et al., 2016; Rahman et al., 2015). Murphy et al. (2016) described pre-hospital pain assessment and management for 6,371 children attending four EDs in Ireland reporting that, of the 2,635 children who complained of pain, 856

(32%) had a formal pain assessment and 689 (26%) received analgesia. Rahman et al. (2015) surveyed primary and advanced care paramedics on pre-hospital pain assessment and management for pediatric patients in Alberta reporting that children were six times less likely to use a validated pain tool for pain assessment.

Pain reassessment and treatment was not recorded for as many children as the initial pain assessment. This finding is consistent with in-hospital patterns of pediatric pain assessment and management where high rates of pain assessment were noted but interventions were not always implemented and reassessments not always conducted after the intervention (O'Neal & Olds, 2016). O'Neal and Olds (2016) analyzed pain assessment, intervention and reassessment practices in 984 pediatric units (including NICU, PICU, step down, medical and surgical units) across 390 hospitals throughout the United States finding that although pain assessments were done well, pain interventions and reassessments were not. While there is a focus on pain assessment in the present research, particularly on the location of pain, pain treatment in the pediatric trauma patient population did not follow as efficiently. The underlying assumption that pain assessment would lead to a pain intervention does not appear to be true for pediatric trauma patients. It is possible that pain assessment does not lead to pain intervention in the pediatric trauma patient because the primary focus of HCPs, as per trauma algorithms, is on establishment of physiological stability and early identification of injuries.

Children interviewed for Phase 2 did not report that they were asked about their pain in the early stages of trauma care, which may indicate that a pain assessment was not part of standard care practices. HCPs interviewed for Phase 2 noted delays in pain assessment and management that were part of the regular standard of trauma care; therefore, patterns indicating lack of pain reassessment found in Phase 1 data aligns with the interview data.

To address the gap in the literature related to pain reassessment for pediatric trauma patients the present research describes patterns of pain reassessment that has not been reported or described well in other research on pediatric trauma patients. In the present research pain reassessment was not performed as frequently as the initial pain assessment. When pain was reassessed it was frequently documented as a combination of narrative notation and the NRS. The lack of focus on pain reassessment in the literature should inform research by focusing on detecting patterns of pain reassessment that may possibly be associated with pain intensity.

Nature of pain management in pediatric trauma patients. Child factors associated with a longer time period from the traumatic event to administration of the first analgesia were number of injuries, mechanism of injury of assault, and presence of head or spinal injury. Also, children who arrived via the indirect trajectory waited longer for the first opioid analgesia. The opioids recorded for the prehospital and ED settings for pediatric trauma patients were morphine and fentanyl, delivered intravenously, in both direct and indirect trajectory groups. However, children in the indirect trajectory group received significantly more frequent opioid analgesia en route to hospital. Though often consisting of a subtherapeutic dose (MacKenzie, Zed, & Ensom, 2016), opioids were administered more frequently to the indirect trajectory group, likely because the second transport period took longer and used more sophisticated monitoring to support appropriate opioid use. In contrast, children in the direct trajectory group were brought from the site of the trauma to the study hospital as quickly as possible and rarely received an opioid analgesia en route. Anantha et al. (2014) also identified morphine and fentanyl as the opioids recorded in their chart review of severely injured trauma patients; however, 52/64 (81%) of patients receiving analgesia did receive an adequate weight adjusted dose.

In Phase 1, 76/104 patient records indicated that the child received an opioid analgesic agent. Despite the larger number of children with a recorded pain assessment, the pain assessment was not necessarily followed by an effective pain management intervention since most doses of opioids were subtherapeutic (MacKenzie, Zed, & Ensom, 2016). In Phase 2, interviews with HCPs revealed that they would titrate the dose of analgesia very carefully in the pediatric patient population to ensure no adverse effects from administering an opioid; therefore, they would give a lower dose and if that did not take effect, another low dose would be given. Use of a titrated approach to opioid analgesia administration would account for the significantly lower doses of opioid analgesia noted in the chart audit done for Phase 1. Documentation in the chart audit of all medications administered, including opioid analgesia, was assumed to be accurate, since opioids are legally tracked and need to be accounted for at all times.

Reasons for suboptimal pain management in pediatric ED patients have been identified as lack of awareness that pain is being undertreated (Chafe et al., 2016; Hennes et al., 2005); busyness in the ED, which prevents optimal care; underuse of behavioural, physical, and/or psychological pain interventions that could offer relief in addition to pharmacologic agents; accuracy of pain assessment; perception of what constitutes a painful condition; and deficiency of medical directives to appropriately treat severe pain (Chafe et al., 2016). In other clinical scenarios, not appropriately treating pain after assessment would be an unacceptable standard of practice and could even be considered an adverse event (Chorney, McGrath, & Finley, 2010; Twycross et al., 2016). Inadequate pain treatment can result in undesirable effects such as increased anxiety, decreased pain tolerance, and fear of future medical encounters (Browne, Shah, et al., 2016). An inconsistent interest in reducing pain after identifying it in pediatric

trauma patients, as demonstrated in the present research, represents a gap in knowledge that leads to poor pain-assessment and pain-management practices for pediatric trauma patients.

Nonopioid analgesic agents such as acetaminophen and ibuprofen given by mouth were provided significantly more often to the direct trajectory group once in the ED at the study hospital. This difference could be due to (a) the lower level of injury severity, and (b) to the expertise of pain and injury assessment by the staff in the regional trauma centre in ascertaining more subtle levels of both pain and injury that would justify more appropriate doses of analgesia. Use of both oral and intravenous paracetamol, along with careful titration of intravenous opioids, was identified by Dijkstra, Berben, van Dongen, and Schoonhoven (2014) as the most effective pharmacologic strategy for adult trauma patients. Further research would be required to see if the same approach would be effective in pediatric trauma patients.

Rates of analgesia administration among children were reported to be 53% by Brown et al. (2003) and 54% by Friedland and Kulick (1994), compared to more recent research by Murphy et al. (2016) where 46.8% of children received analgesia. These results suggest that over a period of two decades, rates of pediatric analgesia administration had not improved.

An important gap in the literature addressed by the present research is related to the time period to administration of first opioid analgesia from the time of the traumatic event. Neighbor et al. (2004) measured the time to first opioid analgesia for a subset of pediatric trauma patients, however, the time period was from arrival in the ED to administration of the first opioid analgesia. In the current research the time period measured was from the time of the traumatic event until administration of the first opioid analgesia which is more accurately reflective of the patient's experience of trauma. Reporting the precise period of time taken to administer the first opioid analgesia for pediatric trauma patients can help to compare similar types of research

outcomes to those of the adult trauma population. It is already known that children wait longer than adults with similar types of traumatic injury (Neighbor et al., 2004). If this waiting pattern persists this observation would lend support to the notion of juvenile ageism with children continuing to have delays to pain relief.

Child factors affecting pain assessment and management in pediatric trauma.

Age. Age is a fundamental factor underlying any pediatric research, since developmental stages influence all aspects of a child's actuality. Speculation about generative mechanisms leading to continued oligoanalgesia in children, particularly in the pediatric trauma patient, must consider age and development that limit a child's ability to clearly communicate pain states.

In the present research, no significant differences were noted between age groups in the time to first pain assessment. Children who were 6 to 12 years had fewer pain reassessments than younger children (0 to 5 years) and older children (13 to 16 years). This finding lies in contrast with other research that has found children less than 5 years of age were less likely to have a recorded pain assessment in the pre-hospital setting (Murphy et al., 2016). Murphy et al. (2016) examined the charts of children with pain as a documented symptom who attended four EDs in Ireland to describe pain management practices in the pre-hospital setting. The lack of recorded pain reassessments could be accounted for by the fact that children in the 6-to-12 year age range could potentially experience more anxiety and distress from a traumatic event, resulting in difficulty discerning between pain and distress. Interviews with HCPs from Phase 2 indicated there were many issues clouding pain assessment; several HCPs were unsure whether pediatric trauma patients they were caring for were in pain or displaying fear because of the sudden traumatic circumstance. The inability to differentiate fear and pain was reported as being

especially problematic in younger children although inability to distinguish fear and pain occurs generally in hospitalized patients (Taddio et al., 2012).

In Phase 1 there were no significant differences in pain management between children in different age groups. The finding that younger children received similar opioid pain management as adolescents in the ED differs from research by Rahman et al. (2015). Rahman et al. reported that EMS personnel were less likely to treat children for identical types of injuries and pain intensity than adults and adolescents; respondents believed children required less analgesia because their nervous systems were immature.

Physiological development is rooted in the actual layer of reality for critical realists, and accounts for the inability of young children to articulate pain as clearly as older children or adults. The neurophysiological basis for the semantic processes is not developed completely until the age of 7 years (Hahne, Eckstein, & Friederici, 2004). Difficulty in articulating pain was evident in the three youngest children (8 years of age) interviewed in Phase 2. The length of the interview for these children was shorter than interviews with the older children. Responses from younger children were very short, and few details were provided unless prompted frequently by the investigator. Additionally, the younger children were much more dependent on their parents to recount what had occurred immediately after the trauma, during transport to the hospital, and in the trauma room.

Children may not be able to verbalize their pain, but this does not mean that they do not experience it. Specific behaviours such as worried facial expression, intermittent flexion and extension of legs, guarding, crying or moaning, and inability to be consoled or comforted are behaviours associated with pain in children (Dorfman, Schellenberg, Rempel, Scott, & Hartling, 2014; Merkel, Voepel-Lewis, & Malviya, 2002). Behavioural observations of children's pain are

helpful in augmenting caregivers' pain assessments. Additionally, Piaget's staged approach to development suggests that between 7 and 11 years of age, a critical stage occurs—the concrete operations stage—when children begin to be able to think logically about an event and understand some of the differences between abstract internal and external influences (Job, Chambers, & Craig, 2002; Kortessluoma, Hentinen, & Nikkonen, 2003; Piaget, 1972). It also has been suggested that when under stress such as an illness, some regression to earlier modes of thinking may take place (Gaffney & Dunn, 1986).

While some patterns of pain reassessment have been reported in the existing body of pain literature, the present research describes differences in patterns of pain reassessments across age groups. School aged children had their pain reassessed significantly less frequently than children in older and younger age groups. Differences in patterns of pain reassessment have been noted by O'Neal and Olds (2016) who reported different patterns of pain reassessment across in-hospital unit types. Detection of patterns and associated factors in pain reassessment should be included in future research on pain treatment for pediatric trauma patients.

Sex and gender. In Phase 1 significant differences in sex of children and time to initial pain assessment were not seen. Pain reassessment data indicated females were significantly more likely than males to have their pain reassessed and more likely to have a change in pain intensity scores from the time of the traumatic event until discharge from the ED. There were no significant differences between males and females in time to first opioid analgesia.

In this research, the term sex refers to the “biological distinction of being male or female” and the term gender role refers to “learned feminine and masculine gender roles.” (Robinson, Gagnon, Riley, & Price, 2003) Robinson et al. (2003) examined the contribution of gender-role stereotypes to sex differences on pain and report that men and women brought gender-based

stereotyped expectations to the experimental setting with men exhibiting a stoic nature and were more willing to endure a painful task than women. Gender differences in pain expression were not raised in interviews with HCPs in Phase 2; however, the sample size for Phase 2 for both children and HCPs was small and the HCP participants were predominately female.

A review by Bartley and Fillingim (2013) found consistent reports of increased sensitivity to pain for women, more catastrophizing (magnification and rumination of pain information) and less self-efficacy (the belief that one can successfully perform the behaviours to attain a desired goal) than men. Sociocultural beliefs about masculine and feminine pain expression affect reporting of pain. Gender differences also have been reported in children. Kozlowski and colleagues (2014) examined prevalence and demographics of pain as well as pain management practice patterns in hospitalized children reporting that being female was associated with higher mean pain scores and consumption of more opioids than males. Powerful social constructions in relation to gender exist; boys are assumed to be tougher and will therefore not demonstrate pain as much as girls (Robinson et al., 2003). The age groups for the present research span from infancy up to eighteen years of age; therefore only a subset of children may be affected by sex differences in pain. In Phase 1 the highest age reported in the retrospective chart review was 15 years; although the study hospital accepts patients up to and including 18 years of age, trauma patients from the age of 16 to 18 years are frequently taken to an adult trauma facility for more appropriate follow up (e.g. orthopedics). Consequently there were only patients younger than 16 years of age in the study sample for Phase 1 and the effect of sex differences would potentially only affect children from about the age of 11 to 15 years. In Phase 2 there were a total of five children between the ages of 12 and 14 years old, including 2 males and 3 females, who could potentially be affected by sex differences and pain.

From the literature on the effect of female sex hormones on pain sensitivity and response to specific pain treatment, and gender on behaviour of the gender of care providers it is possible that the sample of participants from the present research was affected by sex and gender.

Phase 1 participants could potentially be affected since a proportion of the patients were from the older age group of children in the sample (12 to 16 years) and likely affected by sex hormones; however, Phase 1 data did not show any significant differences for sex.

Additionally, participants in the direct trajectory group in Phase 1 and all the children interviewed in Phase 2 were likely cared for by female HCPs since over 90% of nurses and almost 75% of pediatricians are females (Jagsi et al 2014; Spector et al 2014). Of note, characteristics from physicians who cared for children in the indirect trajectory were not available or captured for this research so no comments can be made about effects of gender on pain treatment provided for these children.

Phase 2 participants could potentially be affected by sex and gender effects as several of the child participants were females who were in the age range for start of puberty. HCPs interviewed were primarily female belonging to the nursing and pediatrician groups so the care they provided would be prone to influences of gender previously cited; that children at the study hospital being given non-opioid analgesia more frequently and that children of color being given more analgesia. From Phase 1 data children arriving directly to the study hospital did indicate they were given more non-opioid analgesia compared to children in the indirect trajectory. Data about the racial groups of patients are not captured at the study hospital. Although not formally captured in the current research, analysis of sex differences in relation to pain management as it pertains to interview data could be examined in future research.

The present research contributes to existing body of pain literature by enhancing knowledge about patterns differences between male and female pediatric trauma patients indicating there were not a lot of significant differences

Number of injuries. There were no significant findings related to pain assessment for children with more injuries; they did not have to wait longer for the initial pain assessment nor were there any significant differences in the number of pain reassessments recorded. Children with several injuries were 18% more likely to have received analgesia than children with no injuries. Children with more injuries have previously been reported to have a delay in administration of analgesia (Neighbor et al., 2004). Neighbor et al. (2004) measured time to opioid administration with a chart review of 540 trauma activation patients that included primarily adult patients with only 55/540 (10%) of the sample being less than 10 years of age and report that patients who are younger (< 10 years) or older (> 65 years) and those with more injuries are at risk for oligoanalgesia.

The indirect trajectory group had more children who had suffered more than one injury than the direct trajectory group, although the difference was not significant. Differences in the number of injuries may be due to the fact that children with single injuries who were treated in outlying institutions would not require the advanced surgical services of the regional pediatric trauma centre and would not require transfer to the study hospital.

In Phase 2, interviews with children who had suffered several injuries revealed that they experienced severe pain in multiple injury sites simultaneously. The number of injuries was a significant clinical component from both children's and HCP's perspectives. In interviews, HCPs caring for children with several injuries disclosed that the extent of injuries was the priority and had to be urgently ascertained. They also noted that the presence of several injuries was cause for

concern regarding hemodynamic stability, and were reluctant to administer opioid analgesia. The tension between children and HCPs in this scenario could create a potential disparity in care for pediatric trauma patients. Existing and present research consistently suggests that having more injuries is associated with delays in administration of analgesia, but does not provide a clear picture of precisely how or why the number of injuries a patient sustains during a traumatic event affects pain treatment.

Focusing on identifying injuries as opposed to treating severe pain is an example of symbolic violence. It serves the goals of HCPs but not the children. During the Phase 2 interviews, some of the children verbalized fear; children's ability to be concerned about their own survival in the presence of several injuries cannot be underestimated. Interviews with HCPs in Phase 2 upholds arguments that early identification of injury is necessary to stabilize the child's hemodynamic status, and that identification of injury is an acceptable and necessary element of pediatric trauma care, legitimizes them.

Type of injury. Although children with head injuries in Phase 1 did not have to wait significantly longer to have an initial pain assessment, they were the least likely to have a pain reassessment and waited a longer period for the first opioid analgesia than children with all other types of injuries. In Phase 2, delays in pain treatment for children with head injuries, was cited by almost all the HCPs as a barrier to administration of opioid analgesia in the early stages of trauma. There was fear that deterioration in the level of consciousness could be masked for these patients. Phase 1 data indicated that most children had suffered a head injury (77%) while in Phase 2, study participants were screened to include children who had only had a mild head injury. Therefore, triangulation between Phase 1 and 2 data sets from the aspect of how patients with head injuries perceived their pain treatment could not be meaningfully evaluated.

In Phase 2, children interviewed had memory gaps even if they experienced a mild brain injury with their traumatic event. The HCPs frequently verbalized the presence of head injury as a deterrent to the delivery of opioid analgesia. Given that children reported not remembering the time immediately after the injury, and that head injuries are associated with high levels of mortality in pediatric and adult trauma, it logically follows there would be a reluctance for HCPs to provide early opioid analgesia. The HCPs' reluctance to provide analgesia to patients with a head injury is consistent with extant literature (Chafe et al., 2016). Chafe and colleagues (2016) measured the impact on recent implementation of pain protocols by examining an ED in Atlantic Canada. In this study site, provision of analgesia within 60 minutes of being triaged with acute supracondylar fracture increased from 15% to 54% after targeted efforts to educate nurses, residents, and physicians and the institution of medical directives allowing nurses to administer nonopioid analgesia without being seen by a physician first. While this improvement was important, almost half of children remained without analgesia and documentation of pain scores remained rare. Barriers to improvement were identified as: (a) unawareness of the extent of the problem of poor pain management, (b) business of the department at times, (c) too much of a focus on pharmacological rather than nonpharmacological interventions, (d) reluctance to give pain medication to patients with head injuries or developmental delay, (e) perceived inaccuracy of pain assessment scores, and (f) lack of ability to administer opioids built into the medical directive. Several opportunities to improve were ascertained for continued future work to advance pain management.

Data from Phases 1 and 2 suggest that the type of injury is a significant element requiring consideration for the front-line staff providing direct trauma care and in developing policies for pain treatment for pediatric trauma patients. Research is still required to clearly ascertain whether

there are consequences to providing inadequate pain management for pediatric trauma patients with head injuries.

Injury severity score. The relationship of time from the traumatic event to initial pain assessment on ISS (Garber, Hebert, Wells & Yelle, 1996) was significant with children with a higher ISS having to wait longer for an initial pain assessment. Additionally, children with a higher ISS had significant changes in pain intensity as their pain was reassessed, with their pain intensity decreasing.

Since children with higher ISS may be more likely to have a compromised level of consciousness due to the presence of a serious head injury in almost all children with an ISS > 12, assessment of pain would be more difficult. It is possible that EMS personnel did not have knowledge of a pain assessment tool specific to the unconscious patient, or perhaps they did not know how to assess pain for an unconscious patient. A higher ISS equates to a more intense injury severity; the indirect trajectory group had significantly higher ISSs than the direct trajectory group. Whereas pediatric trauma of a relatively minor nature (e.g., a child's minor head injury or a single fracture of an extremity) can be surgically and medically supported in the community hospital, more severely injured children require the advanced surgical services of the regional trauma centre, and therefore need to be transferred from the community hospital. Since adult trauma centres are often more accessible, children with more severe injuries are frequently taken to the adult centres to be stabilized prior to transport to a pediatric facility (Miyata et al., 2017).

Additionally, interviews with HCPs indicated that children who were more severely injured were at a lower priority for receiving pain management interventions due to the high risk of hemodynamic instability. In contrast to findings in Phase 1 of this study that indicated there

was no significant relationship between time to first opioid administration and ISS (refer to Chapter 5 on Results for statistics), Anantha et al. (2014) reported significantly higher analgesia usage in severely injured children with a higher mean ISS. Anantha et al. (2014) reported significant differences between the two groups with the median ISS (IQR) for severely injured children who received analgesia being 22(16-29) and the median ISS (IQR) for children who did not receive analgesia being 17 (16-25) ($p = 0.027$) indicating that more children with a high ISS score received analgesia than children with a lower ISS score.

Mechanism of injury. Children who were hurt by being struck by an object, rather than being hurt in an MVA (MVA), waited longer to receive an initial pain assessment than children who had experienced a fall or an assault. Similarly, children with non-MVA types of mechanisms of injury (e.g., fall, assault, struck by object) were all significantly less likely to receive any pain reassessments. Children who had experienced an assault waited significantly longer for administration of the first opioid analgesia compared to children with other mechanisms of injury. There may be assumptions and associations related to specific mechanisms of injury that affect the behaviour of the HCPs providing care (e.g., that a fall is a less serious injury than an MVA). Additionally, unfamiliarity with certain mechanisms of injury such as assault may present an unusual clinical scenario in a pediatric environment, one that is not frequently encountered. Additionally, assaults are not common in the pediatric population and may provoke different emotions than those engendered by a child who has experienced a fall or an MVA. Assault was not frequently reported by Powel et al. (2015) who described injury circumstance and frequency of important neurologic complications among 350 children with blunt head trauma. Powel et al. reported that the mechanism of injury of assault accounted for only 7/350 children (2%) injured.

In Phase 2, interviews with children who had experienced a fall voiced a sense that their injuries were not taken seriously by either their parents or HCPs, resulting in a delay in care. Pain, vomiting, and pallor associated with a fall were not perceived as indicators of significant injury when, in all cases, these signs indicated a serious injury. This finding aligns with findings by Burd, Jang, and Nair (2007) who reported that this mechanism of injury is frequently not serious in nature. Burd et al. (2007) analyzed the relationship between mechanism of injury, resource utilization and mortality in the records of pediatric trauma patients less than 15 years and found that children with firearm injuries were more likely to have severe injuries and children with falls were more likely to have less severe injuries.

Anantha and colleagues (2014) reported mechanism of injury was a significant factor when comparing analgesia and non-analgesia groups in their evaluation of analgesia use in severely injured children; univariate analysis indicated children with MVAs made up the largest portion of children in the analgesia group.

Haider and colleagues (2011) attempted to determine an association between the mechanism of injury and fatality rates and the functional outcomes at discharge from hospital among pediatric trauma patients. They used a retrospective analysis of the National Trauma Data Bank in the United States examining all children aged 2 to 18 years from 2002 to 2006 (Haider et al., 2011). Gunshot wounds had the greatest risk of mortality and pedestrians struck by a motor vehicle had the highest risk of locomotion and expression disabilities. They found that MVAs accounted for the largest portion of pediatric patients (48%), followed by falls (25%) and pedestrians struck by motor vehicles (8.5%).

Situational factors affecting pain assessment and management in pediatric trauma.

Children in Phase 2 who stated that they had endured a transfer from another institution indicated

they experienced more pain with required movement and procedures than with pain from the injury. For example, Amanda, who experienced a painful extraction from the vehicle at the scene of her accident, stated the X-rays were very painful; and Peter, who fell while up north skiing and was taken to the closest hospital, required air transfer via helicopter to the study hospital stated the his pain was exacerbated by the helicopter ride to the hospital because it was bumpier than the land ambulance.

In contrast, children in the direct trajectory were significantly more likely than those arriving in the indirect trajectory group to have had an initial pain assessment recorded within 15 minutes of arrival in the ED. Although children in the direct trajectory group had higher pain intensity scores en route to the study hospital, they were significantly less likely to receive a pain intervention en route to the hospital. Once in the study hospital, children in this group were less likely to receive an opioid analgesic than children in the indirect trajectory group and more likely to receive a nonopioid analgesic agent. Jack, who by his own account of his traumatic event was brought directly to the study hospital, stated that his pain was immediate and severe.

Being treated in a mixed adult and pediatric community facility instead of at a specialized pediatric facility has been associated with children receiving significantly less analgesia than adults in the community facility (Anantha et al., 2014; Flynn-O'Brien et al., 2015). Findings from the present research align with the research from both Anantha et al. and Flynn-O'Brien et al.; the children in the indirect trajectory waited longer for the first administration of analgesia than the children in the direct trajectory group. Additionally, more subtherapeutic doses of analgesia were administered to children in the indirect trajectory group. Browne, Shah and colleagues (2016) concluded that children were more likely to receive analgesia if the transport period was longer.

Gaps in pediatric trauma care exist for children who are being transferred to a pediatric trauma centre from an outside institution. Evidence from this research demonstrates that these children wait a longer time for a pharmacological pain intervention. When they do receive an opioid, the dose is most likely to be subtherapeutic. There are also gaps in care for children who arrive via the direct trajectory to the study hospital. These children are more likely to have acute pain of a high intensity but they do not receive an opioid pain intervention as frequently as children in the indirect trajectory.

Time to first analgesia. In Phase 1, for the 79 pediatric trauma patients who received an opioid analgesic, the median (IQR) time from the traumatic event to administration of first opioid analgesia was 99 (77 to 180) minutes, with a range of 25 to 884 minutes (14 hours and 44 minutes). While there were no significant differences between the time to administration of first opioid analgesia between the direct and indirect trajectory groups, there were significant differences between time to first opioid analgesia en route and upon arrival at the study hospital. En route, children in the indirect trajectory group received analgesia sooner; and children in the direct trajectory group received analgesia sooner than children in the indirect trajectory group upon arrival at the study hospital.

The time between the traumatic event to the first opioid administration indicates effectiveness of pain management; there has been an improvement in pain management for children with trauma within the past decade compared to Neighbor et al.'s (2004) results. These authors found that the median time from arrival in the ED to delivery of first opioid analgesia was 162 minutes for children under 10 years who had received opioid analgesia after a trauma activation at a Level 1 trauma center. Neighbor and colleagues measured the time from arrival in the ED to first opioid administration while the current research measured the time from the

traumatic event to administration of the first opioid analgesia. Measuring the time to first opioid administration from the time of the traumatic event more accurately reflects the patient's true perspective of the pain experience.

Children in the indirect trajectory group received the first opioid analgesia en route, sooner than those who arrived via the direct route. This result may reflect the fact that children in the indirect trajectory were transported by highly qualified personnel, often with pediatric training, who were able to comfortably administer opioids during the second transport period, with physician support and monitoring of patient vital signs. The direct trajectory group would not have had time during the initial EMS transport for a thorough assessment for injuries due to the short time before arrival at the study hospital. EMS personnel who bring children in the direct trajectory group perceive many barriers to administration of analgesia. These barriers, as reported earlier by Hennes et al. (2005), comprise an inability of EMS personnel to assess pain in children, a lack of medical oversight, and a lack of education. Consideration for pain management would be given only after their arrival at the study hospital and after having had an assessment completed. Despite attempts to implement nurse-initiated pain management protocols within the ED for children with acute supracondylar fracture (Chafe et al., 2016) and for adult patients with extremity trauma, renal colic, ophthalmology trauma, headache, or soft tissue injury (Doherty, Knott, Bennetts, Jazayeri, & Huckson, 2013) improving times to first analgesia has been a persistent problem.

When examining triangulation of data between the two phases of the study, Phase 1 indicated the time from the trauma event to administration of first opioid analgesia was a mean of 99 minutes; however, HCPs interviewed did make the assumption that EMS providers would

likely have provided analgesia en route to the hospital, and therefore believed that they had some time before they had to worry about pain management.

Quantitative results from Phase 1 mirror the experience expressed by the children and HCPs interviewed for Phase 2. A delay in pain management as reported in the chart review data in Phase 1 is consistent with the children's experience of sudden onset and duration of severe pain. Both the quantitative and qualitative results encompass empirical observations that constitute the empirical layer of reality for the critical realist. Pain physiology associated with tissue trauma and physiological effects of opioid analgesia on pain pathways constitute the actual layer of reality according to the critical realist perspective. The effects of organizational culture, juvenile ageism, gender expectations, symbolic violence, and weighted summary are the unseen influences that constitute the generative mechanisms within the real layer of reality and will be discussed further later in this chapter.

Phase 2: Children's and HCPs' Perspectives on Pain Experience

Children's perspectives on their pain experience. *Immediate pain.* Many of the children interviewed reported immediate pain. These accounts contrasted with research by Melzack et al. (1982) who reported delayed onset of pain of 1 hour and up to 9 hours in 138 adults with traumatic injury. Similar research in children could not be found; however, it could be postulated that children have a developmental and survival response to pain that requires them to convey their pain immediately, signalling the need for help to responsible adults; or that failure to remember has a protective function for them. The ability to control the expression of pain may not yet be fully developed in the pediatric trauma population, accounting for the immediate expression of pain; the inability to self-report does not indicate that this patient population does not experience pain. It is not appropriate to compare children to adults since

development of self-regulation, according to Piaget, begins at around 7 years. Self-regulation is not fully achieved until adolescence (Fox & Riconscente, 2008; Piaget, 1959). The ability to deliberately direct thoughts, problem-solving activities, and one's desires and emotions, constitutes self-regulation as suggested by Piaget (Fox & Riconscente, 2008).

Not all the children reported immediate pain in response to their injuries. Appreciation of the power of human agency lies at the heart of a critical realist enquiry with concern for an individual's own account of the situation. Discovering how children perceive their pain is the first step in analysis and resolution of any gap in treatment of pain in children with trauma. Light can be shed on the range of social systems shaping the behaviour of the children interviewed through critical realist enquiry (Houston, 2001).

Pain with movement. Pain with movement during transport to the hospital and while in the trauma room when being moved for procedures (such as diagnostic imaging) emerged as a major theme from the interviews with children. Loeser and Melzack (1999) suggested that pain can be generated by the expectation of pain and suffering, and that pain results in a stress response involving the injury site, the adrenal cortex, the immune system, and many parts of the brain. An unexpected event such as a traumatic event can provoke the expectation or the fear of pain during the initial moments of the trauma. Crandall et al. (2002) reported that adolescents with blunt trauma reported causes of pain to be the injury, movement, and procedures. Pain on movement was further expanded upon by Crandall and colleagues (2007) for adolescent patients with blunt trauma as they explored internal control the adolescents used to deal with their pain. Fear of movement and re-injury has been researched in adults, using pain-related fear and fear-avoidance models, to suggest that fear of movement leads to chronic pain states (Houben, Leeuw, Vlaeyen, Goubert, & Picavet, 2005).

Hypervigilant awareness. A hypervigilant attempt to identify their own injuries and hypervigilant attention to when pain interventions were provided (or not provided) emerged as a theme from interviews with pediatric trauma patients. Initial stages of experimentally induced acute stress response were found by van Marle et al. (2009) to result in a surge of vigilance originating in the amygdala, augmenting detection of threats in the environment. Excitation of the locus coeruleus in response to stress and trauma exerts a powerful influence on cognitive processes such as attention and task performance (Chapman et al., 2008). The unusual hyperawareness of mouth injuries by children interviewed could be rooted in the physiologically based responses to the acute stress of the traumatic event, which might cause a patient to desperately attempt to locate injuries.

Children who experience trauma are caught within the interplay between the biological reality of tissue damage causing pain (empirical), the socially constructed constraints of the trauma process or algorithm of trauma care that influences pain management (real), and the reality of experiencing the effects of juvenile ageism in a society that condones it. Kemp (2005, citing Bhaskar) reported a distinction between events and influences of events; for children experiencing trauma, the event would be the traumatic event, and the influences of events would consist of all the variables affecting delivery of pain treatment.

Procedural pain. Procedural pain emerged as a cause for discomfort according to many of the children interviewed. Decisions about what tests needed to be done for trauma patients are made by the medical/surgical hospital community. Frequency of painful procedures for hospitalized children has been well documented (Stevens et al., 2011) and untreated procedural pain has been identified as a major source of pain in hospitalized children (Stinson, Yamada, Dickson, Lamba, & Stevens, 2008). Children undergoing assessment after a traumatic event

require, as part of the trauma algorithm, two intravenous lines to support the circulatory system if necessary (Weaver, Hunter-Dunn, Lyon, Lockey, & Krogh, 2016). Combining establishment of intravenous lines with the discomfort of painful movement for diagnostic imaging adds significantly to existing discomfort of the injuries sustained from the traumatic event.

Research on the impact of invasive medical procedures indicates that children accurately recall these events (Salmon et al., 2002). Salmon and colleagues interviewed children aged 2 to 7 years who had undergone a voiding cystourethrogram (VCUG). Interviews were conducted six months after the procedure. Free recall of the experience was accurate in all the children, though the older children provided a more complete recount. Rectal examination that the children in this research experienced in the trauma assessment process could be construed as similar in invasiveness to the VCUG procedure, and could result in similar memories. Reports of longer-lasting effects of painful medical events in childhood have been associated with high levels of fear of medical procedures (such as vaccine-related pain) and fear of future medical treatment into adulthood (McMurtry et al., 2016).

Children's perspectives on their trauma experience. *Surreal sense of trauma.* Some of the children interviewed expressed a sense of unreality such as feeling they were in a dream or they lost track of time during or shortly after the traumatic event. As previously noted, dissociative reactions to a traumatic event can include a sense of emotional numbing or detachment; a reduced awareness of surroundings, and/or distortion in reality, body, and time; or seeing events as if in a dream (Bryant, 2007; van der Velden & Wittmann, 2008). Though not necessarily associated with development of more serious mental health issues such as PTSD, peritraumatic dissociation has been documented as a short-term disorder and must be monitored to identify possible progression to PTSD. Questions specifically designed to detect early signs of

PTSD were not included in the interviews but are worth exploring in future research. Questions that would help detect early signs of PTSD might include asking whether a child blames him or herself in any way for the accident, since self-blame has been associated with development of PTSD, particularly in girls (Alisic et al., 2014). HCPs should ask questions about anxiety over the accident, since internalization of problems is frequently seen in girls while externalizing behaviours are more likely in boys (Alisic et al., 2014).

Responses to a traumatic event vary. They include feelings of helplessness, humiliation, threat to body image, and a defensive dissociative emotional state (Mohta et al., 2003). Feelings of helplessness arise from dependence upon others to provide care and healing. Removal of clothes and digital rectal examination, all part of trauma assessment, may give rise to humiliation. Several of the children interviewed expressed feelings of discomfort with these procedures. For example, one of the children, Peter, mentioned that “they cut my underwear ...and that felt weird but I knew it was for a good reason”.

Digital rectal examinations are part of current trauma protocols and are said to be necessary to look for decreased or absent rectal sphincter tone that would indicate spinal cord injury; rectal blood indicative of intestinal injury; rectal wall integrity, whose absence would indicate rectal injury; bony fragments indicative of a pelvic injury; and a position of the prostate, indicative of urethral injury in males. Digital rectal examination has poor sensitivity for these types of injuries, since almost all of them were missed in research by Shlamovitz et al. (2007), who recommended digital rectal examination be removed as a routine examination for pediatric trauma patients.

Fear, anxiety and uncertainty. Several children expressed uncertainty during their time in the trauma room. Peter expressed uncertainty about whether he was dying and Kaitlyn

expressed high levels of pain intensity because “I didn’t know what was wrong.” Drendel et al. (2006) found that there was a higher documentation of pain intensity scores for pediatric patients in EDs when there was diagnostic uncertainty. Oka et al. (2010) reported that uncertainty about whether experimental shocks would be of high or low level resulted in higher levels of pain, fear, and physiological arousal. Uncertainty has a potent hyperalgesic effect that correlates with activity in the periaqueductal grey (Yoshida et al., 2013). Another component that characterizes uncertainty for pediatric trauma patients pertains to a lack of information about severity of the injuries and the unpredictable course and prognosis children may face (Crombez et al., 2013; Wright et al., 2009).

Stimulus overload. Several of the children expressed feeling overwhelmed by the number of people at the accident scene (e.g., Peter who fell at a ski hill) and then again in the trauma room as the trauma team does the initial assessment. Stimulus overload experienced by the children as they assimilate what has happened to them after the initial impact of a traumatic event is based in physiology and is situated in the actual layer of reality. The capacity to quickly respond to threats to homeostasis in the ED environment is critical for survival. The initial stages of the stress response consist of a surge in vigilance to detect and assess the threat (van Marle et al., 2009). This state of hypervigilance with in the initial onset of stress is accompanied by sensory processing that allows for prioritization of real threats. The increased alertness to threat combined with a decrease in specificity necessary to prioritize real threat can be maladaptive if there is a continued demand for response to innocuous stimuli, resulting in indiscriminate hypervigilance (van Marle et al., 2009).

Children’s and HCPs’ perception of pain experience. Triangulation of data between participants of Phase 2 indicated that the children and the HCPs expressed the presence of fear

and anxiety in the pediatric trauma patient as they faced this unfamiliar situation. Children expressed fear and anxiety during the traumatic event and when the trauma was being assessed, which was noted by the HCPs who cared for them. The children's fear and anxiety were identified as a confounding factor when attempting to assess the state of the child's pain and need for analgesia.

Pain intensity en route to the hospital for both indirect and direct groups was documented within a moderate to severe range. High pain intensity scores reported in Phase 1 align with reports from several of the children interviewed in Phase 2, who reported that their pain was severe during transport from the scene of the accident through the stay in the trauma room. The interview guidelines used for children did not include a question about whether the children were transferred from another hospital, therefore rendering interview data imprecise and unable to reflect statistically significant differences in pain scores reported in Phase 1 between direct and indirect trajectory groups.

Health care providers' perspective of pain in pediatric trauma. *Primacy of physiological stability.* HCPs expressed a fundamental conviction to the primacy of physiological stability in the trauma patient. They stated that almost all held a dedication to the notion of establishing physiological stability as their primary function. Both habitus and weighted summary aid in the deconstruction of power among the HCPs and patients in the trauma room. According to Bourdieu it is through the workings of habitus that the social world continues to reproduce and transform itself (Reay, 2004). Habitus refers to the way the individual orients himself to a society by unconsciously predisposing individuals to a certain way of behaving. Habitus can transform or constrain an individual's course of actions within a culture. As it applies to the trauma room, the habitus of each individual constrains the behavior of

individuals (e.g., the children towards the adults, nurses towards physicians). Habitus is grounded primarily in the social world as opposed to the notion of weighted summary which is grounded within both the social world as well as the neurophysiological as critical realists would have us believe. The commitment to the ALS algorithm could be construed as being part of both habitus and the weighted summary of the HCPs working there. This status quo will be difficult to change, even within the local organizational level of the study hospital. Since the algorithm is used worldwide in many countries, it is a comfort to trauma room staff that there is some consistency in practice as new physicians attend patients in the trauma room.

Organizational culture relates to management of pain in trauma patients, in that the broad organization at the study hospital has adopted general surgeons as the lead providers in trauma care, and existing trauma algorithms as the best practice in the management of pediatric trauma patients that continues to be taught to new staff as they are trained to work with trauma patients. The culture of the surgical specialty focuses very pointedly on the surgical issue and it is the general surgeons who frequently acted as TTLs within the study hospital.

Differentiation between children's pain and anxiety. Data from interviews of children in Phase 2 indicated that most children experienced some form of distress with their pain during their trauma experience. The children's distress, anxiety, and fear were also frequently acknowledged by HCPs in their interviews. Verbal acknowledgement of the tripartite of distress, fear, and anxiety by the children and the HCPs indicates the relevance of these emotions to the patients' pain states. From the children's perspective, fear and anxiety were palpable in the interviews. Also, it is widely recognized that fear for children is related to medical evaluations and procedures as well as to an underlying injury (Cohen et al., 2001). From the HCPs

perspective, the children's fear and anxiety prevented them from being able to attain a clear depiction of the children's real pain state.

From the combination of (a) the inability of HCPs to attain a clear picture of the child's pain, due to the intrusion of behaviours from fear, distress, and anxiety; (b) the fact that children are less able to articulate their pain from a developmental standpoint; and (c) existing trauma protocols that do not place pain as a high priority, it is evident that pain assessment poses a difficult problem for pediatric trauma patients. In the ED, time with each child is limited and there can be high anxiety for the child as they interact with unfamiliar HCPs and an unfamiliar and loud environment in the hospital ED; along with the patients' age and development, all these factors contribute to the existing complexity inherent in pediatric pain assessment (Drendel et al., 2011).

Cartesian dualism is apparent in the struggle to differentiate between the pain and fear or anxiety that is expressed among many of the HCPs who attend to pediatric patients in the early stages of the trauma room. Augmenting the notion of Cartesian dualism is Foucault's (1973) concept of the *clinical gaze*. Foucault historically situated the shift in medicine to an objectification of patients towards the middle of the eighteenth century, when the autopsy was adopted to study disease (Benner, 2004). The clinical gaze is the objectified scientific approach to the body with a focus on disease entities as something separate from the person experiencing the disease. The intense focus on identification of injuries when managing the pediatric trauma patient exemplifies the notions of the clinical gaze and of Cartesian dualism.

According to Descartes, pain is proof of the body's existence; yet at the same time it can deceive the mind (Duncan, 2000). The objectified language of medicine depicts a Cartesian dualism or a clear division between mind and body (Benner, 2004). In Descartes's model of

dualism, the mind receives and interprets information from the body. Thus, the subjective interpretation of the body's real disease experience is often questioned when the HCP tries to discern what is psychosomatic and what reflects an underlying disorder or, in the case of pediatric trauma patients, what reflects tissue damage warranting pain treatment (Benner & Wrubel, 1989).

Differences in educational preparation. Physicians indicated that they received very little pain education related to management of the trauma patient. Watt-Watson et al. (2009) surveyed major Canadian universities to determine the amount of time spent on mandatory pain content in curricula for health sciences and veterinary programs, and reported that only 32.5% of universities could identify specific hours allotted to pain courses. Mean (*SD*) time spent formally studying pain for medicine was 16 (± 11) hours while nursing spent 31 (± 42) hours in formal pain education. This minimal prelicensure training on pain, plus the lack of post licensure training beyond PALS (Kleinman et al., 2010) where pain is addressed only: (a) when conducting procedures such as intubation; (b) as a symptom that can cause tachycardia, and must be distinguished from tachycardia related to shock indicates that pediatric pain management is a gap in care unless tied to procedural pain. In a subsequent update of PALS guidelines, pain is not addressed at all (de Caen et al., 2015).

Differing perspectives on pain management. Many of the HCPs interviewed indicated there was not a standardized approach to pain management in pediatric trauma patients with each doing what they were comfortable with for that patient. There are advantages to a non-standardized approach to pain management as each child receives individualized treatment; however, the presence of some guidelines would be beneficial if used.

Expression of the fractured and unorganized approach to pain assessment and management by HCPs in Phase 2 interview data was reflected in the patterns of opioid administration reported in Phase 1. The fractured and unorganized approach resulted in the necessity to describe most pain assessment and management patterns as median and interquartile range data, since the range of times and patterns in the sample size was so diverse, with many outliers. Curtis (2001) interviewed nurses who cared for trauma patients to gain their perspective on the care of trauma patients and reported that many nurses felt trauma patients continued to experience a lack of coordinated care on the admission unit and that pain was managed poorly.

Inadequacy of pain treatment in trauma. Some of the HCPs interviewed acknowledged that doses of opioids provided to pediatric trauma patients were sub-therapeutic, often for titration purpose but not necessarily. Additionally, some of the HCPs interviewed admitted to titrating the dose of the opioid to achieve effective pain management, an approach they often used postoperatively to ensure that children are comfortable, without giving them more opioid analgesia than they need. Subtherapeutic doses that were reported in Phase 1 could be an indication of titration patterns reported in Phase 2. Anantha et al. (2014) examined analgesia use in the resuscitative phase of 203 severely injured children and adolescents reporting that 64 received analgesia. Of the 64 patients who received analgesia 52 (81%) were administered the adequate weight-adjusted dose of analgesia. The generative mechanism of juvenile ageism proposed as resulting in delays in pain treatment is augmented by the constraints of ATLS guidelines culminating in inadequate pain management for pediatric trauma patients.

Changing approach to trauma care. According to some of the HCPs interviewed in this study, the influence of improved pain practices within the broader ED of the study hospital has yet to move into adopting the pain practices for pediatric trauma patients. However, the shift in

management of trauma care from general surgery to the ED physicians, which continues to move forward, holds promise for a shift in pain practices. Several of the ED nurses interviewed made the observation that ED physicians had clinical expertise in pain assessment that would carry more effective pain assessment and management processes from the broader ED department into the trauma room.

Assumptions about pain management. Although children may have received some form of pain treatment prior to arriving to the trauma room, it cannot be assumed, as many of the HCPs stated in their interviews. Although a medication record exists, which can be checked to see if medications have been administered, HCPs often perceived that there is no time to examine it, since the priority is to care for a child's immediate physiological and hemodynamic stability.

Hennes and colleagues (2005) found significant disparities between what EMS providers thought they had given and what they had actually given to patients for their pain. Few pediatric patients received prehospital analgesia, according to Swor et al. (2005) whose research described the frequency of analgesia administration to pediatric patients during EMS transport. Chafe and colleagues (2016) also reported misconceptions about pain treatment not being a problem for children with supracondylar fractures.

The assumption that children had already received analgesia prior to arriving in the ED is not strongly supported by evidence. In the present research, some children in the indirect trajectory did receive analgesia prior to arriving at the study hospital but an assumption cannot be made that the dose was sufficient. Organizational cultures of both the prehospital and trauma room are implicated in making changes to pain assessment and management practices for children with trauma. Organizations frequently have pain protocols in place; however, they may

not be being followed appropriately. Audits could also be put in place along with the protocols to ensure that staff are constantly aware of the current state of pain treatment practices in their institution.

Assumptions about trauma protocol. Unquestioning acceptance of the trauma protocol by trauma room staff is an indication of how deeply this protocol is embedded into trauma care. The study hospital's hospital-wide clinical best practice guidelines, which include the ED, dictate that any child over the age of three years is capable of self-report and that each patient, at a minimum, should have a pain assessment done with a developmentally appropriate tool upon admission. The ED has instituted an additional component of pain assessment requirements stating that children should have a pain assessment within 15 minutes of contact with a HCP in the ED department. Benchmarks for pain assessment within a specified time period are in blunt contrast to the algorithm of trauma care that places attention to pain in a very ambiguous place in the care priority. The organizational culture of the study hospital supports both the policies of the clinical practice guidelines and the widely accepted trauma protocol indicating that more work is required to reconcile these divergent visions of pain management. Pediatric trauma patients are caught between opposing views and receive a fragmented approach to pain treatment.

Implications of Critical Realism

There are four main tenets of critical realism (Danermark, et al., 2002; Elder-Vass, 2010; Houston, 2001). The first tenet is that there is a layered aspect to reality with three layers. The first layer is the empirical layer which is what you see, feel, hear, observe in the world. To relate the empirical layer to the present research, this layer would refer to all the observations made of pain practices provided to the pediatric trauma patient including their perception of the pain experience as well as the perceptions of the HCPs. The second layer is the actual layer and this

refers to what is actually generated but not necessarily easy to see or comprehend and to relate to pain, this layer would be inclusive of the physiology of pain transmission explained in the gate control theories of pain. Pain physiology has always occurred in the natural world in the same way; however, our understanding of how pain is transmitted has continued to evolve. We now know pain transmission is much more complex. The array of neurotransmitters and excitatory and inhibitory pathways involved in pain transmission is part of the actual layer and has not changed; only our understanding has deepened. The third layer is the real layer where the generative mechanisms reside. These generative mechanisms provide explanations for what is seen in the empirical layer of reality.

The second tenet of critical realism is the inclusion of emergence theory (Blitz, 1992; Elder-Vass, 2010). Emergence theory suggests that an entity has capabilities that are not held by its individual parts resulting in all the layers of reality merging to create a certain reality. All social components along with the layers of reality merge to create the unique circumstances the child experiences in the trauma room.

The third tenet of critical realism is the explanatory concept of generative mechanisms (Bhaskar, 1978). Generative mechanisms are part of the real world and provide explanations for phenomena occurring in the actual world. Generative mechanisms posed as relevant for the present research were symbolic violence, juvenile ageism, weighted summary, organizational culture that espouse widely accepted ALS guidelines that systematically delay pain management in trauma patients. The ALS algorithms are perpetuated by the organizational culture of hospitals and are unquestionable followed as the model of care for trauma patients.

The fourth tenet of critical realism is the interplay between social structure and individual agency in determining the experiences of everyday life. The critical realist believes that social

structure holds a temporal priority over human agency resulting in the perpetuation or reproduction of the culture and society into which one is born (Danermark et al., 2002; Elder-Vass, 2010).

To the critical realist, the physiological response to pain and stress from injury and/or medical procedures within the actual layer of reality combine with socially constructed health care system, comprising the EMS attendants, physicians, and nurses within the real layer of reality, where children may feel vulnerable and unimportant. The actual and real layers of reality converge as children encounter the traumatic event and the subsequent instrumentalism of the trauma room. *Instrumentalism*, a term coined by Habermas (1987), refers to a focus on completion of tasks (e.g., insertion of IVs, monitoring vital signs, record-taking) to the exclusion of attention to problems such as addressing the pain and the emotional quandary of a pediatric trauma patient. The critical realist aspires to gain some depth of investigation by paying attention to identifying structural tendencies and their effect on behaviour (Houston, 2001). Thus, the critical realist would attempt to understand and explain this focus on tasks and competencies of the trauma room staff. In the context of the present research critical realism is useful because the inquiry into the pain treatment patterns and experience of pediatric trauma patient is multifaceted. In order to disentangle the aspects of care, an explanatory approach is most suitable. Generative mechanisms can be located at the individual, personal, and/or societal levels, and interventions or generations of research hypotheses need to target the generative mechanism, not empirical observations. An example of an individual or personal generative mechanism would be the degree to which they have assimilated pain assessment and management for pediatric patients through their education. An example of a societal generative mechanism would be the general views held by society of the competence of children. An example of an

organization generative mechanism is acceptance of the trauma algorithm to guide trauma care. These examples are the generative mechanisms that result in patterns of delayed pain assessment and management observed in Phase 1. The children's comments that they couldn't get pain medications in the ambulance because they were not 18 years of age, shed light on the generative mechanism of juvenile ageism associated with their pain management.

Symbolic Violence

Interactions between persons that imply a mode of domination not arising from physical force is termed symbolic violence (Bourdieu, 1989). For example, there was no recorded use of topical analgesia for procedures such as intravenous insertion as noted in the chart audit done in Phase 1. This absence of a pain management strategy to prevent or minimize procedure pain, often attributed to lack of time and/or urgency, could be construed as symbolic violence for the pediatric trauma patient. Expanding upon the definition of violence may begin to uncover any subtle forms of violence used in everyday life.

Symbolic violence may come into play, since many well-meaning HCPs would insist that it is dangerous to provide analgesia without taking the time to conduct a thorough physical assessment. Any delay in delivery of pain management treatment could potentially cause unjustified suffering and immediate consequences of pain (e.g., increased physiologic stability) to a child under the assumption that the child's physiological status is at risk. The insidious and indirect nature of symbolic violence can take the form of institutional language and procedural norms and can be sustained by the habitus of the institution (Morgan & Björkert, 2006).

Symbolic violence results in the perpetration of domination that has become naturalized and sustains inequality within a given social situation (Rowlands, 2015). Symbolic violence could potentially be a generative mechanism when attempting to unpack the reasons behind the

continued lack of attention to pediatric pain assessment and management. I suggest the current trauma algorithm that places pain as a lowered priority is an example of symbolic violence. The algorithm is a widely accepted approach to trauma care that legitimizes poor pain practice in pediatric (and adult) patient populations. The status quo of poor pain management will continue unless it is identified as poor patient care.

Patients and HCPs are inextricably tied together within the social milieu of the trauma room and ED. The complex web of interactions that exists between patient and HCP may be viewed through the lens of the intrusion of the health care system on a patient's life. Constraints on children within the trauma room scenario are experienced as legitimate and the children become complicit in the intrusion accepting the power differential in the HCP-versus-patient relationship.

Juvenile Ageism

Focusing on medical tasks and procedures and adhering strictly to the algorithm of trauma care surrenders compassionate care of children in the trauma room to the extent that children's voices are scarcely heard. Focus on the tasks may be negatively impacting the actions of the HCP towards the pediatric trauma patient. The mishandling of care can be attributed to juvenile ageism. Although complex and meaningful care is provided, fluidity between the layers of reality highlight the intermingling of these spheres of existence. Problematic sociobiophysical interactions such as management of pediatric trauma patients are better understood if broken down or conceptually stratified (Carolan, 2005).

The assumptions conveyed by children, that they were not old enough to be given pain medication or that they would have to wait till they got to the hospital, are rooted in the concepts of juvenile ageism (Westman, 1991). In this research, juvenile ageism is proposed as a

generative mechanism in the real layer of reality, as it reflects a structural cultural feature not generally recognized. Westman (1991) suggested that there are several ways juvenile ageism is portrayed in our society—for example, when children's needs are not seen as important as the needs of adults. Children's needs not being seen to be as important as the needs of adults was evidenced by Jack, in Phase 2, when he was told he could not receive pain medication because he was too young; and in Jennifer, in Phase 2, who was told she could not have medication until she arrived at the hospital. Other general assumptions about children are often made, including (a) children know less than adults; (b) children have less experience; (c) children contribute less to the everyday workings of the world; and (d) children are less serious than adults (Harden et al., 2000).

Westman's (1991) concept of juvenile ageism suggests that another form of ageism occurs when adolescents are treated as adults. In Phase 2, one of the adolescents interviewed (Amanda, 14 years old) endured a harrowing experience of being removed from the vehicle in her MVA. She then had to endure being hospitalized for several hours, apparently in the hospital hallway of the transferring hospital, without an assigned nurse.

Juvenile ageism is suggested in the comments made by children during the interviews of having to wait for pain medication until they got to the hospital because they were not yet 18 years of age. Juvenile ageism was also suggested when several of the children, particularly children who had experienced a fall (e.g., Kaitlyn and Alexander), were not identified immediately as having a serious injury. In a discussion on the sociology of childhood and children's rights, Mayall (2000b) suggests that by proposing that adults know best what is the best interests of children, we deny their rights. Broad societal issues that point to children not

being treated well can hemorrhage into the trauma room and also become part of the weighted summary of both children and HCPs providing their care.

It is vital to acknowledge the power differential between adults and children in our society (Punch, 2002). Children experience unequal power relations with adults throughout much of their lives and are controlled and limited by adults. Children are not used to being taken seriously in an adult-oriented society. Hagestad and Uhlenberg (2005) suggest that age segregation is closely connected to ageism in society: children are separated out into schools where there is little integration with adults; adults go to work where there little integration with children; and older people go into retirement where there can be a sense of isolation from younger generations. This separation is reflected in the delivery of health care; in hospitals there are pediatric units, and there are also pediatric hospitals. This societal arrangement does not allow for the natural integration of age groups, and fosters ageism (Hagestad & Uhlenberg, 2005).

Weighted Summary

Children would have their own weighted summary that would include the way they had been treated by their family of origin and aspects of society they had been exposed to thus far in their lives (e.g., their school system). Depending upon their age and developmental stage, children would be developing a sense of where they stood in relation to adults. This development would shape the response to the adults in their new surroundings within the social system of the ED. The organizational culture of the broader health care system would intrude into the children's world and, while children would not know the intricacies of the hospital environment, they would know their relationship to adults. A child would likely feel very intimidated in the

face of the many strangers they had unexpectedly been confronted with during their traumatic event. It suddenly had become necessary for the health system to intrude into their lives.

The weighted summary of each HCP also comes into a patient's sphere of reality during the EMS transport and into the trauma room. How each of the HCPs have been socialized as an individual within their culture of origin, as a professional within their respective discipline, and possibly as a parent themselves would be brought into the trauma room at the moment they begin to provide care to the child with pain from traumatic injuries. Emergent properties come together in the trauma room when the psychological traits anchored within each HCP collectively converge with the properties of a higher social level, namely the organizational culture.

Management of pain resulting from tissue damage is part of the critical realist's actual layer of reality, and interventions must be rooted in the physiology of pain transmission modalities. The critical realist also requires us to accept that pain from the trauma itself is rooted in the real layer of reality. The GCT theory of pain (Melzack & Wall, 1965) and the critical realist's notion of weighted summary (Elder-Vass, 2010) both embrace the concept that neuronal matrixes control one's perception of pain (for the former) and reality (for the latter). The physiological basis of reality espoused in both GCT and weighted summary give credence to the *actual* layer of reality, which has a nontransitive and enduring quality for the critical realist. The GCT and other theories of pain, such as the neuromatrix theory of pain (Melzack, 2005), which posits that there are several inputs acting on the brain's neuromatrix contributing to the resulting output neurosignature (Melzack, 2005), all parallel the notion of the critical realist's layered reality, in that there is a basis in physiology. The nervous system plays a strong role in defence by detection of threat in the external environment; cognition (anticipation, appraisal); signalling of incurred tissue injury; and through motor responses geared to escape or fighting (Chapman et

al., 2008). This is the actual layer of critical realism coming into play. The cognitive component of GCT also encompasses the social sphere or the real domain of reality of critical realism.

Organizational Culture

Organizational culture either supports or does not support shared solutions such as implementation of the trauma algorithm; principles of organizational culture suggest that if a shared solution is working well enough, it will be taken for granted, drop from awareness, and become an unconscious assumption (Schein, 1996). The unconscious assumption is then taught to new members coming into the study hospital and becomes the correct way to do things (Schein, 1996). Pain treatment for the pediatric trauma patient is affected by two factors combined, namely, trauma care being in the charge of general surgeons, who have fine-tuned focus on injuries; and the use of the trauma algorithm, which does not place pain as a high priority. Among the many factors that shape organizational culture, including evaluation of practices, communication and resource allocation, organizational culture is shaped by its leaders (Mallidou et al., 2011; O'Reilly et al., 2014; Stevens et al., 2016; Yamada et al., 2017) which places the onus on leadership at the study hospital to influence clinical practices.

The powerful influence of organizational culture is frequently underestimated, particularly where phenomena such as pain management in pediatric trauma are not clearly understood. The critical realist notion of the temporal relationship of society to the individual is evident; the critical realist emphasizes that individuals enter into a society with social structures already in place (Danermark et al., 2002; Elder-Vass, 2010). Surgeons must adapt into a broader culture that developed the trauma algorithm of care and that lay outside of the study institution; thus, they are part of that larger group that does not place pain as a competing priority;

Theories of countervailing power within health care posit that various stakeholders (e.g., the medical profession, governments) vie for resources, territory, and control over delivery of health care (Light, 1997). One such countervailing influence identified in Phase 2 by one of the trauma nurses at the study hospital was the seniority of the trauma room nursing staff; more senior nurses were more likely to assertively advocate for the pediatric trauma patients requiring analgesia for pain while in the study hospital's trauma room. Current patient consumerism is a social movement that constrains the authority and autonomy of the medical profession (Vinson, 2016). Countervailing influences within the boundaries of this research refer to any influences affecting the behaviour of individuals caring for trauma patients. Countervailing influences, such as senior nurses advocating for pain treatment and patient consumerism, could disrupt the power balance established by the hospital, physicians, and the trauma algorithm.

The retroductive process can be utilized to examine the pain processes in the ED that are not working to manage pain well. A retroductive process is adopted by critical realists to (a) identify patterns of unmet needs in people or a society; (b) postulate the underlying cause or mechanism regarding what is generating these patterns; (c) analyze whether the explanation sufficiently explains the pattern under examination; (d) formulate a new explanation if necessary; and (e) expose the influence of the mechanism where appropriate (Houston, 2001). In this process, there is a focus on what produces events rather than on the events themselves (Meyer & Lunnay, 2013). Retroduction is a means of knowing the conditions fundamental to the existence of phenomena (Danermark et al., 2002). In research, the retroduction process is facilitated by several factors: (a) counterfactual thinking, or considering how outcomes may differ if circumstances were different (e.g., thinking of how pain management in adult trauma patients differs from that in children or how pain management would be different if juvenile ageism or

symbolic violence did not exist); (b) social experiments and thought experiments or imagining the consequences of a hypothetical world (e.g., development of hypotheses); (c) studying extreme cases to allow insight into the causes of a specific situation; and (d) comparison of different cases to determine what mechanisms must be in place for a situation to occur (Meyer & Lunnay, 2013).

Summary

Data from Phase 1 reported primary use of narrative notations that focused on the absence or presence of pain and pain location presenting a starkly different pattern of pain narration than that used for in-hospital pediatric patients.

Data from Phase 1 indicated that children with a high ISS, indicative of more serious injury, waited significantly longer for the first pain assessment was postulated to be due to (a) a longer period of time required to conduct a thorough assessment of injury and (b) strict adherence to trauma algorithms of care that place establishment of physiological stability over pain treatment. Mechanism of injury was associated with a longer period of time for the first pain assessment indicating that children who had been struck by an object waited longer potentially due to the fact that HCPs may not have associated this mechanism of injury with serious injury. In contrast, children with the mechanism of injury of MVA received analgesia more often.

Child factors associated with a longer time period from the traumatic event to administration of the first analgesia were number of injuries, mechanism of injury of assault, and presence of head or spinal injury. Number of injuries is potentially related to a higher ISS and more severe injuries which was postulated as taking a longer time to comprehensively assess seriousness of injuries resulting in delays to pain management; additionally, the trauma algorithm of care would guide pain care and augment delays to pain management. Delays to

children with the mechanism of injury of assault may be attributed to unfamiliarity with clinical care for patients with this mechanism of injury within the pediatric population. Delays to children with head injuries was clearly identified through interviews of HCPs in Phase 2 as a barrier to the provision of pain treatment due to the fear of masking changes in neurological status.

Situational factors that affected pain assessment practices indicated that children in the indirect trajectory waited longer for an initial pain assessment and received sub-therapeutic doses of opioids possibly indicative of a pattern of opioid titration utilized by many of the HCPs interviewed in Phase 2. Provision of first opioid analgesia was delayed for the overall sample of pediatric trauma patients (99 min) although there has been improvement in the time since data gathered by Neighbor et al. (2004).

Data from interviews in Phase 2 were examined using critical realism as a lens. Children's experiences of pain and trauma were discussed in relation to HCPs perceptions of their pain management. Critical realism guided explanations for the patterns of pain assessment and management seen in Phase 1 and 2 of the present research. Several generative mechanisms were identified including juvenile ageism that could possibly underlay assumptions of pain care held by both HCPs and, erroneously, children themselves; symbolic violence that wore the guise of trauma algorithms of care; organizational culture responsible for perpetuating use of existing models of trauma care; weighted summary and habitus augmented the influences of organizational culture and juvenile ageism.

CHAPTER 7:

IMPLICATIONS FOR THEORY, RESEARCH, AND PRACTICE

This chapter includes implications for theory, research, and practice that can be gleaned from results of the current research project. Strengths and limitations of the research methodology will be discussed, a knowledge translation (KT) plan will be outlined, and a final summary of the significance of the research and thesis will conclude the chapter.

Results of this study have the potential to (a) initiate development of pain assessment and management guidelines for pediatric trauma patients in the ED; (b) enhance attention to pain assessment and management in current trauma protocols, bringing attention specifically to the delayed interest in pain in both adult and pediatric populations; and (c) stimulate change to existing trauma protocols, generating a more widespread change including the prehospital setting as well as the early in-hospital setting. Educational workshops, self-learning modules, audits with feedback, educational outreach (e.g., huddles), reminders, and presentation of results at ED unit conferences conveying knowledge arising from this research would directly benefit front-line HCPs caring for traumatized children by increasing knowledge and awareness of the pain state of pediatric trauma patients as well as facilitating practice changes to improve pain assessment and management specifically for this patient population.

Implications for Theory, Research, and Practice

Implications for Theory

Critical realism as a guide to research in health care delivery has helped interrogate some of the assumptions of pediatric trauma pain assessment and management. It emphasizes the importance of unravelling some of the confounding aspects of the social facets of health care. It bridges the positivist (i.e., surgical model of care for pain treatment) and the postmodern (i.e.,

lived experiences of children with trauma and the HCPs caring for them) positions, realizing the strengths of both perspectives in solving health problems within the world in which we live. Explanatory components of critical realism underlie health care failures and triumphs that are connected to the success of treatment modalities.

Scrutinizing existing pediatric pain assessment and management practices through a critical realism lens demonstrated the benefits of employing a philosophical approach as a launching platform from which to solve everyday problems. For example, analysis of interviews with the children provided insight into their perception, albeit incorrect, that they had to wait for pain medication because they were too young or because they had not yet arrived at the hospital. Identifying generative mechanisms, such as symbolic violence, provides answers to difficult problems that have eluded resolution. Patterns of behaviour indicative of symbolic violence are very difficult to disentangle in the trauma scenario; HCPs who have spent many years providing care to children cannot fathom that they may be causing harm to them by following legitimized trauma protocols that delay or ignore pain management. Exposing deficiencies in the trauma protocol that have been in use for several decades causes disquiet to its proponents.

Critical realism facilitates the search for a deeper understanding of the empirical layer of reality within both the natural and social sciences. In this study, the empirical layer refers to how the pain assessment and management observations reported in Phase 1 and 2 are influenced by social constructs relevant to the hospital setting (e.g., trauma algorithms of care supported strongly by organizational/surgical culture of the hospital). Critical realism supports research within the health care environment since it helps resolve inconsistencies that exist between the natural and social worlds through reinterpretation of empirical data (e.g., suboptimal pain assessment and management patterns reported in Phase 1 is not being treated with available

physiologically based pain interventions such as distraction or optimal pharmacological pain interventions). However, because the nature of generative mechanisms is abstract, and the environment of health care is strongly influenced by a positivist paradigm, critical realism may fall short of effecting real change to trauma protocols. Despite this seeming failure, it does lay a foundation for future research by pursuing the notion of causality, which can help to resolve theory-practice inconsistencies. The recommendation would be to have a more in-depth understanding of all the facets of critical realism and how it can be applied in health care. Understanding why pain in pediatric trauma patients is in its current state can be achieved through persistent pursuit of the roles of meaning, interpretation, and context. Understanding the “how” and “why” will unpack the reasons behind empirical observations (Smith, 2006).

Some of the specific ways critical realism aided in facilitating understanding of pain assessment and management patterns in this research include: (a) interrogation of the notion of juvenile ageism, (b) questioning of HCPs assumptions that the trauma algorithm of care, that does not place pain as a competing priority, offers the best possible model of care, and (c) querying of the role of organizational culture in maintaining the status quo of pain care in the pediatric trauma patient.

As HCPs struggle to improve pain management interventions, GCT (Melzack & Wall, 1965) assumptions and models that clarify cortical pathways of pain and help explain how the roles of pain-related fear, memory, anxiety, and pain modulation are fundamental to the study of pain. The assumptions of GCT were evident in the words of HCPs who expressed difficulty separating fear from pain in pediatric trauma patients. The implication of further clarifying how GCT explains the relationship of fear, memory and anxiety to pain is that clarification of the relationships will help HCPs with their ability to discern fear and pain when making decisions

about pain management for the pediatric trauma patient. Additionally, optimal management of pain from trauma will serve as a preventive strategy guarding against development of memories related to fear of painful trauma assessment procedures and injuries.

The evolution of pain theory throughout the past century provides a clear example of the stratified approach to reality espoused by critical realism. As pain theory develops (Pereira, & Lerner, 2017; Sun et al., 2017), approaching the actual level of reality, perhaps pain interventions will craft a parallel development in conjunction with theory. For example, current models suggest that the relationship between pain and other concepts such as itching can be explained by blending premises from selectivity theory, which suggests, for example, that pain and itch have separately labelled lines from the periphery with pain-inhibiting itch (Andrew & Craig, 2001) and the “leaky gate” theory. The latter suggests, for example, the existence of a subset of second-order neurons that participates in the coding of both pain and itch sensations by complex neurocircuitry in the dorsal horn of the spinal cord (Sun et al., 2017). The cross-talk within the dorsal horn is done by neurons, specifically gastrin-releasing peptide (GRP) neurons, and upon strong activation of pain sensations, results in a “leaking” of the endogenous opioid system. The “leaky gate” theory differs from GCT in that itch sensations and weak pain sensations are allowed through the gate, thereby allowing tolerance of weak pain signals while blocking strong pain signals and preventing overwhelming pain (Pereira & Lerner, 2017). In terms of theoretical development, this adaptation of the GCT suggests that inroads into physiological underpinnings of the pain experience continue to be made. The implication of continued theory development is that progress can lead to new understandings and potential treatments targeting large nociceptive input. The huge nociceptive input assumed to be associated with major trauma holds confounding pathways yet to be found. Preventing establishment of central sensitization by

managing pain from peripheral injury and inflammation is relevant to the trauma patient and begins with an understanding of pain pathways.

Results from the present study generally support the sensory, affective, and cognitive dimensions of the GCT (Melzack & Wall, 1965) by divulging the child's perspective of the pain experience during the traumatic experience. One of GCT's premises is that there is an attentional modulation of pain that is a top-down process influencing spinal transmission of nociceptive inputs by "gating" incoming afferent inputs (Torta, Legrain, Mouraux, & Valentini, 2017). Using this premise provides substance to children's affective responses to trauma that may exacerbate their pain experience; their ability to modulate their pain response is affected by fear and anxiety from the traumatic event. Utilizing the GCT to help understand children's responses to their pain experience provides a way to anchor their pain response into physiology and critical realism's actual layer of reality.

Data from Phases 1 and 2 provided insight into critical realism's empirical layer of reality and have afforded a glimpse into the mechanisms that generate the reality of pain practices for the pediatric trauma patient. For example, children's acceptance that they depend on adults to be taken to the hospital, or their perception that they had to wait for pain interventions because they were not old enough, all while they tolerated pain, offers a glimpse into the power imbalance that exists between adults and children. Widespread acceptance of the trauma algorithm used by HCPs to treat traumatized children that places pain treatment as a delayed priority in the trauma algorithm offers a glimpse of symbolic violence.

Critical realism lends itself to triangulation of data because the philosophy embraces the interplay of the social and natural worlds and a mixed methods methodology for research (Shannon-Baker, 2016). A mixed methods design leads to triangulation of data between the two

or more designs. In the present research interviews from Phase 2 provided substance for expansion of social concepts that could represent generative mechanism and provide reasons for observations made in Phase 1. Advances and modifications to the GCT complemented critical realism by acknowledging the physiology of pain transmission which aligns with the natural world in the actual layer of reality according to the critical realist, and also by acknowledging the affective aspect of pain modulation which aligns with many components of the social sphere in the real layer of reality.

Tenets of critical realism are not always clearly translated into research methodology, although continued use of critical realism for future mixed-methods methodologies within the health sciences will verify its usefulness. Critical realists adopt a wider lens that works toward more sophisticated explanations and more effective solutions (Angus & Clark, 2012).

In summary, from a theoretical standpoint it is not just the establishment of associations between variables that are brought to light when discussing generative mechanisms for the critical realist; rather it is what lay between the interventions and results. Symbolic violence embedded within the trauma protocol as well as effects from juvenile ageism that result in delays of 99 minutes to pain treatment for pediatric trauma patients are some of the generative mechanisms that lay between available interventions and the empirical results of Phase 1 data. Critical realism provides a useful framework to launch speculation of the reasons underlying existing pain practices.

The critical realist approach blends an understanding of pain assessment and management of the pediatric trauma patient beyond a dualistic perspective of either/or by incorporating both positivist and constructivist paradigms and allowing for incorporation of a broader perspective.

Implications for Research

Further research on pain assessment and management in pediatric trauma patients is needed, to address the acute pain that persists in this patient population. The research questions outlined represent the most urgent problems that arose from the present research and need to be addressed first. With regards to the first question, in the absence of clear pain assessment and management guidelines for the pediatric trauma patient it is important to begin development of trauma specific approaches to pain care. The second question addresses the recurrent theme of pain with movement that could be managed by simple techniques such as using a blanket to move the patient. Use of a blanket to assist in movement was mentioned by one of the children interviewed who stated this technique greatly helped with her pain during movement. The last question posed regarding interviews with children with more serious injury will expand the current research by attempting to gain the perspective of more seriously injured children. Establishing a clear baseline of current pain practices in pediatric trauma patients will inform the current lack of knowledge around these practices and provide some foundational data on the pain state of children in this patient population.

A few key research questions arising from study findings include:

- Can standardized approaches or guidelines—consisting of benchmarks to have pain assessed within a specified time after a traumatic event followed by a titration protocol—be developed for pain management in pediatric trauma and what impact would they have on pain assessment and management practices?
- What strategies could be used to assist with moving patients during transport from stretcher to bed with the least amount of discomfort?

- What are the perceptions of pain of children who are more seriously injured as well as the perceptions of their parents?

Pain assessment and management guidelines. Findings from the present research highlight the need to develop evidence-based guidelines specifically for pediatric trauma patients. Such guidelines would need to be successfully implemented at the study hospital as a regional pediatric trauma center before they could be considered as the standard of practice. A preliminary consideration could pose the question of why the trauma room within the ED at the study hospital was not using the pain assessment and procedural pain management guidelines and policies that were up to date and in place for the rest of the hospital.

Validation of existing pediatric pain assessment tools in the trauma setting may lead to a formal acceptance of preferred tools that would be based on evidence and could potentially lead to better pain assessment. Potential validated pain tools for pediatric trauma patients could be the VAS (Lasagna, 1960), COMFORT-B (van Dijk, Peters, van Deventer, & Tibboel, 2005), the PBCL (LeBaron & Zeltzer, 1984), and the PBRS-R (Katz et al., 1980) pain assessment tools, as well as the NRS (Downie et al., 1978). For the younger child, the Faces Pain Scale–Revised (von Baeyer & Hicks, 2000) could be validated for pediatric trauma patients. However, the use of only one pain tool would not suffice across ages or situations and further validation in the trauma scenario is required.

Creating or determining effective strategies to make HCP aware of current opioid recommendations would be highly recommended since there have been updated guidelines for opioid administration from the National Pain Centre in 2017 (Busse, 2017). Minimizing the worry about adverse side effects from opioids would provide physicians with confidence to prescribe appropriate doses as required. More studies emphasizing the safety of morphine and

fentanyl in the pre-hospital setting are required and would support the safety of opioids to clinicians and potentially improve times to first analgesia that are currently prolonged.

Retrospective chart audits could be conducted to examine whether associations exist between administration of opioids and adverse events such as respiratory deterioration on route. While fentanyl has been identified as a safe analgesic agent in the prehospital setting (Hostetler et al., 2002; Thomas, Rago, Harrison, Biddinger, & Wedel, 2005), RCTs comparing other analgesic agents with fentanyl would clarify the optimal analgesic choice(s) for use in the pediatric trauma patient.

Evidence-based guidelines for prehospital pain management have been instituted in the United States, although improvements in administration of opioids have not been reported (Brown et al., 2014; Browne, Shah, et al., 2016). Attempts to improve prehospital analgesia continue to be made despite the rising epidemic of opioid abuse (Alghnam & Castillo, 2017). Outcome research using outcomes of pain intensity, duration of time till first opioid analgesia, and pain interventions measured at regular intervals would keep information current about the pain pediatric trauma patients endure.

Adoption of existing benchmarks for assessment and management of pain for children with trauma could be developed to keep the issue of pain in the forefront of research efforts. Research evaluating effectiveness of education as a knowledge translation strategy should be developed since education regarding pain management for pediatric trauma patients was found in the HCP interviews in Phase 2 to be lacking, particularly for physicians. Successful change interventions identified by Johnson and May (2015) in an overview of systematic reviews examining professional behaviour changes were reported to be audit and feedback, educational outreach visits, and reminders. Education emphasizing the general premise that a pain intensity

level of > 4 requires treatment in all patients inclusive of the pediatric trauma population (Kozlowski et al., 2014).

Children waited longer for administration of the first opioid analgesia when transported from a community hospital in this study. Future research efforts on the pain management for pediatric trauma patients being transferred from community hospitals is essential, given that they were recorded as having a higher ISS and greater number of injuries than children in the direct trajectory. A research question that would attempt to understand why children wait for a prolonged period of time to first opioid analgesia may be stated as: What are the perceived barriers in pain treatment for pediatric trauma patients in a non-urban setting? Specific factors that could be considered in an exploratory survey research design could include examination of education around pain recognition in children and subsequent treatment modalities in early stages of trauma for EMS and HCP personnel in a non-urban community. Responses from the research should then be directly acted upon to create programs of education targeting training programs for EMS and HCP personnel in the non-urban setting. Highlighting pain care in the pre-hospital and ED setting may result in a shift in attention to pain management in current trauma algorithms.

Transport strategies. Future research will need to address a balanced approach for multimodal interventions that would provide optimal pain relief for this type of patient. A multimodal, balanced approach for pain interventions would include pharmacological, physical, and psychological pain interventions. Lack of use of psychological and physical interventions were revealed through Phase 1 of this research project. Future efforts are needed to conduct research for physical pain interventions. One such pain intervention would be improved transfer lifts, which would ease pain from movement during transitions from accident scene to stretcher,

stretcher to trauma room stretcher, trauma room stretcher to X-ray table, and finally stretcher to hospital bed. Effects of a transfer lift could be evaluated with a randomized control trial or a cohort study in which pain intensity scores between the control and experimental groups could be compared where the experimental group was moved using a transfer lift during transport to the ED. Establishing whether a transfer lift is effective in relieving pain with movement would help address this issue as reported by children in Phase 2. Other examples of physical interventions should be evaluated, such as improved splinting techniques and materials that would contribute to the comfort of patients suffering from fractured extremities.

Children's views of pain in trauma. The current research inclusion criteria for Phase 2 interviews comprised children with relatively minor injuries; future research should be expanded to include children with more serious injuries and varying levels of consciousness, so as to compare the differences in pain experience and treatment between the children in the Phase 2 sample in the present research. To ensure inclusion of more seriously injured children in future research a clear definition of serious injury is required. For example, children with an ISS of ≥ 16 at time of injury would be a crucial part of inclusion criteria since this score is considered an indicator of moderate/severe injury state. An observational repeated measures design would include monitoring the status of pain assessment and interventions over the entire period of hospitalization and post-discharge for a period of one year to trace development of sequelae such as chronic pain after the traumatic event in these more seriously injured children. Measures such as a health-related quality of life tool along with pain intensity measurements/pain narratives and pain intervention tracking as well as interviews could be used to detect any changes in pain status if conducted at monthly intervals with home visits or use of a diary.

Future research should build upon the present research by refining the mixed methods convergent design with better alignment between qualitative and quantitative data. In the current research the patient data from the chart review in Phase 1 did not link with the participants interviewed in Phase 2. Alignment between the two datasets would form a more comprehensive representation of the pain experience for pediatric trauma patients by providing data such as the ISS, number of injuries, type of injury, mechanism of injuries, pain intensity scores, and pain management interventions for the participants interviewed. Alignment of the quantitative and qualitative datasets by having the same participants in both datasets would provide strength and validity to the study findings. Additionally, the conceptual framework (e.g., critical realism) could be used to more adequately fuse the data collected to theoretical constructs.

To complement the above research design and add another element of triangulation a participant observation methodology could be with the purpose of observing the behaviours related to the experience of pain of patients as well as those behaviours related to pain treatment provided by HCPs in the trauma room. Participant observation enables a researcher to observe and participate in a culture to facilitate a better understanding of the behaviours and activities (Kawulich, 2005) while understanding the context that influences the observed behaviours (Dahlke, Hall, & Finney, 2015). Direct observations of how HCPs interact with children from the point of entry into the hospital trauma room and during the trauma assessment process by a researcher would offer insight into patients' pain behaviours in response to movement and procedures. The researcher could also directly observe responses of HCPs to their patients' pain experience. Verbal and nonverbal behaviours of the HCPs and children witnessed by a researcher in participant observation would add contextual information not captured in chart reviews.

Additionally, future research should include two groups of children that co-incide with developmental stages; one group who are under the age of 11 years and another group 12 years and older in order to discern sex differences that were alluded to in the present research.

To further build upon Phase 2 of this research, future research designs should also continue to include qualitative investigation into the children's, parents', HCPs', and hospital administrators' perceptions of pain, since analysis of varying perceptions will provide better insight into the pain experience, and yield ideas for intervention development.

Children's perception of their pain experience during trauma have identified incorrect beliefs (for example of the child who felt he was too young to have pain relief until he reached the hospital). Further qualitative research with pediatric trauma patients could reveal the presence of other misperceptions about pain treatment that children may hold.

Qualitative research with parents of pediatric trauma patients could be informative, since the parents often arrive very soon after their children's accidents, and bear witness to their children's pain behaviours. With the paradigm shift to family integrated care in pediatrics (O'Brien et al., 2013) with the parent at the centre of care for their child, the importance of their perceptions in the distressing scenario of trauma would be valuable. Additionally, children with head injuries are frequently undertreated for pain; parents could provide insight into their experience of pain associated with neurological trauma. Further exploration of the views of HCPs is warranted to validate where attention to pain treatment in the trauma algorithms of care should be placed, and why treatment of pain in pediatric trauma differs from pain treatment in the broader ED.

The views of children and HCPs' perception of pain assessment and management revealed some discrepancies. For example, many HCPs assumed EMS staff had provided pain

relief en route to the study hospital yet results from Phase 1 of the present research indicated that dosing was suboptimal. Further efforts are needed to dissect the differences and examine the impact on pain outcomes for these children. Results from each viewpoint could be used to inform, develop, and test multimodal intervention approaches for better pain assessment and management such as development of a standardized opioid titration protocol that would guide pain management. Future research should include a more comprehensive examination of parents', EMS technicians, and administrators' perspectives to complement those of children and HCPs.

In summary, recommendations for future research include: (a) evaluation of the impact of guideline implementation for the pediatric trauma patient; (b) determination of pain assessment tools that have clinical utility in the pre-hospital and trauma room setting; (c) continued evaluation of associations between administration of opioids and adverse events to demonstrate safety of opioids in the pre-hospital setting; (d) development of transportation modalities that will minimize patient movement and therefore minimize discomfort during transitions of care; and (e) continued qualitative research involving children to uncover misconceptions they may have related to their right to have their pain treated and parents to further explore their perceptions of their child's experience of pain in trauma.

Implications for Practice

Results of this research directly inform clinical practice within the trauma room environment. In terms of pain assessment and management, children from the indirect trajectory group had a larger number of injuries and waited a longer period before a pain assessment was recorded. Front-line staff must be made aware of the prolonged period without analgesia, through quality improvement initiatives involving audit checks of trauma patient records that are

communicated in regular meetings or through presentation of current research regarding pain assessment and management in pediatric trauma.

Pain assessment. A thorough pain handover report, including when the last pain intervention was provided, should be taken by the trauma room nurse designated as the recorder in the trauma room immediately upon arrival of the patient into the trauma room. The information obtained would provide an accurate report of pain assessment and any pain interventions that have been given or that work for that particular patient and would clearly detail the pain the patient has had to endure up to the point of admission to the ED trauma room. Additionally, linking responsibility to professional accountability (whether the provider is a nurse or the EMS), requiring reporting of pain treatment at handover, would possibly improve pain care. It might also be useful to communicate with community hospital and EMS community members about ensuring pain assessment and management is included in a patient transfer protocol or engaging community members in the development of such a protocol. Currently there are no clear guidelines to ensure a complete handover of pain care for children who arrive directly or indirectly to the study hospital and algorithms of trauma care do not place pain as a competing priority at the moment of arrival in the trauma room. Using the family integrated model of care when handing over care of the pediatric trauma patient from the ED to the in-patient unit, parents could be invited to be present during the handover to advocate for their child's pain treatment.

In Phase 1, pain assessment in the early moments of the traumatic event was recorded for most children; however, pain assessment is not efficiently followed by adequate pain interventions or pain reassessment following administration of pain interventions. Implications for practice for EMS personnel would suggest that it is necessary to consider that a pain

assessment must be very closely tied to possible pain intervention; training for these early responders needs to be provided, to improve pain assessment and management. Additionally, it would be helpful to gain the perspective of the early responders while developing training strategies. Adopting a practice of documenting a reason for why a pain intervention was not provided could be one way to improve provision of pain interventions. Inclusion of physical (e.g., splinting if qualified, comfort measures such as warm blanket) and psychological (e.g., distraction) pain interventions should be emphasized in the early stages of transport, given the discomfort of administration of pharmacological interventions.

Current pain assessment and management guidelines in the broader ED at the study hospital suggest a pain assessment with a validated pain tool be done upon admission, whenever vital signs are being taken as well as before, during and after painful procedures. Additionally, a pain assessment needs to be done when a child experiences moderate to severe pain (>4 on a 0-10 point scale) and must be reassessed hourly after receiving a pharmacological, physical, or psychological intervention (Kozlowski et al., 2014). Given the acuity of the trauma patient, these pain assessment and management policies, geared toward hospitalized patients, provide a starting place from which to begin developing trauma pain assessment and management protocols. It would be reasonable to expect a pain assessment with a validated pain tool be done upon admission; before, during and after painful procedures; and then hourly after interventions had been given. For pediatric trauma patients, a pain assessment would likely need to be done at least hourly during the initial hours after the traumatic event.

Documentation of pain intensity scores and the effectiveness of pain management strategies remain problematic. Discussion with unit decision makers (e.g., the educator in the ED, the trauma patient care coordinator on the trauma unit) concerning the inclusion of a space

specifically for pain assessment and management on current trauma documentation records is necessary. Although there is a space for medications on the trauma record at the present time, an explicit area for pain medications may bring pain more to the forefront of care. Consulting with front-line trauma room HCPs regarding optimal placement of the area for pain assessment and management on the trauma current paper form and on the future electronic format would engage users in implementing this potential initiative.

With the advent of electronic charting, development of best-practice advisories for pain and reminders to alert users when vital signs are overdue, can be built into the hospital information system (HIS) to remind end users to document pain assessment and provide timely pharmacological pain interventions. However, it is not confirmed whether integration of the new HIS with incoming EMS systems is within the current scope of the project so a smooth transition at this point may remain elusive.

Findings from the present research highlight the need for development of evidence-based guidelines specifically for pediatric trauma patients. These guidelines would need to be successfully implemented in the setting before they could be considered the standard of practice at the study hospital as a regional pediatric trauma center. Despite established ED and hospital-wide pain policies, the research revealed a sentiment that the trauma population was exempt from having these policies in place. A key question is why the trauma room within the ED at the study hospital was not using the pain assessment and procedural pain management guidelines and policies that are up to date and in place for the rest of the hospital. To break through this issue at the organizational level, dialogue with senior management in the study hospital ED and the hospital trauma team, is required to effect changes. It is possible senior management for the

organization, who are strategically placed to make changes to optimize care, are unaware of the extent of delays in pain treatment for the pediatric trauma patient.

Children with head and spinal injuries waited a longer time for pain assessment. The HCPs interviewed in Phase 2 recognized their reluctance to administer analgesia to children with head injuries due to uncertainty about whether it would mask changes in level of consciousness. It is possible the unique and acute nature of providing care to patients in the trauma room differs from usual care provided in the broad ED and inpatient units, and underlies reluctance of the HCPs to provide usual pain treatment. Research regarding delays in pain management for children with head injuries is scarce but evidence does exist that children with intellectual compromise from head injuries or developmental delay are difficult to assess for pain and likely result in suboptimal pain management as a result (Breau, Camfield, McGrath, & Finley 2003; Herr, et al., 2006).

Pain management. Recommendations for practice would target efforts to monitor children with head injuries from trauma to observe for changes in consciousness. As soon as the trauma patient has reached a state of consciousness when pain can be assessed or, alternatively, as soon as the extent of brain damage can be ascertained, evaluation of pain should take place with a validated pain tool such as the FLACC (Merkel et al., 1997) or the Revised FLACC (Malviya, Voepel-Lewis, Burke, Merkel, & Tait, 2006), and a decision made whether pharmacological analgesia should be administered.

Interviews with pediatric trauma patients indicated that they experienced a special connection with HCPs who seemed to extend comfort and reassurance to them, even when their parents were present. This special connection indicated that it is possible to make a lasting impact on children simply by being supportive during this stressful time. Many of the children

were aware and appreciated support from the staff encountered along their journey through the trauma assessment and management process. Primary care models of nursing dictates that one nurse should be the primary caregiver for a patient; perhaps a hybrid of this model of care could be proposed for the trauma room, where one nurse could be designated as the contact person for the child during their time in the ED. One of the primary objectives would be to ascertain a pain summation and develop a pain intervention plan. Designated roles (e.g., recorder) for nurses during a trauma code activation do exist, but do not include the role of being a contact nurse specifically to communicate with the patient. Perhaps the recorder could take on the role of being a pain advocate who would inquire about pain interventions that had been given already and make suggestions about pain management strategies while continuing with the recording role.

Pediatric trauma patients have to endure movement from the accident site to stretcher and then again onto the hospital stretcher; children stated that such movements were profoundly painful. Attention needs to be paid to strategies to decrease or ease movement from stretcher to stretcher as much as possible. A paucity of research exists on strategies to move critically ill patients; however, several children stated in their interviews that movement using a blanket was much more comfortable. The strategy of using a blanket for movement should be emphasized for use by EMS and trauma room staff whenever appropriate and possible, where for example there was no evidence of spinal injury. Caregivers most involved in the movement of children need to know about strategies to help minimize movement to institute such strategies of care. Workshops given by the study hospital or tip sheets developed with key points about movement strategies could be provided to EMS staff when they bring a patient into the trauma room. Forethought should be given about every movement considered for pediatric trauma patients. Despite many technological advances, no mechanized transfer equipment currently exists for EMS to facilitate

minimization of pediatric trauma patients' movement during transport to hospital. However, the use of stretchers, carry chairs, evacuation chairs, and rescue sheets were recently cited as the types of devices used to evaluate the performance of staff using movement assist devices to evacuate people with reduced mobility (Hunt, Galea & Lawrence, 2015), indicating that a few advances have been made in this area.

Data from Phase 1 indicated that 61 patients had at least one type of extremity injury, yet splinting was recorded as an intervention in only seven (11.5%) of them. Given that immobilization of the limb is indicated in most extremity injuries (Keene, Williams, Segar, Byrne, & Lam, 2016), use of splinting to help immobilize injured limbs should be encouraged. Well-done effectiveness research needs to take place, followed by synthesis of results to develop evidence to base development of guidelines upon. Since expertise is required regarding the application of a splint to the fracture site and there is evidence that immobilization at times may not always be necessary and may prolong recovery (Schuh, Whitlock, & Klein, 2016), a panel spearheaded by orthopaedic specialists at the study institution could lead in the development of and consensus about guidelines for splinting. Although consensus is not as strong as other forms of evidence synthesis (e.g., systematic review of randomized control trials or cohort studies) it is a useful strategy to evaluate and implement guidelines. Given that the study institution is a leading pediatric trauma center recommendations from such a working panel may carry some weight in changing pain practices.

Data from interviews with HCPs indicated the urgent need for a standardized approach for pain management in pediatric trauma patients. Titration of opioid analgesic agents is the most effective and safe approach, as indicated by many physicians who managed care for trauma

patients, and as supported by evidence (MacKenzie, Zed, & Ensom, 2016). Titration of analgesic agents should be recommended and incorporated into a standardized pain management approach.

Detection of significant findings pertaining to child and situational factors have major implications for practice. Front-line ED staff need to be told as soon as possible about school-age children waiting longer than older children for pain reassessments. Short presentations on pain assessment and management of pediatric trauma patients, emphasizing the importance of paying attention to this age group, could be provided during regular staff meetings and included in orientation programs for new staff members for both nurses and physicians. A reminder, in the form of a small poster with key points from the present research, could be posted in the trauma room near the charting area.

Some of the systemic barriers to effective pain management in this patient population identified in the current research are the lack of (a) clear pain policies or institution guidelines for use with children with trauma; (b) recommended pain assessment tools; (c) a standardized approach to pain management; and (d) a formalized pain education program for HCPs regardless of discipline. A review by Hatherly, Jennings, and Cross (2015) examining 15 research studies that measured time to opioid administration in EDs in both children and adults indicated that pain score recording and nurse-initiated analgesia protocols demonstrated improvements in pain treatment. While there are other analgesic interventions, such as paracetamol, that could be affective (Dijkstra et al., 2014) opioids remain the cornerstone of pain treatment for acute pain. A policy standardizing use of a pain assessment tool and suggestions for appropriate pain management could be informed by results of the current research project. Existing policies need to be updated by trauma care teams at both community hospitals and the study hospital to include

appropriate pain tools that would be most optimal within the trauma room with conscious pediatric trauma patients for several age groups.

In summary, recommendations for practice include (a) development and evaluation of pain assessment and practice guidelines specific to the pediatric trauma patient and inclusive of recommended pain assessment tools and a safe, effective opioid titration protocol in order to prevent delays in pain treatment; (b) implementation of a formal handover report specifically addressing the patient's pain state and treatment; (c) provision of pain education specific to pain assessment and management in the pediatric trauma patient such as educational workshops, self-learning modules, audits with feedback targeting EMS and HCPs in non-urban trauma care settings; (d) ensuring patient transport is as smooth and pain-free as possible; and (e) engaging administrators from both the ED and the trauma unit in re-evaluation of attention to pain in accepted trauma algorithms that guide trauma care.

Knowledge Translation Plan

The length of time to get research into practice has been estimated to be 17 years (Morris, Wooding, & Grant, 2011); therefore, development of a KT plan is an important component of any research project. The following section describes the KT plan to be put into place for the present research project.

Elements of a KT Plan

Barwick (2008) categorized KT strategies according to their level of effectiveness, emphasizing that combined or multifaceted KT strategies are more effective than single-strategy approaches. However, in a systematic review conducted by Squires, Sullivan, Eccles, Worswick, and Grimshaw (2014), examining whether multifaceted interventions were more effective than single-component knowledge interventions, strong evidence supporting the use of multifaceted

interventions was not found. Because the nature of pain assessment and management is multi-dimensional, the proposed KT plan does include a multifaceted approach; effectiveness of the approach will require repeated measures of pain assessment and management practices in pediatric trauma patients similar to the approach utilized in Phase 1.

Integrated KT. Integrated KT plans involve multiple stakeholders in the research process and have been proposed as a way to address underutilization of research findings (Kothari & Wathen, 2013). The integrated knowledge translation approach involves active collaboration between researchers and knowledge users throughout the research process. Stakeholders were involved in all stages of the present research; one of the members of the investigator's research team was a physician pain champion in the ED at the study hospital who was involved in development of the research proposal. Study participants for Phase 2 consisted of staff members in the ED of the study hospital representing various professional disciplines as per inclusion criteria. Recruitment of child participants was aided by the TPCC in the trauma unit at the study hospital.

Connection to some members in the ED practice environment from the very beginning was ensured by engaging an ED physician on the doctoral committee to develop this research proposal. Profiling and placing results from this study in a relevant context such as the ED is an important KT strategy (Bowen & Graham, 2013).

End-of-study KT plan. An end-of-study KT plan was developed to disseminate and apply the results of the study for the improvement of pain treatment practices in pediatric trauma patients (Barwick, 2016).

Goals of the KT plan. The overall aim of the KT plan was to change and improve pain assessment and management for pediatric trauma patients. Goals of the KT plan are to (a)

generate awareness of existing delays and deficiencies in pain practices for pediatric trauma patients; (b) increase knowledge to HCPs providing direct care to pediatric trauma patients and their parents; and (c) facilitate changes to relevant policies. A sustained partnership between research and research users during knowledge generation and application bridges the two groups that can lead to research questions that are more relevant, findings that specifically target a knowledge-practice gap, and prepares the audience for research-based changes to practice (Kothari & Wathen, 2013).

Partners. Partnership with HCPs is necessary to augment buy-in of the KT message. Beginning with those involved at the conceptualization stage of the project and branching off to front-line ED staff who were pain champions, attempts will be made to convey results of the present research. Conveying results from the present research will be done by arranging presentations at staff meetings with the ED and the trauma unit. Branching out to offer presentation of results from the present research to community hospitals will be arranged.

Audience. The KT plan is aimed at three target audiences: HCPs caring for these children, children and their parents, and policy makers responsible for updates to trauma care. Policy makers at the study hospital and at the American College of Surgeons who update the ATLS manuals and courses should be made aware of the state of pain treatment for the trauma population.

KT Strategies

The knowledge-to-action framework (Graham et al., 2006) supports a process that is iterative, dynamic, and complex with the boundaries of knowledge creation and knowledge application being fluid. Knowledge inquiry and synthesis of research results lead to development of knowledge tools that can lead to changes in clinical practice. Action is based on planned

actions that deliberately focus on changing health care systems and groups. Included in the action plans are identification of the problem; selection of the knowledge to implement; tailoring the knowledge to the local context; evaluation of the impact of using the knowledge; and determining strategies for ensuring sustained knowledge use (Straus, Tetroe, & Graham, 2011; Field, Booth, Ilott, & Gerrish, 2014).

For this research knowledge synthesis will take the form of audience-specific reminders and posters presenting key findings from results of this research project that will inform practice and which will be posted in the trauma room and in strategic places throughout the ED (e.g., in the central and satellite stations) targeting front-line staff who make decisions about pain treatment. Additionally, publication of results to journals specific to pain (e.g., *Pain*, *Pain Research and Management*), pediatrics (e.g., *Pediatrics*), and emergency care (e.g., *Annals of Emergency Care*) would make findings from this research available to other clinicians and inform their decisions about the care they provide in their institutions. Poster presentations and workshops at conferences, both national and international, will be sought at every opportunity.

For this research action parts of the cycle can take the form of interactive small group sessions on pain assessment and management for pediatric trauma patients which will target the teams of HCPs providing direct care to pediatric trauma patients. Other targeted strategies will include short presentations at regular staff meetings, workshops offered on professional development days, and daily huddles for patients with difficult pain problems. Audit and feedback cycles regarding pain practices for trauma patients could be part of regular monthly or bimonthly staff meetings directed at the team of front-line staff members to ensure awareness of pain is a prioritized part of regular care within the ED at the study hospital. Audit and feedback cycles can also be targeted to individuals and their specific pain practices. Key findings from the

present research that indicate the delay to first opioid analgesia can be emphasized during both team and individual audit sessions.

To target KT strategies towards children and families, a one-page summary of research results will be developed for study participants and their families outlining key findings written in lay language including the impact these findings will have on future clinical practice in pain care for children with multiple injuries. Opportunities will be sought to attend public forums with interest in hosting presentations on pain in children for the broader public audience (e.g., CIHR Café Scientifique). Key findings to focus on for parents relate to juvenile ageism and should take the form of letting parents know they can advocate for their child by requesting pain interventions, including pharmacological and physical intervention types, at any point along the trauma journey whether that be in the ambulance or in the emergency department. Parents should be encouraged and shown how to provide psychological support to their child throughout the trauma process.

The trauma algorithm of care is an accepted and legitimized approach to care trauma management. Because the algorithm does not place pain as a competing priority, it is being conceptualized in the present research to be indicative of symbolic violence since it results in delays to pain management interventions. Changes to the algorithm of care may begin if awareness of pain delays resulting from this approach to care can be brought to the forefront of health care delivery. Specific ways changes to the algorithm of care may include (a) formally moving treatment of pain forward in the algorithm, if possible, up to D for Disability and Discomfort, (b) raising awareness of delays in pain treatment by highlighting results of research measuring times to administration of analgesia for pediatric trauma patients, and (c) continued measurement and examination of such delays in pain treatment for this patient population.

As a well-respected pediatric facility any improvements in pain practice adopted by the study hospital may reverberate beyond the hospital walls to the EMS community and to the transferring hospitals. Members of the EMS and transferring hospital communities report patient status to the study hospital. Therefore, if the expectation by the study hospital includes appropriate pain care be reported, attention to pain care may improve.

Targeting policy makers who can influence changes in the existing trauma care algorithm would be very challenging because of its widespread use. However, making the trauma care committee within the hospital aware of the findings would be an important first step. As a condition of conducting research in their patient population, it was necessary to present the proposal to them before starting the research. Arrangements will be made to return with research findings, planting seeds for change. It would also be appropriate to present results from this research to ED staff, to demonstrate the current practices required to ensure the context component of a successful implementation. Gaining cooperation from ED management staff will need to be established to accomplish a change in culture for the ED at the study hospital. Pain champions currently exist in the ED of the study hospital, so encouragement to continue in this role would serve to facilitate further changes that may arise from the knowledge gained from this research.

Facilitation of change to achieve sustainability of changes to practice need to be undertaken by all levels of management; the trauma care committee represents a mid-level of management within the study hospital. Engle et al. (2017), in examining the role of middle managers in health care organizations, found that middle managers can be effective facilitators of change, since they bridge the gap between front-line staff and senior leaders.

In summary, to facilitate changes to relevant pain policies, it is necessary to undertake several knowledge translation strategies. An overall aim would be to generate awareness of existing delays and deficiencies in pain practices for pediatric trauma patients. With this in mind, HCPs who provide direct care to pediatric trauma patients, and parents of these patients, could be provided with knowledge about existing pain states. KT strategies that might be effective in achieving these goals could incorporate brief sessions that engage front-line staff at the point of care. Audit and feedback cycles and reminders placed close to the point of care would directly address and target the front-line worker as well. Publication of results and presentation at professional conferences interested in pediatric trauma care, while less effective, would help achieve the goals of generating awareness of the pain state of pediatric trauma patients.

Strengths of the Study

The current research addresses a major gap that currently exists in care for pediatric trauma patients. The lack of knowledge of pain assessment and management provided to these children was first uncovered through the retrospective chart audit (Phase 1). The chart audit contributes to existing pain research that has been conducted in children with trauma by highlighting the precise nature of pain assessment and management practices currently being provided to pediatric trauma patients. Knowledge gained in the present research indicates that there is (a) minimal use of validated pain tools; (b) administration of suboptimal doses of opioid analgesia; and (c) a delay both in doing pain assessments and, among children who were being transferred to the study hospital, in receiving an opioid analgesia. This new knowledge has not before been related to children with trauma and will help inform a revision of trauma care algorithms.

Interviews with children who have endured injuries from a traumatic event and the HCPs caring for them provided further insight into the inner world of trauma care in the ED. Finding out from children how their pain experience progressed from the beginning of the traumatic event through to the ED visit—research not previously pursued—was revealed. It is imperative that patients' perspectives become more salient, so as to improve patient care in hospitals and to develop interventions. Tapping into the insights from front-line HCPs is similarly valued and is also rarely sought. This research represents a concerted attempt to obtain the differences and similarities in pain perspectives that do exist, from children and HCPs.

Use of a mixed-methods quantitative and qualitative design in this research was a strength; it is an approach espoused by critical realism (McEvoy & Richards, 2006). It is also a robust methodology for health care research, given the effect on human health reaped from research in both the natural sciences, responsible for the discovery of crucial medical advances, and the social sciences, as health-related events impact upon the individual.

The interviews from Phase 1 provided specific details about the types of pain assessments and management practices recorded for a recent cohort of pediatric trauma patients. The interviews from Phase 2 provided insight into the thoughts and experiences of both pediatric trauma patients (and, by extension, their parents) and the HCPs providing care to this patient population. Information from pediatric trauma patients and HCPs from several disciplines who work in trauma rooms in the ED has not previously been clearly articulated, with the result that this research has made a significant contribution to literature on pediatric trauma patients.

Limitations of Study

A major limitation of the present research was the lack of interviews with EMS personnel who play such a crucial role in the initial stages of care for pediatric trauma patients. EMS

personnel could provide vital understanding of the barriers they perceive when providing pain care to children in the most immediate period following trauma. Another limitation is the lack of perspective from unit administrators or management; this group would be influential in changing algorithms of trauma care, as well as ensuring that existing guidelines within the ED are endorsed to the extent they can be adapted to the trauma room. Examination of existing pain protocols for children would have provided valuable insight into the organizational position of the broader EMS community on pain treatment for pediatric trauma patients.

In Phase 2, a proportionately larger number of physicians were interviewed than nurses, according to the total number of physicians and nurses who worked within the ED at the study hospital. The lack of nurse participants was significant, since pain assessment and management is commonly considered to be within the scope of nursing practice. The dearth of ED nurse participants could be mitigated in future research by using more engaging recruitment strategies geared specifically to the nursing population. Such strategies could include stressing the key contributions that could be made from the nursing perspective, and engaging senior management to provide acknowledgement in participation in pain research.

Additionally, there was an unintentional recruitment of a larger number of female HCP participants. This was representative of the number of females in the population of HCPs at the study hospital, but, although it is possible the gender imbalance would not have made a difference in the development of themes, it could have resulted in a one-sided viewpoint on pain management in pediatric trauma patients.

Interviewing children to include their perspectives in research has been shown to provide in-depth data reflective of many misperceptions they hold; however, collecting these data can be problematic. Conducting interviews with children who had recently undergone a very traumatic

event was a critical factor in this research study. Innovative techniques, such the use of storyboards that use felt characters and felt boards to help children tell their stories in critical care illness (Rennick, McHarg, Dell’Api, Johnston, & Stevens, 2008), could have been used to encourage interaction with children during the interviews. Additionally, children more representative of the urban population using the study hospital, such as children who were not English-speaking and who could have represented a more diverse ethnicity, were omitted from the study.

In the critical realist approach, interviews are used to access the patients’ perceptions; however, interviews could not take place immediately following the traumatic event due to medical fragility of the children. This timing raised concern for recall biases and memory distortion that point to some difficulties engaging children in conversation associated with this approach.

Not formally including parents in the research design was a limitation to the current research. It was not optimal to separate parents from children, since this dyad is very strong and most certainly it may be stronger during a time of crisis such as in the post trauma period. Parents spoke up in nearly all interviews and offered their view on their child’s pain but formal analysis of their contribution was not done and parents were not interviewed independently from the children. Future research efforts should include a more in-depth probing of parental views of their child’s pain, particularly gaining their perspective on the point at which they felt their child should have initially been provided with analgesia. Foster, Young, Mitchell, Van, & Curtis (2017) interviewed 40 parents of 30 children a child 0–13 years who experienced critical injury in one of four Australian paediatric hospitals recommending that psychological first aid and assessing parental blame need to be addressed early in the hospitalization .

Use of only one research site was a limitation of the present research; however, pain data of children in the indirect trajectory did reflect practices from several transferring institutions. Future endeavours should include attempts to interview children and HCPs at several community hospitals. Additionally, more study participants would allow a more comprehensive assessment of the perceptions of both children and HCPs, since the sample size for Phase 2 of the present research was small.

Use of chart review permits investigation of research questions that are difficult or almost impossible to evaluate in prospective trials and are used in 25% of peer reviewed emergency medical journals (Kaji, Schriger, & Green, 2014). However, potential bias from chart review data arises from the data being far removed from the patient. Additionally, not all events are recorded because of perceived relative unimportance (e.g., psychological or physical pain interventions) or oversight. Errors can be compounded by data abstractions including misinterpretation of chart entries, miscoding of data or omissions in the medical record. In spite of the potential for systematic error, few validated criteria for chart review study quality exist (Kaji, Schriger, & Green, 2014). Data recorded in medical records is often captured for purposes such as billing or medical-legal reasons and not research, therefore there is often a lack of quality and comprehensiveness of data (Lowenstein, 2005). Training of data collectors to know where in the chart to find information and support in resolving internal discrepancies in the medical record can help in collection of data; both were provided for the data collector (VK) in this research.

Loss of consciousness in some of the children was another limitation of the present research as the ability to recall an accurate picture of the pain experienced may have been compromised. However, inclusion of children with a brief loss of consciousness was an

acknowledged but necessary step to ensure adequate enrolment in the study. Attempts were made initially to recruit children who had no loss of consciousness; however, momentum of enrolment was not established and the need to include children with a brief loss of consciousness became apparent. Inclusion of children with a brief loss of consciousness was discussed with experts in pediatric emergency medicine and a consensus was reached that there would likely be little influence on data obtained although there was no data to support this conclusion.

Multiple types of trauma could be viewed as a limitation of the present research since the mechanisms of injury and types of injuries attained were varied across the samples of both Phase 1 and 2. However, many reflected the common causes of trauma noted in the Ontario Trauma Registry.

The wide age range of the children could also be perceived as a limitation of the research. The range of development between an adolescent and a child is vast and did pose tension within the analysis of interview data in view of the younger children that were less able to articulate their pain and trauma experience. The inability of younger children to articulate their pain experience was likely reflected in the chart review data; however, the distance between the child and the recorded data prevents detection of this issue. Inclusion of children within a wider age range is reflective of the pediatric facility within which the research was conducted and to restrict the research to a specific age range would significantly impact the timelines of the study. However, future research could make age categories the focus of the study and enrol only children of specific age ranges or include multiple research sites in order to ensure sufficient samples sizes for all age ranges to allow for separate data analysis.

Significance

The present research has made significant contributions to the knowledge gaps in pain assessment and management of pediatric trauma patients. Phase 1 revealed that HCPs conducting pain assessments for pediatric trauma patients focused on a narrative description of the location of pain with the intent to identify injuries, with little attention to treating or minimizing the child's pain. Subtherapeutic doses of opioid analgesia were provided after prolonged periods of time, especially for children transferred from another institution. Phase 2 revealed that children experienced sudden and severe pain that was often made worse by being moved during the trauma assessment process. Additionally, children were overwhelmed by the procedures required for trauma assessment. Fear and distress from the situation they suddenly found themselves in contributed to the intensity of the trauma experience. Interviews with HCPs revealed that pain was not seen as a priority for the pediatric trauma patient in the early stages of their traumatic event. Significant educational differences in pain education about pain assessment and management for pediatric trauma patients between disciplines was identified. The trauma algorithm of care was strongly endorsed by all HCPs and was strictly adhered to within the trauma scenario, to the detriment of pain assessment and management. HCPs admitted that it was often difficult to discern between fear and pain in the pediatric trauma patients' population.

Child and situational factors in the trauma room that lead to a delay in pain management interventions were identified in this study. This knowledge is helpful in informing and improving the current pain management status for these patients within the overall care of the child and family. Attention to severe acute pain from trauma is a competing priority with potential life-saving efforts in current trauma protocols. How pediatric patients cope with this reality has garnered little research interest. The present research contributes to the body of research for

pediatric trauma patients but deserves continued urgent consideration due to the overwhelming effect trauma can have, on the immediate consequences to children as well as long-term consequences to development of these children as they mature.

Discussion of the present research suggests that pain assessment for the pediatric trauma patient was reported primarily as narrative notations focused only on location with a paucity of other details as compared to narrative pain assessment reported for in-hospital pediatric patients. Pain management was pharmacological in nature and was delayed but time to first opioid administration has improved over the past decade. Sub-therapeutic doses of opioids administered to children as reported in Phase 1 are likely reflecting titration of opioids frequently used by HCPs interviewed. Interviews with children indicated that the pain they experienced was sudden and severe and the trauma was overwhelming at times. The fear and anxiety expressed by children confounded the ability of HCPs to assess their pain which potentially led to less than optimal pain management.

Theoretical concepts of critical realism were applied to assist in understanding the pain patterns observed and the interview data obtained from the present research. The critical realist's real layer of reality contains many ideas that help untangle the reasons for suboptimal pain assessment and management. These ideas include the notion of symbolic violence, which posits that the algorithm for trauma care so widely adopted for the trauma population by national and international communities, as well as the organizational culture of the study hospital, endorsed the delayed priority to pain care. The GCT of pain transmission that lays within the actual layer of reality and account for understanding the modulation of pain in the pediatric trauma (e.g., hyperawareness of injuries) provided insight into the child's experience of pain by recognizing the affective aspect of pain and fear.

Summary

In the present research, I examined pain practices for pediatric trauma patients conceptually framed using tenets of critical realism and supported by concepts from the gate control theory of pain and developmental theory. A two phase mixed methods study that consisted of a retrospective chart review and interviews was undertaken at a regional pediatric trauma centre. Phase 1 consisted of a retrospective chart review of pain assessment and management practices provided to 104 children who had a trauma protocol initiated at the study hospital. Phase 2 consisted of interviews with 9 children who were hospitalized in the study hospital after enduring such a traumatic event to learn about their perception of pain from the trauma. Additionally 13 HCPs spanning several disciplines who provide direct care to children with trauma at the study hospital were interviewed to understand their perception of how these children experience the pain of trauma.

Key findings from Phase 1 indicated that from the time of the traumatic event through to discharge from the hospital ED, a pain assessment was recorded for 90/104 (86.5%) children. The most common form of pain assessment was a brief narrative notation which was utilized in 67% of patient records and focused primarily on location of pain and injury. Narrative notations for pediatric trauma patients were considerably less descriptive than those for hospitalized children. Validated pain assessment tools were recorded less frequently with the NRS recorded in 27% of patient records and the FLACC tool used in 2% of patient records.

The time from the traumatic event to administration of first opioid analgesia to pediatric trauma patients, intravenous morphine or fentanyl, was measured and the median (IQR) time from the traumatic event to administration of first opioid analgesia was 99 (77 to 180) minutes. There was no statistical significance in the difference between times from traumatic event to first

opioid analgesia in the direct and indirect trajectories with children waiting a median of 85 and 145 minutes, respectively. Although not statistically significant, the time difference was clinically significant.

The influence of child contextual factors (e.g., age, sex, ISS, number of injuries, types of injuries, mechanism of injury) and situational factors (e.g., direct and indirect trajectory) were determined, demonstrating patterns unique to the trauma population. Children who had the mechanism of injury of being struck by an object and children who had a higher ISS waited significantly longer to have a pain assessment. Children who had been assaulted waited longer to receive the initial opioid analgesia than children with other mechanisms of injury. Additionally, children with a greater number of injuries and those with head or spine injuries waited longer for the initial opioid analgesia.

Children who had arrived at the study hospital via the indirect route waited significantly longer to have a pain assessment, received a less than optimal dose of opioid more often than children in the direct group, and waited significantly longer than children in the direct trajectory to receive the first opioid analgesia. Children who arrived at the study hospital via the direct trajectory route experienced significantly higher pain intensity scores during transport and in the hospital trauma room than children who arrived via the indirect route.

In Phase 2, themes from the children's interviews indicated they had perceptions related to pain from the trauma and perceptions related to the trauma itself. Key themes developed from interview data indicated children felt immediate severe pain, accompanied by chaos, fear, and uncertainty. Delays in pain treatment were perceived by children to be because they were young and that it was normal to have to wait for pain interventions. Pain with movement was identified by many children as was pain and distress with procedures. In the early stages after the traumatic

event, the children appeared to be hypervigilant about conducting their own assessment for injuries. Many of the children were keenly aware of their pain interventions including when they received them and if they helped the pain. The trauma experience was viewed as being surreal and overwhelming at times as children were surrounded by strangers at the scene and in the trauma room.

Themes from the HCP's interviews indicated there was a focus on hemodynamic stability perpetuated by adherence to trauma protocols that do not place pain as a competing priority. There were differences in educational preparation for pain management for pediatric trauma patients with physicians stating that they had received minimal or no pain education during their training for trauma care while nursing training minimally addressed pain. Interviews with HCPs also revealed quite fractured approaches to pain management, and no pain guidelines for the pediatric trauma patient. Underlying assumptions regarding the care of trauma patients included two main points: HCPs in the trauma room assumed that children had already been provided with adequate analgesia prior to arriving at the study ED, and they also assumed that the trauma algorithm of care represented the best evidence. The impact of both these assumptions combined on pain care for the pediatric trauma patient logically lead to suboptimal pain treatment.

Clinical practice guidelines tailored specifically to the pediatric trauma patient may help improve pain practices. Guidelines need to be developed by engaging both administrators from both the ED and the trauma unit in the process in an attempt to shift emphasis onto pain in the trauma algorithm of care. Education in the direct delivery of pain care, including use of appropriate pain assessment tools and safe delivery of opioids, and strategies to minimize pain spanning all transport occurrences for pediatric trauma patients need to be added as important

elements of training for HCPs as they prepare to work in the pre-hospital and trauma room settings.

Future research measuring the impact of any guidelines that have been developed and implemented for the pediatric trauma patient would be vital. Future research around clinical utility of pain assessment tools that would best suit the pediatric trauma patient is required. Ongoing research validating administration of opioid safety in the pre-hospital setting would help assuage fears of HCPs. Research and development of transport modes would help minimize patient discomfort during transitions of care. Qualitative research involving children and parents to gain insights into the pain experience of trauma would help identify any misconstrued ideas they may hold about pain treatment in the trauma setting.

Theoretical implications of the present research indicate that further exploration of critical realism as a foundation for future research can be helpful in resolving theory-practice inconsistencies by pursuing the notion of causality. For example, symbolic violence embedded within the trauma protocol and effects from juvenile ageism that result in delays of 99 minutes to pain treatment for children are some of the generative mechanisms that lay between available interventions and the empirical results of Phase 1 data. The theoretical contributions of GCT contribute to our understanding of pain in children and further explain how attentional modulation may exacerbate their pain experience because of inability to modulate their pain response due to fear and anxiety from the traumatic event. Additionally, premises of GCT models link to pain-related fear, memory, anxiety, and pain modulation are fundamental to the study of pain and underscore the importance of developing theoretically based educational tools for HCPs who struggled with differentiation of fear and pain.

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APPENDICES

Appendix A The Injury Severity Score (ISS)

The ISS is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score. ISS range is 1-75. Interpretation of the ISS: 1-9 Minor, 10-15 Moderate, 16-24 Moderate/Severe, >25 Severe/Critical.

Below is an example of an ISS calculation.

Region	Injury description	AIS	Square top three
Head and neck	Cerebral contusion	3	9
Face	No injury	0	
Chest	Flail chest	4	16
Abdomen	Minor Contusion of liver	2	
	complex rupture spleen	5	25
Extremity	Fractured femur	3	
External	No injury	0	
Injury Severity Score:			50

Source: Garber, Hebert, Wells & Yelle, 1996

Appendix B

Trauma Algorithm including Primary and Secondary Assessment

Primary assessment		
A	Airway:	Airway with simultaneous cervical spine stabilization for any child with suspected trauma
B	Breathing	
C	Circulation	
D	Disability or neurological status	
Secondary assessment		
E	Environment:	Exposure and environmental control to prevent heat loss.
F	Family:	Full set of vital signs, including weight, and family presence
G	Give comfort measures	
H	Head-to-toe assessment and history	
I	Inspect posterior surfaces	

Note. Source: Emergency Nursing Pediatric Course Provider Manual, Emergency Nurses Association (ENA), 2004.

Appendix C
Table of Studies for Child Factors in Acute Pain Assessment and Management

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Johnston et al., 1998	Obtain data to determine the significance of pain in the general ambulatory ED population as part of a quality assurance program	Prospective Survey conducted over one week	Adults – 86 Children - 334 ED patients who were 4 years of age or older, required to speak English or French, arrived by means other than ambulance, admitted to noncritical, nonpsychiatric ward of the ED	Colored Analogue Pain Scale	Adults – mean pain score was 3.76 on admission and 3.0 on discharge with 52% still complaining of pain >4 on discharge with 52% still complaining of pain >4 on discharge Children – mean pain score on admission was 3.59 and on discharge 2.98 with 48% still complaining of pain>4. Children presenting with the father attained better pain scores than a child with the mother alone. This study does not clearly point to any disparity in pain management although pain assessment was the focus and interventions were not identified or investigated.

(table continues)

Appendix C (cont'd.)

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Hostetler et al., 2002	To explore whether significant variations among the proportions of patients receiving PAS	Secondary analysis of data collected from the National Hospital Ambulatory Medical Care Survey for EDs over a six year period from 1992-1997	43,725 children and 114,207 adults Probability sample of all US emergency and outpatient departments	All patients receiving PAS (fentanyl, ketamine, meperidine, methohexital, midazolam, morphine, nitrous oxide, or Propofol)	For patients with ortho injuries 5.6% of pediatric patients versus 7.8% of adults received PAS (OR 0.8, 95% CI 0.6-1.6, $P = .05$). For patients with wound-related injuries, little difference was seen with 2.3% of children receiving PAS (OR 0.8, 95% CI 0.6-1.0, $P = .05$) versus 2.8% of adults (OR 1.0, 95% CI 1.0). Combining interactions for age, race, and insurance indicated that African American children covered by Medicaid were least likely to receive PAS (OR 0.2, 95% CI 0.1-0.6). These data represent a secondary analysis, which may not be optimal when studying a defined patient population for a specific purpose other than what the data were originally gathered for.

(table continues)

Appendix C (cont'd.)

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Selbst & Clark, 1990	To assess whether children received analgesic treatment similar to that of adults with the same acute, painful conditions.	Retrospective chart review	112 pediatric and 156 adult patient charts All patients presenting to the ED of a children's hospital during a 5 month period in 1987-1988 with a diagnosis of painful crises from sickle cell disease, lower extremity fractures or second-or third-degree burns.	Receipt of analgesia	Children were much less likely than adults to receive analgesics (28% vs 60%) ($P < .001$) Children less than 2 years of age were much less likely than older children to receive any medications for pain (17% vs 38%) ($P < .01\%$). Children were shown to be less likely to receive medication on discharge. Management of pain was generally not regarded as important in comparison to other treatments. This research is two decades old reflecting outdated practices.

(table continues)

Appendix C (cont'd.)

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Brown et al.,2003	To describe analgesic use for patients with extremity or clavicular fractures, comparing analgesic use between adults and children and between the subsets of adults and children with documented moderate to severe pain	Analysis of ED records over a year period	2,828 patient records of patients from the National Center for Health Statistics National Hospital Ambulatory Medical Care Survey for 1997-2000 who had closed extremity or clavicle fractures	Administration of analgesia of any type	Children were least likely to receive pain medications, especially opioids. 102 children aged 0-3 years received any analgesia 54% (CI 0.41, 0.67) & opioid analgesia 21% (CI 0.11, 0.31) of the time; 232 children aged 4-8 years received any analgesia 63% (CI 0.57, 0.68) & opioid analgesia 30% (CI 0.22, 0.37) of the time; & 487 children aged 9-15 years received any analgesia 57% (CI 0.57, 0.64) & opioid analgesia 27% (CI 0.23, 0.32) of the time. Young adults aged 16-29 years received any analgesia 67% (CI 0.62, 0.73) & opioid analgesia 47% (CI 0.40, 0.54) of the time & adults aged 30 to 69 years received any analgesia 68% (CI 0.64, 0.72) & opioid analgesia 51% (CI 0.46, 0.56) of the time. 454 patients aged ≥ 70 years received any analgesia 58% (CI 0.52, 0.65) & opioid analgesia 41% (CI 0.35, 0.48) of the time. Only records in the ED were examined; thus, medication may have been given in pre-hospital but this information was not considered in this research. Patient population included only patients with a specific, single fracture type and excluded subjects with more injuries, so results cannot be generalized to the multiply injured child.

(table continues)

Appendix C (cont'd.)

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Friedland & Kulick, 1994	To investigate frequency of ED analgesia in children with obviously painful fractures	Descriptive, retrospective review of computerized trauma registry	$N = 99$ Children who arrive in emergency with painful fractures and at risk for associated multiple injuries	Analgesia administration	53% (52/99) received narcotics with 46/99 having multi-system injuries 59% (10/17) of children with chest or abdominal injuries received analgesia 62% (33/53) of children with isolated fracture received analgesia 31% (9/29) of children with a head injury received analgesia. There were small sample sizes in subgroups that limits power to detect differences in analgesic use Additionally research is close to two decades old
Herd et al., 2009	Audit pain management practices and organization in pediatric ED across Australia and New Zealand	Retrospective audit of pain management practices in PREDICT sites	Pediatric patients with migraine, abdominal pain and femur fracture in 10 EDs Total of $N = 196$ migraine $N = 197$ abdominal pain $N = 177$ femur fractures	Pain assessment Analgesia interventions	Migraine patients received analgesia in 62% of cases (opioids in 11%) Abdominal pain patients received analgesia in 62% of cases (opioids in 14%) Femur fractures received analgesia in 78% of cases (opioids in 49%, femoral nerve blocks 40%) Less than 50% of all patients had pain scores documented Provider care in Australia where this research took place may potentially not be reflective of local practice and therefore not be generalizable to regional care

(table continues)

Appendix C (cont'd.)

Petrack et al., 1997	To explore differences between adult and pediatric analgesic utilization in the ED	ED chart review	ED charts from 3 institutions in the United States 40 adult and 40 pediatric ED charts from each of the 3 institutions	Analgesic use, dosing in ED and on discharge, and time from triage to analgesic use	Pediatric patients received significantly less analgesia (64/120; 53%) than adult patients (88/120; 73%). Also, pediatric patients were less likely to receive adequate doses of analgesia on discharge with 27% going home with inadequate analgesia while 3% of adults went home with inadequate analgesia. Pediatric patients received significantly less analgesia than adults at the combined (pediatric 23/40; 58% versus adult 35/40; 88%, $p < .003$) and community (pediatric 15/40; 38% versus adult 26/40; 65%, $p < .02$) ED settings but not at the separate adult and pediatric centre (pediatric 26/40; 65% versus adult 27/40; 68%) Reporting of results across settings is less clear due to the number of confounding variables that cannot be accounted for (i.e. differences in training related to analgesia between each organization). Sample consisted of patients with isolated long bone fractures and thus results are not generalizable to the trauma patient with multiple injuries.
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(table continues)

Appendix C (cont'd.)

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Neighbor et al., 2004	To identify factors associated with failure to receive opioid administration in patients with acute trauma who subsequently required hospitalization	Retrospective cohort study of trauma team activation patients	$N = 540$ charts of hospitalized first-tier trauma team activation patients	Opioid administration	258 (47.8%; 95% CI = 43.5% to 52.1%) patients received intravenous opioid analgesia within 3 hours of ED arrival. Median time to receiving the first dose of opioid analgesia was 95 minutes. Patients were less likely to receive opioids if they were younger or older, if they were intubated, had a lower RTS, lower GCS, or were more seriously injured. Multiple logistic regression analysis indicated that patients who were 10 years of age or younger (OR 0.39; 95% CI = 0.2, 0.78; $p = .008$), 65 years of age or older (OR 0.52; 95% CI = 0.29, 0.93; $p = .026$), being intubated (OR 0.39; 95% CI = 0.23, 0.67; $p = .001$), and had a lower RTS indicative of more severe injuries (OR 1.53; 95% CI = 1.2, 1.94; $p < .0005$) were predictive of failing to receive opioid analgesia. This research also examined the mechanism of injury in relation to pain treatment and found that patients with burns or those who had been in a motorcycle crash were more likely to receive analgesia. Of the motorcycle crash victims (11/258) 73.3% received opioid analgesia and of the burn patients (10/258) received opioids within three hours of ED arrival. The number of children within this sample was really quite small ($n = 55$). Authors did not stratify types of injuries within age groups which would have provided another layer of clarity to the nature of pain treatment with diverse types of injuries and mechanisms of injuries

(table continues)

Appendix C (cont'd.)

Study	Purpose	Design	Sample & setting	Outcome measures	Results and limitations
Alexander & Manno2003	To compare analgesic use in the very young patient to older children with isolated painful injuries	Retrospective chart review	Total $N = 180$ Two groups of patients, one group containing younger children ages 6 to 24 months ($n = 96$) and the other ages 6 to 10 years ($n = 84$). Patients sustained long bone fracture or 2 nd or 3 rd degree burns arriving in a pediatric ED between 1999 and 2000	Administration of analgesia	Children in the very young age group received no analgesia more often than older age group for all injuries - 62/96 (64.6%) vs 40/84 (47.6%), respectively), for all fractures – 48/68 (70.6%) vs 39/80 (48.8%) respectively), for displaced fractures 11/20 (55.0%) vs 9/41 (22.0%), respectively), and burns – 14/28(50.0%) vs 1/4 (25%), respectively). Opioids were given less frequently to the younger age group. This study used only one nonblinded reviewer for data collection, which may bias results. The study was conducted in a pediatric ED so may not be generalizable to community EDs

Note: PAS = parenteral analgesic and sedative; OR = odds ratio; CI = confidence interval; RTS = Revised Trauma Score; GCS = Glasgow Coma Scale.

Appendix D
Table of Studies for Situational Factors in Acute Pain Assessment and Management

Study	Purpose	Design	Sample & setting	Intervention	Outcome measures	Results and limitations
Izsak et al., 2008	Analyze the documentation of pain assessments and interventions for injured children	Retrospective study of trauma charts	Injured children in the pre-hospital setting from 2002 to 2004 in Toledo, Ohio <i>N</i> = 696		Pain assessment documentation Pain interventions	Mean age was 8.4 years (<i>SD</i> ± 5.0 years) with 457/696 (65.7%) males and 230/696 (33.1%) females. There was only one chart that used a validated pain assessment tool, the Verbal Rating Scale. Pain was most frequently documented in bicycle-related injuries (40/47, 85.1%), sports-related injuries (63/78, 80.8%), and other vehicle crashes (8/10, 80%). No pain interventions were given to 379/446 (85%) children with documented pain. Pharmacological interventions were used in 15/696 (2.2%) of patients and nonpharmacological interventions were used in 86/696 (12.4%) of patients. The most frequently used nonpharmacological interventions were traction and splinting (36/93, 38.7%) Pain was noted in 64.1% (446/696) of subjects, “no pain” was noted in 17.2%(120/696) and pain was undocumented in 18.7%(120/696),.

(table continues)

Appendix D (cont'd.)

Study	Purpose	Design	Sample & setting	Intervention	Outcome measures	Results and limitations
Brent et al., 2009	To evaluate an intervention implemented to reduce cycle times in the main ED and decrease time to first analgesia for children with suspected extremely fractures	Intervention Evaluation	Annual patient volume which increased from 25,596 to 27,946 All pediatric patients in the Ed with the exception of those patients requiring admission to hospital.	Clinical component – Clinical Care Pathways, standing medication orders, standing radiology orders, and bedside registration Operational Adjuncts – commitment by steering committee, participation of every staff member on committee, setting of high expectations, provision of continuous feedback, and rapid mid-cycle adjustments	Time in department (TID) Time to initial administration of analgesia to children with suspected extremity fracture	Baseline mean TID of 3 hours and 6 minutes decreased by 9% to 2 hours and 50 minutes with sustainable results that are improving year over year Baseline time to administration of medication improved 58% from 1 hour and 42 minutes to 45 minutes Although TID is showing improvement the difference remains is not meaningful clinically with the mean wait decreasing by only 16 minutes

(table continues)

Appendix D (cont'd.)

Study	Purpose	Design	Sample & setting	Intervention	Outcome measures	Results and limitations
Hennes et al., 2005	To compare the practice perceptions of EMT-Ps to actual practice of pain management interventions	Review of EMS database Survey of Emergency Medical Technicians-Paramedics (EMT-Ps)	Patients of all ages with burns, chest pain or extremity fractures 155 EMT-Ps surveyed and 5,383 patient records of which 5,099 were adults, 188 adolescents (aged 8 to 17 years) and 96 children (aged 0-7 years)		Pain assessment Analgesia given	Children - 4% had pain assessments done; Analgesia - 3% (95%CI 1,5) with extremity injuries and 9% (95% 0,26) with burns received morphine Adults - 67% had pain assessments done; Analgesia – 5% with chest pain (95%CI 4,5), 12% with extremity injuries (95%CI 8,15) and 14% with burns (95%CI 8,20) received morphine. EMT-Ps perceptions were that they administered much more than was documented Retrospective research is limited in that there is limited ability to assess for any contraindications that may have been present at the scene. The pre-hospital duration of care is often very short term and not conducive to providing other than life saving measures

(table continues)

Appendix D (cont'd.)

Study	Purpose	Design	Sample & setting	Intervention	Outcome measures	Results and limitations
Devellis et al., 1998	To review a 5.5 year safety record of a protocol guiding fentanyl administration during transport	Retrospective review of air transport team responses to pediatric trauma	$N = 131$ Children age < 15 years requiring air transport following trauma		Fentanyl administration Adverse effects	<p>211 doses of fentanyl given to 131 patients; 60.3% (79 patients) were intubated and these patients received 65.9% (139/211) of the total number of doses</p> <p>Seventy-nine of the 131 patients were intubated and received 139 of the 211 total Fentanyl doses (65.9%). Vital sign assessment was done 1-35 minutes after Fentanyl administration with the mean interval being 9.5 minutes. Hemodynamic and ventilator compromise were evaluated and no untoward events were reported. Median changes in SBP and HR after fentanyl administration were - 4.7 and - 2.9% respectively. The mean postfentanyl SBP (122 ± 21) and HR (114 ± 22) were lower and statistically different ($p < 0.0001$) from the prefentanyl SBP (128 ± 20) and HR (119 ± 24) although none of the patients became hypotensive. The changes were possibly related to the amelioration of pain-mediated symptoms. In nonintubated patients, the postfentanyl oxygen saturation was not significantly</p> <p><i>(table continues)</i></p>

Appendix D (cont'd.)

Study	Purpose	Design	Sample & setting	Intervention	Outcome measures	Results and limitations
						<p>different from prefentanyl levels with mean postfentanyl oxygen saturation ($99.2 \pm 1.3\%$) not significantly different ($p = 0.70$) than prefentanyl oxygen saturation levels ($99.1 \pm 1.3\%$). No adverse effects noted over this 5 year period</p> <p>Pain was not measured as this study focused on safety rather than efficacy of fentanyl in the pediatric population, although only subjects who had received fentanyl for analgesia as opposed to intubation were enrolled</p>

(table continues)

Appendix D (cont'd.)

Note: SD = standard deviation; TID = time in department; EMT-P = emergency medical technician – paramedic; EMS = emergency

Study	Purpose	Design	Sample & setting	Intervention	Outcome measures	Results and limitations
Iyer et al., 2011	To report the effect of a process intervention that aimed to decrease time to delivery of first dose of analgesia to within 45 minutes after arrival in ED	Chart review assessing a quality improvement project designed to reduce delays of intravenous opioid delivery	Large urban pediatric academic centre Children with long bone fractures $N = 387$ before intervention $N = 615$ after intervention	a) Identifying appropriate patients with extremity fractures; (b) paging providers to a designated room; (c) gathering members of the care team to the patient with all necessary equipment and analgesic agents; and (d) fostering cooperative completion of tasks to be done by physicians and nurses by having the physicians place necessary orders.	Time in minutes to first opioid administration	Proportion of patients with long bone fractures who received first opioid administration within 45 minutes of arrival in ED rose from 20% preintervention to 70% postintervention with median and mode times 27 and 20 minutes respectively. The proportion of parents who rated their child's pain management as excellent rose from 54% prior to the intervention period to 77% after the intervention. No evidence of sustainability of the effects of the intervention were reported.

Note: SD = standard deviation; TID = time in department; EMT-P = emergency medical technician – paramedic; EMS = emergency medical services; CI = confidence interval; SBP = systolic blood pressure; HR = heart rate.

Appendix E

Summary of Common Injuries for the Pediatric Trauma Patient

Site of Injury	Characteristic Specific to Pediatric Population
Head	<p>Produce a diffuse edema as opposed to space occupying lesion typical of adult head injuries</p> <p>More mobile cranial suture lines and open fontanelles allowing a hidden expansion of brain mass until rapid decompensation occurs</p> <p>Greater cranial-mass-to-body ratio results in increased susceptibility to craniofacial trauma</p>
Spinal Cord	<p>Vertebral column is not completely calcified so stretching of the cord and nerve roots may occur resulting in transient neurological deficits that have resolved by the time the child reaches hospital however reinjury may easily occur</p> <p>Spinal cord injury without radiologic abnormality (SCIWRA) is unique to children as there is greater elasticity of ligaments and joint capsules which allows for stretching as opposed to tearing injuries</p> <p>30 to 40% of children with multiple injuries have flexion-distraction fractures of the lumbar spine because of inappropriate use of seat belts</p>
Ocular	<p>Up until the age of nine years, the ocular system is still developing and permanent disability is possible</p>
Thoracic	<p>Incomplete ossification of ribs with greater cartilage content decrease the likelihood of this type of injury in children</p> <p>Because of increased flexibility, fractures are less common but contusions are the more common injury in paediatrics</p>
Airway	<p>Of special note is that about half of rib fractures in children under the age of three years may be due to child abuse</p> <p>Airway is smaller, shorter with large, flaccid oral and pharyngeal soft tissues which may result in increased airway resistance and easier obstruction</p> <p>Combined with a compliant chest wall can result in decreased lung reserve in the presence of respiratory distress</p>
Abdomen	<p>Underdeveloped abdominal muscles with the abdomen beginning at the level of the nipple making the liver, spleen, and kidneys more vulnerable to injury</p> <p>Less fat and more elastic connective tissue around internal organs make them more prone to abdominal injuries</p> <p>Associated with spinal fractures from inappropriate use of seat belts is hollow visceral injuries of the small bowel</p>
Orthopaedic	<p>Less peri-renal fat and incompletely ossified ribs can result in renal injuries</p> <p>Pediatric bone is softer and prone to incomplete fractures such as greenstick fractures</p> <p>With associated vascular injury, growth retardation and long term disability may occur</p>

Appendix F
Table of Studies for Children's Perceptions of Acute Pain in Trauma

Study	Purpose	Design	Setting & sample	Outcome measures	Results and limitations
Crandall et al., 2002	Examine pain management in several trauma units Evaluate the impact of implementation of a trauma pain management protocol	To examine the pain experience of adolescents after acute blunt traumatic injury	$N = 13$ Adolescents aged 11-17 years who had experienced multiple sites of blunt traumatic injury	Open ended interviews Adolescent Pediatric Pain Tool Temporal Dot Matrix	82% recalled their worst pain at the scene, in the ED with high, intense pain persisting through hospitalization; causes of pain were injury site, movement related to specific injuries, and procedures Only adolescents were interviewed while interviewing of children over the age of 8 years is more of interest; although subjects did have multiple sites of blunt trauma similar to the patient population of interest. Although reference was made to the use of grounded theory for analysis, no conceptual framework was identified

(table continues)

Appendix F (cont'd.)

Study	Purpose	Design	Setting & sample	Outcome measures	Results and limitations
O'Brien et al., 2004	To determine patient perspectives on the experience of resuscitation during a trauma to see if they had perceptions of vulnerability during the resuscitation and what factors influenced their experience	Qualitative study using phenomenology	Greater than 18 years of age, had a trauma protocol initiated, GCS > 13, RTS > 10 and able to speak English 4 men and 3 women	N/A	Four themes were revealed – “I remember”, “I was scared”, “I felt safe”, and “I will be okay”. Several factors were identified as contributing to a positive patient experience: Organized approach to trauma Identifiable leader Staff who are in control Expert trauma team members who were familiar with their role Clear, simple communication Confident decision-making Knowing patient's name Connection with family, friends, and staff Constant reassurance Contributing to their own care Study consisted of adults only. It seemed that there were preconceived ideas of what the authors were searching for from the patients (e.g., perceptions of vulnerability) which is inconsistent with phenomenological methodology.

(table continues)

Appendix F (cont'd.)

Study	Purpose	Design	Setting & sample	Outcome measures	Results and limitations
McIntosh & Mata, 2008	To benchmark detection of PTSD in children with trauma and to develop a guideline that would help to identify and begin to treat PTSD as early as possible	Interrupted time series study	Children who had experienced trauma One year's worth of patients with trauma from one urban Level 1 trauma center in Michigan	N/A	Guidelines were developed to identify early symptoms of PTSD in children after trauma. The guidelines, which were developed by a multidisciplinary team identified criteria that were to be utilized in identifying children at risk for PTSD and those children were given a psychological consult. Although this research does attempt to assess the effect of the experience of trauma on children, it is not a qualitative study.

(table continues)

Appendix F (cont'd.)

Study	Purpose	Design	Setting & sample	Outcome measures	Results and limitations
Zink & McCain, 2003	To describe psychological responses to motor vehicle related injuries	Longitudinal descriptive	<i>N</i> = 143 Children 7 to 15 years of age who had experienced a motor vehicle related injury	Child Behaviour Checklist Behavioural Problem Scale filled out by parent/guardian and the PTSD section of the DICA was filled out by parent and child – both were done at 2 and 6 months post injury	22% of these children met criteria for PTSD with no associations found for age, gender, race, injury, or cause of injury. Although an attempt is made to access the patients' experience of trauma, this is a quantitative study utilizing scales and neither does it discuss pain specifically.

Note: GCS = Glasgow Coma Scale; RTS = Revised Trauma Score; PTSD = Post Traumatic Stress Disorder; DICA = Diagnostic Interview for Children and Adolescents

Appendix G
Table of Studies for Pain Perceptions of Health Care Providers

Study	Purpose	Design	Setting & Sample	Outcome measures	Results and limitations
Macioci a et al., 2003	To compare patient, guardian, and professional assessment of acute pain in children	Pro- spective, observ- ational cohort study	73 children (4 to 14 years) with acute injuries presenting to a pediatric hospital ED in the United Kingdom	Comparison of pain scores measured with the Wong Baker FACES Pain Scale and a 10 cm linear pain scale by child, guardian, and professional. Pain was assessed using both scales just after triage. Child, guardian, and professional were surveyed separately	Pain scores were rated significantly lower by HCPs [median linear scale score was 3.1; interquartile range (IQR) 1.6 – 5.3] than patients (6.6; 4.9 – 7.4) and guardians (6.0; 3.9 – 7.1). Additionally, significant correlations exist between pain scores obtained using both scales for professionals [Spearman <i>R</i> value 0.88; 95% CI 0.82 – 0.93], for guardians (0.83; 0.74 – 0.89), and for patients (0.42; 0.21 – 0.59) although higher correlations were noted between the guardian and professional groups. No significant differences were noted between patient and guardian groups. This study sample is small and the majority of patients (53%) had an upper arm injury indicative of selection bias thus limiting generalization of results. The single institution with a specific geographical location of this research may reflect a specific practice that also may limit generalization of results. Use of the FACES Pain Scale and a linear scale limit the population age that could have been captured. There were slightly more mothers (52) than fathers (23) which may have skewed results.

(table continues)

Appendix G (cont'd.)

Study	Purpose	Design	Setting & Sample	Outcome measures	Results and limitations
Marquié et al., 2003	To investigate for the existence and causes of systematic differences between physician and patient pain intensity ratings	Prospective	An ED in a mid-sized city in France Patients ($N = 200$) and physicians ($N = 48$)	Physicians and patients rated the patient's pain upon admission and discharge using a visual analog scale; for patients $N = 200$ with 121 men and 79 women between the ages of 14 and 83 ($mean = 32$, $SD = 14$); for physicians $N = 48$ with $N = 15$ experts (7 men and 8 women) and $N = 33$ novices (18 men and 15 women) Patient age was controlled for by introducing it as a covariant in the ANOVAs	Physicians gave significantly lower ratings of pain intensity than did patients both upon arrival ($mean$ difference -1.33 , standard error (SE) = 0.17 , on a scale of $0 - 10$, $p < 0.001$) and upon discharge from the ED (-1.38 , SE = 0.15 , $p < 0.001$). The extent of the difference was noted to be more with expert rather than novice physicians with interactions between physician gender, patient gender, and the obviousness of the cause of pain. The mean 'pain miscalibration' was significant, $m = -1.42$, (SE = 0.15), $t(171) = -9.67$, $p < 0.05$ with no differences in miscalibration between arrival ($mean = -1.33$, SE = 0.17) and discharge ($mean = -1.38$, SE = 0.15), $t(171) = 0.46$, $p > 0.05$. Novices undervalued patient pain intensity much less often -1.26 (SE = 0.20) than did experts -2.39 (SE = 0.43), $F(1, 171) = 5.79$, $p = 0.017$. However, this was only upon exit to the ED as there were no significant differences seen upon arrival between novice and expert physicians. A three-way interaction among physician expertise, physician gender, and patient gender approached significance $F(1,171) = 3.8$, $p = 0.053$.

(table continues)

Appendix G (cont'd.)

Study	Purpose	Design	Setting & Sample	Outcome measures	Results and limitations
Hennes et al., 2005	To compare the practice perceptions of EMT-Ps to actual practice of pain management interventions	Review of EMS database Survey of Emergency Medical Technicians Paramedics (EMT-Ps)	Patients of all ages with burns, chest pain or extremity fractures 155 EMT-Ps surveyed and 5,383 patient records of which 5,099 were adults, 188 adolescents (aged 8 to 17 years) and 96 children (aged 0-7 years)	Pain assessment Analgesia given	Children - 4% had pain assessments done; Analgesia - 3% (95%CI 1,5) with extremity injuries and 9% (95% 0,26) with burns received morphine Adults - 67% had pain assessments done; Analgesia – 5% with chest pain (95%CI 4,5), 12% with extremity injuries (95%CI 8,15) and 14% with burns (95%CI 8,20) received morphine. EMT-Ps perceptions were that they administered much more than was documented Retrospective research is limited in that there is limited ability to assess for any contraindications that may have been present at the scene. The pre-hospital duration of care is often very short term and not conducive to providing other than life saving measures

Note: HCP = health care provider; IQR = interquartile range; R = correlation coefficient; CI = confidence interval; SE = standard error; t = t-test; Cohen's d_s = effect size; F = f-test; SD = standard deviation; ANOVA = analysis of variance; EMT-P = emergency medical technician-paramedic; EMS = emergency medical service.

Appendix H

Criteria for Code 50

Vitals	SBP <80 for ages 1 to 5 years; respiratory rate <10 or >50; and/or GCS ≤ 8.
Anatomy	All penetrating injuries to head, neck and torso; flame burns to head and neck region; two or more proximal bone fractures; obvious pelvic fracture; amputation proximal to elbow and knee; severe maxillofacial injury with airway compromise; two or more system involvement or injuries.
Mechanism of Injury	Ejection from an automobile; at the scene within same passenger compartment; extraction > 20 minutes; roll over; high speed MVA > 70 km/hr; major auto deformity > 50 cm; intrusion into passenger compartment of > 30 cm; auto vs. pedestrian injury > 10 km/hr; pedestrian thrown or run over; cycle crash > 30 km/hr or separation of rider and bike (cycle = moped, motorcycle, bicycle, ATV); fall > 3 times the victim's height or > 1 to 2 stories; high velocity impact (e.g., skier vs. tree); burns that are massive (> 50% total body surface area), house fire victims, or with multiple injuries (e.g., MVA involving burns)
Comorbid Factors	Child abuse with significant change in vital signs/neurologic status; hostile environment (extremes of heat/cold)

Note: SBP = systolic blood pressure; GCS = Glasgow Coma Score; MVA = motor vehicle accident; ATV = all-terrain vehicle. Source: Hospital for Sick Children

Appendix I Audit Tool

Date and Time of Audit: _____

Auditor: _____

Please see database for details on data entry.

Demographic Data

Factors related to **Age**

1. Date of Birth: _____ (year/month)

Factors related to **Sex**

1. Sex: Female [] Male []

2. Weight of child (if available) in kilograms _____

Factors related to Frequency and Type of Analgesia

1. Date of Admission to Emergency: _____ (year/month/day)

2. Time of Admission to ED (24 hour clock): _____

3. Duration of stay in ED in #hours/minutes: _____

4. Note any analgesia/nonpharmacological treatments for pain documented during transport:

(Please see definitions in database) _____

5. Time of injury from the Ambulance Sheet (record with 24 hour clock): _____

6. Pharmacological, psychological, physical interventions given at scene prior to arrival of

Paramedics or Emergency Services: Yes [] No []

If so, what was given, when, and how often (include pharmacological, psychological and physical interventions): (Please see definitions in database)

7. Time of First Opioid Analgesia (24-hour clock):

8. Name of First Opioid Analgesia: _____

9. Type of Intervention according to database: _____

Record all Interventions given - enter in chart below according to database.

Pharmacological, Psychological, and Physical Intervention Details							
Was intervention given at the transferring institution	Type of Intervention (including name of medication)	Time given	Route	Dose	Frequency	Date of order	Details of interventions (e.g., devices or mechanisms used)

Factors relating to **Pain Assessment**

1. Was Pain Assessed as per narrative: Yes [] No [] If so, what was recorded?

2. Was a Pain Tool used: Yes [] No [] Name of tool, if used: _____

3. Pain Intensity Score (1 -3 mild; 4 – 6 moderate; 7 – 10 severe): _____

4. Was pain reassessed: Yes [] No [] List times and scores time?

5. Which measure was used? _____

6. How many times was assessment repeated? _____

Factors relating to **Mechanism of Injury**

1. Mechanism of Injury: Motor Vehicle Accident []

Pedestrian Hit by Car []

Fall ☐ Other ☐ Explanation: _____

Factors relating to **Transfer from another institution**

1. Transferred from another hospital: Yes ☐ No ☐

2. Time of traumatic event: _____

Factors relating to **Admitting unit**

1. Was the patient admitted to hospital: Yes ☐ No ☐

If yes, which admission unit: _____

Factors relating to **Types and Number of Injuries**

1. Types of Injuries according to database:

Injury #1: _____

Injury #2: _____

Injury #3: _____

Injury #4: _____

Injury #5: _____

2. Surgical Interventions: No ☐ Yes ☐

If yes, type of surgery: _____

Factors relating to **Severity of Injury**

1. Was a Injury Severity Score (ISS) calculated? Yes ☐ No ☐

If so, what was the SOI score? _____

Intubated: Yes ☐ No ☐

2. Glasgow Coma Scale : _____

3. Description of behaviour (e.g., crying, combative, moaning): _____

Source: Vijenthira et al., 2012

Appendix J

Phase 1 Data Dictionary

Variable	Value			
sex___0 and sex___1	0 - female	1 - male		
		2 - Motor Vehicle Accidents	3 - Struck by Objects	4 - Assaults
mechanism_injury	1 - Fall			
head_and_spine	0 – no	1 - yes	same up to v13	Note: if no entry this means no injury Note: if no entry this means no injury
il_chest_injury	0 – no	1 - yes	same up to v13	Note: if no entry this means no injury Note: if no entry this means no injury
il_abdomen_injury	0 – no	1 - yes	same up to v13	Note: if no entry this means no injury Note: if no entry this means no injury
il_extremity_injury	0 – no	1 - yes	same up to v13	Note: if no entry this means no injury Note: if no entry this means no injury
location_analgesia	1 - EMS1	2 - transferring institution	3 - EMS2	4 - Emergency department
pre_hosp_loc___1	EMS1			
pre_hosp_loc___2	transferring institution			
pre_hosp_loc___3	EMS2			
transfer_from_hospital	0 – no	1 - yes		
discharge_unit___0	5C			
discharge_unit___1	5A			
discharge_unit___2	5B			
discharge_unit___3	CCU			
discharge_unit___9	Discharge Home			
discharge_unit___10	Observation Unit in ED			
discharge_unit___11	OR			
ems_1_pa_ems_yn	1 - yes	0 - no		Note: Blank means no information

ems_1_pa_painassess_yn	0 – no	1 - yes	2 - No Information Given
ems_1_pa_paintool_yn	0 – no 2 - Pain	1 - yes	
ems_1_pa_nt	Narrative	3 - Pain Assessed with General Assessment	
ems_1_pa_type_pt		2 - NRS	
Note: Question was if Pain Tool was used yes or no			
ems_1_pa_pt_yn_rl	1 - yes	2 - no	
ems_1_pa_type_pt_rl		2 - NRS	
sk_pa_painassess_yn	0 – no	1 - yes	
sk_pa_nopainwhy	1 - Sedated	2 - Unconscious	3 - Language Barrier
sk_pa_paintool_yn	0 – no	1 - yes	
sk_pa_type_pt	1 - FLACC	2 - NRS	
nonpharm_yes_no	0 – no	1 - yes	
non_pharm_type	1 - psychological	2 - physical	
non_pharm_physical_type	1 - Blanketing	2 - Splint	3 - Ice
ems_1_pi_pi_yn	0 – no	1 - yes	2 - no information given
ems_1_pi_typepain_med	1 - opioid pain medication	2 - nonopioid pain medication	3 - topical pain medication
sk_pi_type_o	1 - Fentanyl	2 - Hydromorphone	3 - Morphine
sk_pi_route_o	1 - Bolus	2 - IV	3 - PO

Appendix K

Definitions of Terms

Term	Definition
Child	For Phase 1 of this study, child refers to any person from newborn up to the age of eighteen years who has had a traumatic event resulting in activation of the trauma protocol. For Phase 2 of this study, child refers to any person over the age of seven years and up to the age of 18 years who has had a traumatic event occur resulting in activation of the trauma protocol. It is necessary to change the definition for the second phase of this study to capitalize on the ability to verbally articulate experience in the interviews.
Code 50	The formal trauma protocol at the pediatric trauma centre where this research will take place. The protocol is triggered when patients present with criteria in any one of three areas, namely Vitals, Mechanism of Injury, or Anatomy. Specific details of these criteria for Code 50 implementation are outlined in Appendix G. Additionally, co-morbid factors are classified as conditions that are to be taken into consideration when making the decision to initiate the trauma protocol. This protocol provides an important link to pediatric patients with multiple injuries. Any chart that does not have “Trauma” as the admitting diagnosis will be excluded from the chart review.
Ethnicity	Characteristics of a social group that have racial, religious, linguistic and cultural traditions in common (World English Dictionary). Ethnicity will be a consideration only for Phase 2 this research, if recorded in the child’s medical records from the pre-hospital, trauma room within the hospital ED, and in-hospital settings.
First analgesia	The first pharmacological analgesic agent administered by any route to the child with multiple injuries at any time during the pre-hospital or hospital setting. From the literature review, the analgesic agent most often administered in the trauma setting is intravenous fentanyl or morphine; however, for this research, the first opioid analgesic agent administered and documented for the multiply injured child will be considered the first analgesia. Any subsequent analgesia (recorded throughout the time the child is in the pre-hospital or trauma room hospital ED only) will also be recorded.
Frequency of pain assessment practices	How many times pain assessment for the multiply injured child is conducted by HCPs in the pre-hospital, trauma room in the hospital ED, and in-hospital settings as reported in the child’s medical records during the chart audit for this study.
Frequency of pain	How many times are pain management interventions for the multiply injured child recorded as per the child’s medical records during the chart

Term	Definition
management practices	audit for this study covering the time period when the child is in the pre-hospital, trauma room within the hospital ED, and the in-hospital unit.
Glasgow Coma Scale	The GCS is commonly used in the pre-hospital and ED settings to provide an indication of level of consciousness for patients. It was developed by Teasdale and Jennet (1974) to provide assessment of the depth and duration of impaired consciousness and coma. Motor responsiveness, verbal performance, and eye opening are the three aspects of behaviour that are measured independently. Each aspect is scored with a total of 15 indicating a fully conscious state. Brain injuries associated with a GCS score of 3 to 8 are considered severe; 9 to 12, moderate; and 13 to 15, mild, respectively (Udekwu, Kromhout-Schiro, Vaslef, Baker & Oller, 2004). See Appendix K for details on the GCS.
Health care provider	An individual HCP may be a health care professional, an allied health professional, a community health worker, or another person trained and knowledgeable in medicine, nursing or other allied health professions, or public/community health. For this study, health care provider consists of individuals, regardless of professional category, who are specifically trained and have experience in the care for children with multiple injuries.
Hospital ED	The ED, commonly found within a hospital, provides medical treatment specializing in acute care of patients who arrive without prior appointment, either via ambulance or on their own. For this research, the hospital ED will refer to the ED of the study hospital, which is a tertiary care pediatric hospital serving children up to the age of 18 years; however, trauma patients over the age of 16 years attend an adult facility. The facility also serves as a Level 1 (comprehensive service) pediatric trauma centre to the southern Ontario region.
In-hospital setting	The hospital rooms, organized and grouped as units within the hospital that provide medical, surgical, and psychiatric care. For this research, the in-hospital setting refers to the hospital unit the child with multiple injuries will be transferred to upon admission from the ED to hospital.
Mechanism of injury.	The method of how the injuries were incurred (e.g., pedestrian hit by car, fall). Mechanism of injury will be described according to information obtained from the patient records for Phase 1 and according to the patient account for Phase 2.
Multiple injuries	A child with at least two bodily systems injured (e.g., an orthopaedic injury and a head injury which involves both the skeletal system and neurological system respectively). Injuries will be described according to type and number of injuries.
Number of injuries	Injury is defined as a body wound or shock produced by sudden physical impact. The number of injuries refers to the injuries obtained during the

Term	Definition
Pain	<p>traumatic event. This count of the number of injuries the child attained during the traumatic event will be described in medical records from the time period specified for Phase 1 from when the child encounters EMS until the child is admitted to the hospital ED and the hospital unit.</p>
Pain assessment practices	<p>Pain is defined by the International Association of Pain from the Task Force on Taxonomy 2011 update as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.” For this research, pain for Phase 1 will refer to any recorded patient assessments of pain located within the patient’s medical record during the pre-hospital setting and the trauma room within the hospital ED.</p> <p>The validated and unvalidated pain assessment tools and/or narratives used by health care professionals to describe the nature and frequency of pain assessment in the multiply injured child during the pre-hospital and hospital setting. The pain assessment practices will be recorded from the patient’s medical records from the time the child encounters EMS at the scene of the event until the time of transfer to a hospital unit during the chart audit for this study. Self-reporting with a validated pain tool (e.g., NRS; Wong-Baker FACES Pain Rating Scale; Colored Analogue Scale) is considered a reliable means of pain assessment (Mikrogianakis et al., 2008). Challenges do exist with children unable to verbally communicate their pain. Observational (behavioural) (e.g., FLACC), or composite (e.g., CHEOPS) tools for assessing pain may be necessary (Breau et al., 2003; LaChapelle et al., 1999; Oberlander et al., 1999; Johnston & Strada, 1986; Craig et al., 1993). For this study, pain assessment will include any and all validated and nonvalidated or narratives measures and/or narratives utilized to describe pain in the multiply injured child. These data will be collected from patient records in the chart audit that will be done in Phase 1.</p>
Pain management practices	<p>The types and frequency of pain interventions used by health care professionals to manage pain in the multiply injured child. The pain management practices may include pharmacological (e.g., administration of opioids), physical (e.g., splinting of fractured limbs), and/or psychological (e.g., reassurance) interventions. For this research, these data will be collected from the patient’s medical records from the time the child encounters EMS at the scene of the event until the time of administration of first analgesia. If the time period between the time the child encounters EMS at the scene of the event and the time of administration of first analgesia should extend beyond the time of transfer to an in-hospital unit, the chart audit will continue on that in-patient unit until the first analgesia is recorded.</p>

Term	Definition
Pre-hospital setting	The environment where the child is located from the time of injury (e.g., the scene of the incident and transport to the in-hospital setting whether by ground or air). For this research, the pre-hospital setting will cover the time period from the time of the traumatic event at the scene of the accident until arrival in the trauma room within the hospital ED.
Severity of injuries	Subjective assessments of severity assigned to specific anatomical diagnoses by experts in the field and based upon threat to life, permanent impairment, treatment period and energy dissipation. Each injury is assigned a numerical rating ranging from 1 (minor injury) to 6 (maximum injury, virtually unsurvivable). The injuries are measured by the ISS, which is an anatomical scoring system providing a score for the overall state of injuries for patient with multiple injuries (Baker, O'Neill, Hadden, and Long, 1974). The ISS is a validated anatomical scoring system providing a score for the overall state of injuries for the pediatric trauma patient (Garber, Hebert, Wells & Yelle, 1996). The tool and a sample calculation can be seen in Appendix A. The range of ISS scores is from 0 to 75 and is linearly related to mortality, morbidity, and hospital stay with a higher score indicating more severe injuries. This score will be computed for this study and utilized in regression analysis for Phase 1 only.
Single injury	A child with one injury only involving a single body system as a result of the traumatic event (e.g., lung contusion involving the respiratory system only). This type of injury is not the subject of this study although reference to children with single injuries will be made in the literature review.
Social structures	Enduring patterns of behaviour by participants in a social system in relation to each other. For this research, social structures will be considered the enduring patterns of behaviour characteristic primarily of the health care providers caring for children with multiple injuries during the initial stages of care and most commonly within the hospital ED.
Transferred trauma patient	Pediatric patients who have been initially stabilized at another hospital close to where the traumatic event took place and transferred to the study hospital by ground or air and usually accompanied by more advanced paramedic personnel.
Trauma patient	Any patient who has received injuries from an untoward event that has had the trauma protocol started in the hospital trauma room.
Trauma protocol	A series of steps widely adopted by HCPs in the care and management of the trauma patient, with special considerations specified for the care of the pediatric trauma patient.

Term	Definition
Trauma room	A designated room within the hospital ED that is specially equipped with life saving equipment to be used for patients who have experienced traumatic injuries requiring intensive medical care as a result. The trauma room referred to in this research is located within the study hospital ED and is further specially equipped to manage pediatric trauma patients.
Traumatic event	The incident (e.g., MVA, fall) causing the child's injuries and instigating emergency medical service intervention and transport to the hospital setting. Details of the traumatic event are recorded by EMS on their standardized medical incident reports. Details concern many facts about the traumatic event (e.g., approximate or exact time of the event, what occurred) including the medical condition of the child during the entire time period from initial encounter with the child at the scene until arrival in the trauma room at the hospital ED.
TTL	Trauma team leader
TTL summary of trauma	This summary document is a template utilized as a summary of events that have taken place in the trauma room and which is to be completed by the TTL for each trauma patient that arriving at the research site. Information included in this summary document includes treatment approaches, patient status, description of injuries, and rationale for all actions taken by trauma team members. The summary document is attached to the patient's medical record and accompanies the child throughout the entire length of the hospital stay.
Type of injury	The description of attained injuries as described in the patient's medical record including as much detail as possible. For example, the type of injury is a fractured femur or lacerated liver.

Appendix L

Information Letter

To Whom It May Concern:

Thank you for becoming involved in this important research study by helping to identify patients that may be eligible for the study and by approaching them to see if they are willing to participate. You need only ask if they are willing to talk about being in the study as the investigator or her delegate will explain the study in detail to any willing participants.

This research project is an attempt to find out how children who have acute pain from multiple traumatic injuries experience their pain. The principal investigator is XXX

Co-investigators are:

The purpose of the research is to learn more about the acute pain that children experience after a traumatic event such as a motor vehicle accident or fall when they attain multiple injuries. One way to find out about this is to talk with children who have recently undergone such an event. We want to find out in any way possible if there are ways to help with their pain.

Thank you

Appendix M

Study Explanation to Parents

Dear Parent:

Your child's care provider has approached you to see if you and your child are willing to participate in a research study. The study investigator or her delegate will explain the study in detail to you.

This research project is an attempt to find out how children who have acute pain from multiple traumatic injuries experience their pain. The principal investigator is XXX.

Co-investigators are:

The purpose of the research is to learn more about the pain that children have after being hurt badly in something like a car accident or fall. One way to find out about this is to talk with children who have recently undergone such an event. We want to find about their pain experience to see if we can find ways to make this experience better.

The study will take place when your child is in the hospital. We will come to talk to him/her with you when they are feeling well enough to talk for about an hour. We may come back and talk to him/her with you more than one time. If your child would rather draw a picture than talk to us then we will bring some paper and pencil crayons for her/him to do so. We do not think any harm will be done to your child from the study although there is a chance that your child may be bothered by some of the questions we ask because they involve talking about their experience. If your child is bothered, they can withdraw from the study and we will arrange counselling with a professional who is not working on the study if it is necessary to do so. Participation in this study may cause some inconvenience because of the time involved for the interview(s).

Potential benefits come directly from taking part in this study because the interview provides your child with a chance to talk about their pain and the experience they have been through. A newsletter will be sent to participants once the study is completed telling them about the results if you wish. Another good thing about this study is that it will help us to understand how to better treat and recognize pain in children with acute pain from multiple injuries.

No information about your child will be released or published without consent unless required by law. The research consent form will be inserted in the patient health record. Health

records identifying the patient may be given to and inspected by the XXX Clinical Research Office Monitor.

Participation in research is voluntary. If your child chooses not to participate, they will continue to have access to quality care at XXX.

Your child's participation may contribute to the understanding of pain assessment and management in children who have experienced traumatic events but there are no future economic benefits. The patient will be given a copy of their written consent form for their records.

Thank you

Appendix N

Interview Guides

Interview Guidelines for Children Aged 8 to 11 Years

Interview With Children Aged 8 To 11 Years

Tell me about the pain while you were in the Emergency Department when you first got to the hospital.

Probing questions. What do you remember about what happened in the ED or when you first got to the hospital? How did people help you when you first got here with your pain? Can you tell me about how you felt when you were in the ED? Can you tell me about how well you were able to move around in emergency? How did your pain affect your ability to move around?

Can you tell me about how the pain was when you first arrived at the hospital?

Probing questions. Can you tell me about how much it hurt when you were moved from the ambulance to the bed in the hospital? Who helped you when you got to the hospital? How did you feel when you saw all the people at the hospital? Who talked to you about your pain when you got to the hospital? Did it seem like it was a long time before you got any medicine or things to help with your pain like somebody helping to distract or relax you for your pain? Did anybody ask you how much pain you had?

Can you tell me the story of what happened to you when you had your accident?

Probing questions. Can you tell me everything you remember about the accident? What happened to you? Did you feel that you were hurt right away? Who was with you when you had your accident? What were you doing when you had your accident? Were you afraid after your accident?

Can you tell me about the time you first received some medicine to make the pain better.

Probing questions. Do you remember getting anything for your pain? Can you tell me about who helped that first time to help your pain feel better? How did you feel to finally have the pain go away a little bit? If your pain didn't go away, what did you do? Did you ask for something for your pain? What did people tell you about when you could have something for your pain? Did it seem like a long time before you could have anything for your pain?

Can you talk about or tell me about how much the pain hurt.

Probing questions. Are there any words that you can think of that would explain what your pain was like? Were you able to talk to anybody about your pain and how much it hurt? Was there anything that you could do to help the pain get better? Or was there anything that happened that made the pain worse? If you think of 0 as having no pain at all and 10 as having the worst pain you have ever felt, how would you say your pain was when you were first hurt? When you were in the ED? When you were moved onto the hospital unit? How is your pain now?

Do you think your pain was taken care of well after your injury?

Probing questions. Talk about when you finally felt like your pain felt better. What helped you feel better? What was it that made your pain better?

Interview With Children Aged 8 To 11 Years

Can you think of any ways your pain could have been taken care of better by the doctors and nurses?

Probing questions. Can you tell me if you thought your pain should have felt better faster? What do you think they could have done to make your pain better?

What has been the biggest problem for you here in the hospital?

Probing questions. Would you think your pain was one of the biggest problems?

Can you tell me what helped the most to make your pain feel better?

Probing questions. What did you do to make your pain feel better? Pain medicines, physical things like hot pack or ice, trying to relax? What did your parents do, what did the doctors and nurses do to help you feel better? Who talked to you about your pain?

If you had to tell a friend what the pain was like during the accident, what would you tell them?

Probing questions. How would you tell them it made you feel? How would you tell them you were able to move around with your pain? Who would you tell them helped you the most with your pain? Tell me about who you would talk to about your accident and your pain.

What would you tell them about your pain?

Do you remember how you got help?

Probing questions. Tell me about how you got help. How did you get to the hospital? Can you tell me what you remember about the ambulance ride? Can you tell me what your pain was like at first. Who came to help you when you first got hurt? Were you glad that somebody came to help you?

Tell me about the pain once you got into the room you are in now.

Probing questions. What has been the hardest thing for you? Can you tell me about how your pain went away? Who helped the most to make your pain go away? Can you move around now and do everything you have to do like eat, walk to the washroom? Do you think your pain is better now that you are in your bed here than when you were in the ED? Do you think the nurses and doctors in the ED took care of your pain well? Do you think the nurses and doctors here on the unit take care of your pain better?

Can you tell me about any other times you have had a lot of pain.

Probing questions. What happened the last time that caused you to have a lot of pain? Was it the same amount of pain as this time or worse? What helped you at that other time? Do you think that would help this time?

Interview Guidelines for Children Aged 12 to 18 Years

Interview With Children Aged 12 to 18 years

Tell me about the pain while you were in the Emergency Department when you first got to the hospital.

Can you tell me about how the pain was when you first arrived at the hospital?

Can you tell me the story of what happened to you when you had your accident (or at least everything you remember)? Can you tell me about the ambulance ride?

Tell me about what the most bothersome problem was for you throughout your hospital stay.

Can you tell me about the time you first received pain medication of any kind?

Can you talk about or tell me about how much the pain hurt? If you think of 0 as having no pain at all and 10 as having the worst pain you have ever felt, how would you say your pain was when you were first hurt? Using the same scale, how much did it hurt in the Emergency Department? How much did it hurt when you were first moved to this unit? And how much does it hurt now?

Do you think your pain was taken care of well after your injury? Talk about when it was finally feeling under control. What helped you feel better?

Can you think of any ways your pain could have been taken care of better by the doctors and nurses?

What has been the biggest problem for you here in the hospital?

Can you tell me what helped the most to make your pain feel better?

If you had to tell a friend what the pain was like during the accident, what would you tell them?

Tell me about the pain in all the units you were in the hospital. What was the hardest thing for you?

Do you remember how you got help? Tell me about how you got help. How did you get to the hospital? Tell me what the pain was like at first.

Can you tell me what helped the most to make your pain feel better? What did you do, what did your parents do, what did the doctors and nurses do to help you feel better?

Have you had other experiences of pain that were the same as this time? Can you tell me about that time and what made the pain better or worse? What helped the most at that time?

Interview Guidelines for Health Care Professionals

Interview With Health Care Professionals

Can you tell me about pain management in the children you have cared for with multiple injuries?

How do you think trauma algorithms affect pain assessment and management practices for these children?

Where you work, what is the extent of care you provide with children with multiple injuries?

As a (insert specific profession of participant), how much influence do you believe you have in pain management?

As an individual, how do you feel pain for children with multiple injuries is treated?

Generally, how do you feel pain assessment and management practices at your institution are administered?

Do you detect inconsistencies between what executive management desires and what you can provide?

In what ways can pain practices be improved?

Do you feel children with multiple injuries experience a lot of pain?

Appendix O

Mapping of Coding to Critical Realism

Children' Interviews

Theme	Sub-theme	Meaning of Code	Code	Mapping to Critical Realism
Assumptions about pain management	Apparent acceptance of poor pain treatment	Evidence of poor pain management	Initial minimization of pain by adults with child	Juvenile Ageism
			High levels of pain intensity accepted	
			Delays in pain management expected	
	Immediate pain	High pain intensity levels at time of incident	Emphatic account of pain right away after being hit by car or falling upon recall of event	Symbolic Violence
			Specific areas of injury such as head, arms, legs causing the most pain	
	Pain with movement	Pain from injuries made worse with each bump or extra move	Bumpy ambulance rides making pain worse	
Discomfort having to move from stretcher/gurney for x-rays or to bed				
Vigilant awareness of pain treatment	Knowledge of when pain treatment was provided	Statements about specific time frames of pain treatment administration		
Procedural pain	Frequent mention of pain with necessary tests that at times was	Catheterization worse than pain from injuries		
		Frequent mention from several patients of having		

		greater than pain from injuries	intravenous cannulation started	
	Surreal sense of reality	Dissociative emotional condition associated with traumatic event	Having pain with diagnostic imaging procedures such as CT Disbelief about being in a traumatic event Finding oneself in an unusual circumstance such as having underwear removed in a crowded room or being extricated from a car Patient feeling convinced he was going to die Higher pain intensity due to uncertainty of injury extent Distress over pain to the point of not clearly remembering painful procedures Fear of being trapped in vehicle and crossing street Crowds gathered at scene of traumatic event Sudden exposure to large number of strangers (e.g., trauma personnel Questions from multiple care providers	Juvenile Ageism
Perception of trauma experience	Tripartite of fear, distress, uncertainty	Complex mix of feelings expressed in response to unusual circumstances		
	Stimulus overload	Suddenly surrounded by many strangers		
Presence of support	Important relationships between HCP and child can be made at this critical time	Rapport with child being developed	One person stands out as helpful even in the presence of parents Strong relationship with child during time spent in hospital	Juvenile Ageism

HCPs Interviews

Theme	Sub-theme	Meaning of Code	Code	Mapping to Critical Realism
Primacy of physiological stability	Pain is not the priority initially	Emphasis on haemodynamic stability and identification of injuries	Blood pressure must be stabilized Pain management not what is initially addressed	Symbolic Violence
Differentiation between pain and anxiety	Ability to discern pain and anxiety poses difficulty across all disciplines	Confusion interpreting child's behavioural cues of child in trauma room	Cannot tell whether screaming and crying is indication of pain or anxiety Inability to discern between fear, anxiety and pain	Juvenile Ageism
Differences in educational preparation between disciplines	Diverse focus on pain education between RNs and MDs with no efforts being made to change	RNs focus some education on pain treatment while physicians' education does not Organizational culture accepts status quo of trauma pain management	Pain not mentioned in trauma care education for physicians for adult or paediatric patients Nursing protocols do address pain but later	Organizational Culture

Fractured approach to pain management in trauma	Pain not a competing priority in trauma care	Inadequacy of pain treatment in trauma	Little attention paid to trauma care
			Several different disciplines admitting inadequate pain treatment
			Differing opinions about how pain should be treated
	Lack of clarity in approach to pain treatment in trauma room	No roles or protocols developed specifically for pain treatment room	Candid statements that pain treatment was not a high priority in trauma room
			Tension between documentation and what individual wants to administer for pain
			Difficulty delivering an individualized approach to pain management
			Individual physicians treat pain their own way and do not know what

			other physicians are doing	
			Hectic attempts to bring attention to patient's pain	
			Experienced staff more likely to advocate for pain treatment	
	Changing approach to trauma care	Transition of trauma care in progress at study hospital	Current shift from general surgery to ED physicians caring for trauma patients	
	Assumptions about pain management	Adequate analgesia has been given prior to arrival at emergency department	EMS has provided pain medication on route	
Underlying assumptions about pain management in trauma care			Transferring hospital has provided analgesia prior to arrival at study hospital	Symbolic Violence
	Assumptions about trauma protocol	The best approach to trauma care is currently in place	Trauma protocol is based on current research	
			Trauma protocol is best practice	
			Trauma protocol would be very difficult to change	

Acknowledgement of unique experience of trauma and pain	Awareness of impact of trauma experience	Complexity of pain, fear, trauma, stress and horror experienced by patients/families	Statements of how patient is dealing with experience of trauma	Juvenile Ageism
		Long term impact on child after trauma experience including impact of trauma assessment procedures	Questioning whether HCPs are aware of the impact of assessment process on patients	

Appendix P
Consent Form for Children for Phase 2

Title of Research Project

This research project is trying to find out how children who have pain from accidents feel about their pain.

Investigator(s)

Principal Investigator: XXX

Co-investigators

Purpose of the Research

We would like to learn more about the pain that children have after accidents or falls. One way to find out about this is to talk with children who have just had an accident. We want to find out if there are ways we can help with their pain.

Description of the Research

We will come to talk with you when you are feeling well enough to talk for about an hour. You can have your parents with you, if you like. We may come back and talk to you with your parent(s) more than one time. If you would like to draw a picture and talk to us about the picture, then we will bring some paper and pencil crayons for you to do so.

Potential Harms

We do not think there are any bad things about the study.

Potential Discomforts or Inconvenience

There is a chance that you may be bothered by some of the questions we ask you because they involve talking about your accident. If you are bothered, you can stop the interview at any time and withdraw from the study. We will also find somebody you can talk to who is not working on the study if you wish to do so.

Potential Benefits

To Individual Subjects

You may benefit directly from participating in this study because the interview provides you with a chance to talk about your pain and the experience you have been through. A newsletter will be sent to you once the study is completed telling you about the results.

To Society

The good thing about this study is that it will help us to understand how to better treat and know about pain in children with injuries such as you have.

Confidentiality

No information about you will be given to anybody.

Reimbursement

Since you are taking part in this study, a token gift with a value of about \$10 (e.g., movie pass) will be provided to you for helping out.

Participation

If you don't want to talk with us for our study, you don't have to and the nurses and doctors will still take really good care of you here at XXX.

By talking to us you are helping other children who may get into accidents just like you because we will understand better what kind of pain they have and what we can do to help them. You will be given a copy of this consent form to keep.

Consent

By signing this form, I agree that:

The study has been explained to me. All my questions were answered.

The good and bad things about this study have been explained to me.

I know I can stop being a part of study anytime and it won't make any difference to how the doctors and nurses take care of me at the XXX Hospital.

I can ask any questions at any time about the study.

I know that nobody will know I have been in a study without asking me about it first. I will take part in this study.

Name of Patient and Age

Signature

Name of person who obtained consent

Date

The person who may be contacted about this research is: XXX

Appendix Q
Consent Form for Health Care Professionals Phase 2

Title of Research Project

This research project is attempting to find out how children who have acute pain from multiple traumatic injuries experience their pain.

Investigator(s)

Principal Investigator

Co-investigators

Purpose of the Research

We would like to learn more about the pain that children experience after a traumatic event such as a motor vehicle accident or fall when they sustain injuries. One way to find out about this is to talk with the health care providers that care for children have recently undergone such an event. We want to find out if there are ways we can help with their pain.

Description of the Research

We will come to interview you at a time that is convenient for you to talk for about an hour. It may be necessary to come back and talk to you again if the interview is interrupted before completion.

Potential Harms

We do not think there is any harm to you about the study.

Potential Discomforts or Inconvenience

Participation in this study may cause you some inconvenience because of the time involved for the interview(s).

Potential Benefits

To Individual Subjects

A summary of the study results will be sent to you once the study is completed.

To Society

The good thing about this study is that it will help us to understand how to better treat and recognize pain in children with injuries.

Confidentiality

Confidentiality will be respected and no information that reveals your identity will be released or published without consent unless required by law. This legal obligation includes a number of circumstances, such as if you suspect child abuse and infectious disease, expression of the patient of suicidal ideas where research documents are ordered to be produced by a court of law and where researchers are obliged to report to the appropriate authorities. For your information, the research consent form will be inserted in the employee record. Health records identifying you may be given to and inspected by the XXX Clinical Research Office Monitor.

Reimbursement

A token of appreciation with a value of about \$10 will be provided as reimbursement for taking part in this research.

Participation

Participation in research is voluntary. Your participation may contribute to the understanding of pain assessment and management in children who have experienced traumatic events but there are no future economic benefits. You will be given a copy of this consent form for your records.

Consent

By signing this form, I agree that:

The study has been explained to me. All my questions were answered.

The possible harms and discomforts and the possible benefits (if any) of this study have been explained to me.

I understand that I have the right not to participate and the right to stop at any time. I am free now, and in the future, to ask any questions about the study.

I understand that no information that would identify me will be released or printed without asking me first. I hereby consent to participate.

Name of Health Care Provider

Signature

Name of person who obtained consent

Date

The person who may be contacted about this research is: XXX

Appendix R

Assent Form Phase 2

Title of Research Project

This research project is trying to find out how children who have bad pain from an accident feel their pain.

Principal Investigator

Co-investigators

We would like to learn more about the pain that children have after an accident like a car accident or fall when they hurt themselves very badly. One way to find out about this is to talk with children that have had that happen to them. We want to find out in any way possible if there are ways to help with their pain.

The study will take place when you are in the hospital. We will come to interview you with your parent(s) when you are feeling well enough to talk for about an hour. We may come back and talk to you with your parent(s) more than one time. If you would rather draw a picture than talk to us then we will bring some paper and pencil crayons for you to do so.

We do not think there are any bad things about the study.

There is a chance that you may be bothered by some of the questions we ask you because they involve talking about what happened to you. If you are bothered, you can stop the study. We will also find somebody you can talk to who is not working on the study if you wish to do so.

The study may be good for you because it provides you with a chance to talk about your pain and what you have been through. A newsletter will be sent to you once the study is completed telling you about the results.

The good thing about this study is that it will help us to know how to better take care of pain in children with bad pain when they are hurt.

Nobody will know that you took part in this study but there will be a form in your patient chart that you did.

You will receive a token of appreciation for about \$10 for helping us with our research.

Even if you do not want to talk to us for our study, the doctors and nurses will still take very good care of you.

By helping us with our study you will be helping us to understand how other children feel about their pain when they are badly hurt.

By signing this form, I agree that:

The study has been explained to me. All my questions were answered.

The bad things about the study have been explained to me.

I know that even if I don't take part in the study I will still be taken care of well by the doctors and nurses in the hospital.

I can ask questions anytime about the study.

I have been told that nobody will know that I was part of the study without asking me first.

I agree to be in this study.

Name of Patient and Age

Signature

Name of person who obtained consent

Date

The person who may be contacted about this research is XXX.

Appendix S (a)
Consent Form for Audiotaping of Interview for Health Care Professionals

This research project is attempting to find out how children who have acute pain from multiple traumatic injuries experience their pain.

Principal Investigator: XXX

Co-investigators

We would like to learn more about the acute pain that children experience after a traumatic event such as a motor vehicle accident or fall when they attain multiple injuries. One way to find out about this is to talk with children who have recently undergone such an event. We want to find out in any way possible if there are ways to help with their pain.

The study will only last as long as you are in the hospital. We will come to interview you with your parent(s) when you are feeling well enough to talk for about an hour. This interview is the part of the study that will be audiotaped with your permission. We may come back and talk to you with your parent(s) more than one time. This part of the interview will also need to be audiotaped. If you would rather draw a picture than talk to us then we will bring some paper and pencil crayons for you to do so.

We do not think there are any bad things about the study.

There is a chance that you may be bothered by some of the questions we ask you because they involve talking about your experience. If you are bothered, you can withdraw from the study. We will also find somebody you can talk to who is not working on the study if you wish to do so. Participation in this study may also cause you some inconvenience because of the time involved for the interview(s).

You may benefit directly from participating in this study because the interview provides you with a chance to talk about your experiences in the management of pain for the trauma patients you care for. A newsletter will be sent to you once the study is completed telling you about the results.

The good thing about this study is that it will help us to understand how to better treat and recognize pain in children with acute pain from multiple traumatic injuries.

Confidentiality will be respected and no information that discloses your identity will be released or published without consent unless required by law. This legal obligation includes a

number of circumstances, such as suspected child abuse and infectious disease, expression of suicidal ideas where research documents are ordered to be produced by a court of law and where researchers are obliged to report to the appropriate authorities. For your information, the research consent form will be inserted in the patient health record. Health records identifying you may be given to and inspected by the XXX Clinical Research Office Monitor.

Since the research is taking place in the hospital, there is no justification for financial reimbursement.

Participation in research is voluntary. If you choose not to participate, your ability to continue to work at XXX will not be affected.

Your participation may contribute to the understanding of pain assessment and management in children who have experienced traumatic events but there are no future economic benefits. You will be given a copy of this consent form for your records.

By signing this form, I agree that:

The study has been explained to me. All my questions were answered.

The possible harms and discomforts and the possible benefits (if any) of this study have been explained to me.

I know about the alternatives to taking part in this study. I understand that I have the right not to participate and the right to stop at any time. The decision about whether or not to participate will not affect my employment at the XXX.

I am free now, and in the future, to ask any questions about the study.

I have been told that my research records will be kept confidential, except where release of information is required by law, e.g., suspected child abuse, public health.

I understand that no information that would identify me will be released or printed without asking me first. I hereby consent to participate.

Name of Patient and Age

Signature

Name of person who obtained consent

Date

The person who may be contacted about this research is XXX

Appendix S (b)
Consent Form for Audiotaping of Interview for Children

You have already been asked to talk to us about the pain you felt when you had your accident and we would also like to be able to tape record the interview for the study and need your permission to do that.

Principal Investigator: XXX

Co-investigators: XXX

We would like to learn more about the pain that children have when they are really hurt. One way to find out about this is to talk with children who this has happened to. We want to find out in any way possible if there are ways to help with their pain. We need to tape when we are talking to you. We will listen to the tape at a later time to make sure we didn't forget anything you said.

The study will only last as long as you are in the hospital. We will come to talk to you with your parent(s) when you are feeling well enough to talk for about an hour. We would like to tape you talking to us with a taping machine with your permission. We may come back and talk to you with your parent(s) more than one time. We will also want to tape when you talk to us then.

There is nothing bad about taping our talk for the study.

There is a chance that you may be bothered by some of the questions we ask you because they involve talking about your experience. If you are bothered, you can stop the study. We will also find somebody you can talk to who is not working on the study if you wish to do so.

You may feel good about being in this study because you talk about your pain and what you have been through. The taping of our talk will not change that. The good thing about this study is that it will help us to understand how to pain in other children like you with bad pain from getting hurt.

Even though we are taping when we talk and I will be listening to the tape later, I still will not let anybody else know that you talked with us. I will make sure the tape is thrown away in a safe place when I have finished listening to it and the study is all finished.

By signing this form, I agree that

Use of the taping machine has been explained to me. All my questions were answered.

The ways the tape will be used is not going to hurt me and I know that.

I can ask questions about the taping at any time.

I know the tape will be thrown away into a safe place when this study is all finished.

I know that nobody will know I have been in a study and I agree to tape our talks.

Name of Patient and Age

Signature

Name of person who obtained consent

Date

The person who may be contacted about this research is XXX