Pain and Psychological Outcomes Following Traumatic Musculoskeletal Injury

by

Brittany Nicole Rosenbloom

A thesis submitted in conformity with the requirements for the degree of Master of Science
Institute of Medical Science
University of Toronto

© Copyright by Brittany Nicole Rosenbloom 2014
Pain and Psychological Outcomes Following Traumatic Musculoskeletal Injury

Brittany Nicole Rosenbloom
Master of Science
Institute of Medical Science
University of Toronto
2014

Abstract

**Background:** Traumatic musculoskeletal injury (TMsI) often leads to chronic pain and post-traumatic stress disorder (PTSD). This study examined factors of a modified diathesis-stress model in the development of PTSD symptoms following TMsI. **Methods:** 205 patients were recruited in this prospective, observational study. Within 14 days of injury, participants completed an in-hospital questionnaire investigating acute symptoms of anxiety, depression, pain, and PTSD. **Results:** Logistic regression identified multiple factors associated with symptoms of PTSD (p<.0001). Neuropathic pain (odds ratio[OR]=1.091, 95% confidence interval[CI] 1.020-1.168), general anxiety (OR=1.176, 95%CI 1.046-1.318), pain anxiety (OR=1.056, 95%CI 1.018-1.094), and pain catastrophizing (OR=1.168, 95%CI 1.016-1.348) were associated with acute symptoms of PTSD. **Conclusions:** The results support the modified diathesis-stress model indicating that neuropathic pain, general anxiety, pain anxiety, and pain catastrophizing are associated with symptoms of PTSD. Future studies should examine the influence of these acute factors on the development of chronic pain and PTSD following TMsI.
Acknowledgements

This multicenter project would not have been possible without the support of many people. Before I thank those that helped with the development and running of this research project, I would like to thank the patients and their families for participating. Without their willingness to share their experiences and emotional responses to trauma, this project would not have been possible.

I would like to thank my supervisor, Dr. Colin McCartney, for agreeing to take me on as his Master’s student. I am incredibly grateful for his patience, time, and mentorship throughout this degree. With his own passion for research, exploring the unknown, and interest in finding ways to improve patient care, Dr. McCartney allowed me to explore areas of clinical research that were important to me. He has also taught me how to tailor my excitement into a project that I have enjoyed conducting and that I am passionate about.

I am very grateful to my wonderful committee members, Drs. Judy Watt-Watson, Joel Katz, and Hans Kreder, who have been a great support, given valuable feedback, and have been sources of expertise throughout my thesis. I am appreciative to Dr. Watt-Watson’s insights on the early stages of this project. I am very grateful to Dr. Katz who has provided me with many opportunities to develop my research skills. He has always been there to help problem solve any issue that came up, whether it be a quick question or a long discussion about clinical research as a whole. Similarly, Dr. Kreder’s ongoing support for my learning and development within research and clinically in the fracture clinic and operating room has been invaluable.

Next I would like to thank all of my collaborators at Sunnybrook Health Sciences Centre within the Departments of Anesthesia and Orthopedics for helping me to run this study; Lynn Haslam, Meera Sidhu, Kelly Chin, Laura Bosco, Carolyne Pasichny, Melanie MacNiven, Katrine Milner, and Monica Kunz. In particular, I am grateful for Lynn Haslam’s time and commitment to helping me get this study set up on the trauma units, introducing me to all of the phenomenal nurses on D5, C5, C6, and D6, and recruiting patients at St. Michael’s Hospital.

I would like to thank the research group from St. Michael’s Hospital for their help in recruiting patients as well as being supportive of this project and myself from the moment I mentioned interest in this topic; Ms. Sonya Canzian, Dr. Jane Topolovec-Vranic, Dr. Marlene Santos, Dr. Yangmei Li, Amanda McFarlan, and Matthew Hui. It would not have been possible
to collect all the data without their help. I would like to add a special thank you to Ms. Sonya Canzian who has believed in my research abilities since before the inception of my Masters Degree. She has had unwavering support, words of encouragement, a listening ear, and resources throughout my thesis for which I am eternally grateful.

I would also like to thank Dr. Alex Kiss for his statistical consulting during this project. I am grateful that he took time to help me understand the different methods of analysis. I would also like to thank Mr. Richard Foty for patiently running the analysis with me countless times and in different combinations.

Finally, my Master’s thesis would not have been possible without funding from the Department of Anesthesia’s Ontario Student Opportunity Trust Funds Graduate Award, the Ontario Graduate Scholarship, the Toronto Musculoskeletal Centre Scholarship, the Holland Musculoskeletal Research Scholarship, and the Institute of Medical Science Open Fellowship.
## Table of Contents

Abstract ........................................................................................................................................... ii

Acknowledgements ......................................................................................................................... iii

Table of Contents .............................................................................................................................. v

List of Acronyms .............................................................................................................................. viii

List of Tables ..................................................................................................................................... ix

List of Figures .................................................................................................................................... x

List of Appendices ........................................................................................................................... xi

Chapter 1 ............................................................................................................................................. 1

Introduction ......................................................................................................................................... 1

1 Introduction ...................................................................................................................................... 2

Chapter 2 ............................................................................................................................................. 4

Literature Review ............................................................................................................................... 4

2.1 Defining Traumatic Musculoskeletal Injury ............................................................................... 5

2.2 Epidemiology of traumatic injury and traumatic musculoskeletal injury ............................... 5

2.3 Traumatic Musculoskeletal Injury Interventions and Treatment ............................................. 6

2.3.1 Acute Assessments and Interventions ................................................................................. 6

2.3.1.1 Primary Survey .............................................................................................................. 6

2.3.1.2 Secondary survey ......................................................................................................... 7

2.3.2 Traumatic Musculoskeletal Injuries and their Management ............................................. 8

2.4 Factors Associated with chronic post-traumatic/ post-surgical pain .................................... 11

2.4.1 Acute Pain ............................................................................................................................... 14

2.4.1.1 Peripheral Nerve Injury ............................................................................................... 16

2.4.1.2 Primary Hyperalgesia ................................................................................................. 16

2.4.1.3 Secondary Hyperalgesia ............................................................................................ 18

2.4.1.4 Pain Modulation and Central Nervous System Involvement ................................... 18

2.4.2 Chronic Post-traumatic/ Post-surgical pain ......................................................................... 20
2.4.2.1 Neuropathic Pain ................................................................. 21
2.4.2.2 Epidemiology of chronic pain post traumatic musculoskeletal injury ............ 21
2.4.3 Psychological factors associated with acute pain ........................................ 26
  2.4.3.1 Anxiety ........................................................................ 26
  2.4.3.2 Depression ................................................................... 30
  2.4.3.3 Associations between Anxiety Constructs and Depression ...................... 32

Chapter 3 .......................................................................................... 34
Research Objectives and Hypotheses ................................................................. 34
  3.1 Objectives .......................................................................... 35
  3.2 Specific Hypotheses .................................................................. 35

Chapter 4 ............................................................................................ 36
Methods ............................................................................................... 36
  4.1 Project Design ....................................................................... 37
  4.2 Participant Selection ............................................................... 38
    4.2.1 Inclusion Criteria .......................................................... 38
    4.2.2 Exclusion Criteria ........................................................ 38
    4.2.3 Inclusion/ Exclusion Rationale ........................................ 38
  4.3 Sample Size ......................................................................... 39
  4.4 Recruitment Rate .................................................................... 39
  4.5 Sampling Procedure .................................................................. 40
  4.6 Data Collection Procedures .................................................... 41
    4.6.1 Chart Review ................................................................ 41
    4.6.2 Assessment .................................................................... 42
    4.6.3 Questionnaire Administration ......................................... 47
  4.7 Ethical Considerations ............................................................ 48
  4.8 Statistical Analysis ................................................................. 49
    4.8.1 Descriptive Statistics ...................................................... 49
    4.8.2 Site Differences ............................................................ 50
    4.8.3 Logistic Regression ....................................................... 50

Chapter 5 ............................................................................................ 54
<table>
<thead>
<tr>
<th>Chapter 5: Results</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Study Recruitment and Questionnaire Completion</td>
<td>55</td>
</tr>
<tr>
<td>5.2 Site Differences</td>
<td>58</td>
</tr>
<tr>
<td>5.3 Questionnaire Completion</td>
<td>58</td>
</tr>
<tr>
<td>5.4 Participant Characteristics</td>
<td>58</td>
</tr>
<tr>
<td>5.5 Injury Characteristics</td>
<td>60</td>
</tr>
<tr>
<td>5.6 Pain Severity and Pain Characteristics</td>
<td>62</td>
</tr>
<tr>
<td>5.7 Pain Management</td>
<td>63</td>
</tr>
<tr>
<td>5.8 Symptoms of Anxiety and Anxiety Sensitivity</td>
<td>64</td>
</tr>
<tr>
<td>5.9 Symptoms of Posttraumatic Stress</td>
<td>65</td>
</tr>
<tr>
<td>5.10 Symptoms of Depression</td>
<td>66</td>
</tr>
<tr>
<td>5.11 Associations with Symptoms of Posttraumatic Stress</td>
<td>66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 6: Discussion</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Main Conclusions</td>
<td>72</td>
</tr>
<tr>
<td>6.2 Study Advantages</td>
<td>76</td>
</tr>
<tr>
<td>6.3 Study Limitations</td>
<td>77</td>
</tr>
<tr>
<td>6.4 Conclusions and Future Directions</td>
<td>78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Appendix A: REB Approval Letters</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix B</td>
<td>96</td>
</tr>
<tr>
<td>Introduction Letter of Study to Participating Hospital Units</td>
<td>96</td>
</tr>
<tr>
<td>Appendix C</td>
<td>97</td>
</tr>
<tr>
<td>Script for Consenting Patients</td>
<td>97</td>
</tr>
<tr>
<td>Consenting Script for Research Personnel</td>
<td>97</td>
</tr>
<tr>
<td>Appendix D</td>
<td>100</td>
</tr>
<tr>
<td>Consent forms for Sunnybrook Health Sciences Centre and St. Michael’s Hospital</td>
<td>100</td>
</tr>
<tr>
<td>Appendix E: Data Collection Tool</td>
<td>112</td>
</tr>
<tr>
<td>Appendix F: Study Questionnaire</td>
<td>114</td>
</tr>
</tbody>
</table>
List of Acronyms

ATLS: Advanced Trauma Life Support
DNIC: Diffuse noxious inhibitory controls
FAST: Focused abdominal sonography for trauma
IASP: International Association for the Study of Pain
ISS: Injury severity score
MOI: Mechanism of injury
MRI: Magnetic resonance imaging
MVC: Motor vehicle collision
NeP: Neuropathic pain
NRS: Numeric rating scale
NSAIDs: Non-steroidal anti-inflammatory drugs
OR: Operating Room
PAG: Periaqueductal Grey
PET: Positron emission tomography
PTPS: Post-traumatic/ post-surgical
PTSD: Posttraumatic Stress Disorder
PTSS: Posttraumatic stress symptoms
RVM: Rostral ventromedial medulla
TMsI: Traumatic musculoskeletal injury
VRS: Visual analogue scale
WHO: World Health Organization
List of Tables

Table 1. Pain incidence and intensity at various times reported by Rosenbloom et al 2013. Permission to reproduce this table was provided.
Table 2: DSM-IV TR Classification of Posttraumatic Stress Disorder.
Table 3: International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) classification of posttraumatic stress disorder.
Table 4: DSM-IV TR criteria for depression.
Table 5: Predictive variables for in-hospital posttraumatic stress following traumatic musculoskeletal injury.
Table 6: Reasons for refusal to participate.
Table 7: Participant Demographics
Table 8: Trauma Injury Characteristics
Table 9: Pain medications used during the time that participants completed the study questionnaire.
Table 10: Bivariate associations between predictor variables and posttraumatic stress symptoms. Outcome variable split at the median with symptoms of posttraumatic stress group represented as 1.
Table 11: Odds ratios of predictor variables on posttraumatic stress for the final model.
List of Figures

Figure 1: Combined shared vulnerability and mutual maintenance model of disability in the context of traumatic injury. Single headed arrows indicate the direction of a temporal relationship between factors. Double-headed arrows indicate some of the possible association between factors. Not all possible relationships are shown.

Figure 2. Nociception and ascending and descending pain modulation.

Figure 3: Melzack and Wall Gate Control Theory of Pain.

Figure 4. CONSORT Flow of Participants

Figure 5: Mechanisms of Injury for Participants

Figure 6: Injured Body Regions

Figure 7: Distribution of Pain Intensity Scores at Time of Study Participation.

Figure 8. Distribution of Posttraumatic Stress Scores at Time of Study Participation.
List of Appendices

Appendix A: REB Approval Letters
Appendix B: Introduction Letter of Study to Participating Hospital Units
Appendix C: Script for Consenting Patients
Appendix D: Consent forms for Sunnybrook Health Sciences Centre and St. Michael’s Hospital
Appendix E: Data Collection Tool
Appendix F: Study Questionnaire
1 Introduction

Traumatic injury is the leading cause of death and morbidity worldwide among individuals under the age of 45 years and is the fourth leading cause of death for all age groups. The majority of traumatic injuries are caused by falls, motor vehicle accidents, homicide or injury purposely inflicted by another person, or self-inflicted injury. Of those individuals that survive, approximately 16% acquire a long-term disability. Traumatic injury is a serious clinical and public health concern.

Orthopedic injuries are the most common type of injury, can involve more than one body region, and may require multiple surgical interventions. Although medical advances continue to allow for improved mortality rates related to trauma, a proportion of patients go on to develop pain beyond the acute phase and develop chronic post-traumatic post-surgical (PTPS) pain.

Chronic pain often exacerbates psychological distress, with many patients who have sustained TMsI going on to meet diagnostic criteria for anxiety disorders, including posttraumatic stress disorder (PTSD), and mood disorders such as depression. Thus, despite increased survival rates after traumatic injury, many patients exhibit substantial comorbidities, including a diminished quality of life, chronic pain, and an increased risk for psychiatric disorders.

The development of chronic PTPS pain is not well understood as there are a number of factors that contribute to the development of chronic PTPS pain. Based on the diathesis-stress model of chronic pain, Rosenbloom and colleagues proposed a model to explain the complex interactions between variables (e.g., psychological vulnerabilities, injury characteristics, in-hospital pain management, anxiety, depression, pain catastrophizing). Although there is support for components of this model, the support comes primarily from cross-sectional studies including patients with chronic pain or from longitudinal studies with patients undergoing particular planned surgeries. Furthermore, there are no studies to date that have investigated the association between these variables during the acute period following traumatic injury.

The purpose of this thesis was to examine factors commonly used to explain chronic pain during the acute phase following injury. Specifically, these factors were examined among
patients who experience traumatic musculoskeletal injury through the use of questionnaires and chart review in a prospective, observational cross-sectional study. An in-depth analysis of these factors immediately following injury may allow for future studies to better understand the interactions between modifiable variables, if any, that predict chronic PTPS pain, and therefore target potential interventions. The literature review chapter explores previous research on each of the factors associated with chronic pain.
Chapter 2

Literature Review
2.1 Defining Traumatic Musculoskeletal Injury

When the transfer of energy, or force, from one object or person to another person (i.e. penetrating, blunt, or temperature contact) has enough force, it can cause injury to the person receiving the force. For the purposes of this thesis, this transfer of energy causing injury is termed traumatic injury. In the literature, traumatic injury is often described in terms of (1) mechanism of injury (MOI), where the cause of injury may be fall, motor vehicle accident, homicide or injury purposely inflicted by another person, or self-inflicted injury leading to tissue damage, (2) type of injury sustained, which could be classified as orthopedic, brain injury, or soft tissue laceration, and (3) injury severity, usually defined by the Injury Severity Score (ISS). The focus of this thesis is on outcomes related to pain and psychology among those patients who survived a traumatic injury. Previous studies have provided valuable information pertaining to disability outcomes of certain populations of trauma patients, for example, those experiencing head \(^ {20,21}\), whiplash \(^ {22}\), or spinal injuries \(^ {23}\), or burns \(^ {24}\). However, this thesis excluded patients with injuries caused by self-injury and burns, or those that sustained a traumatic brain injury and/or a spinal cord injury in order to focus on traumatic musculoskeletal injuries (TMsIs) and the biopsychosocial mechanisms involved in the development of chronic post-traumatic/ post-surgical (PTPS) pain and pain disability in the absence of confounding variables.

2.2 Epidemiology of traumatic injury and traumatic musculoskeletal injury

Worldwide, traumatic injury is the leading cause of death and disability for people under the age of 45 years and it the fourth leading cause for all age groups \(^ {1,2}\). In 2008, 5.13 million deaths occurred because of traumatic injury \(^ 1\). Of those people that survive, 16% resulted in long-term disability \(^ {1,3}\). In 2010 it was calculated that injuries accounted for 47.2 million years lived with disability, where disability was measured as short or long-term health loss \(^ {25}\), as well as economic loss \(^ {26}\). The number of years lived with disability has increased 38.4% since 1990, which may be attributed to the sheer number of people with injuries and the mounting evidence from studies evaluating follow-up from trauma \(^ {25}\). When assessing the impact of traumatic injuries by mechanism, falls and motor vehicle collisions (MVC) account for 69.8% of all years lived with disability \(^ {25}\).
Similar to global data, traumatic injury remains the leading cause of death and morbidity among Canadians under the age of 45 years and it is the fourth leading cause of death for all age groups. In 2000-2001 there were 198,040 injury-related hospital admissions in Canada. Approximately 33% (n=65,329) of these occurred in Ontario, with the most common types of injuries being orthopedic. Orthopedic injuries can affect individual body regions or multiple body regions simultaneously.

In the literature, follow-up studies have different definitions of injury types, ranging from specific (e.g., tibia) to general (e.g., lower extremity, upper extremity) body locations, the number of injuries (e.g., isolated, multiple), and/or the type (e.g., amputation, fracture, general orthopedic injuries). Worldwide, however, lacerations, multiple wounds, dislocations, eye injuries, fractures to the patella, tibia, or ankle, and moderate to severe brain injury account for 52.3% of years lived with disability among patients who sustained a traumatic injury.

2.3 Traumatic Musculoskeletal Injury Interventions and Treatment

2.3.1 Acute Assessments and Interventions

2.3.1.1 Primary Survey

The World Health Organization (WHO) mandates that trauma patients must be treated in a standardized manner such that (1) any life-threatening injuries must be appropriately and quickly dealt with to minimize the likelihood of imminent death, (2) any potentially disabling injuries should be appropriately dealt with to minimize functional impairment as a result of the injury, and (3) the pain and psychological distress from the traumatic injury should be minimized. In order to achieve these goals, the Advanced Trauma Life Support (ATLS) was developed to standardize guidelines for assessing and treating trauma patients. Similar guidelines are found in the WHO Guidelines for Essential Trauma Care, however the principles remain the same.

In Canada, trauma patients are generally transferred to trauma centers where a trauma team is activated. Each trauma team consists of an intensive care physician, general surgeon, orthopedic surgeon, anesthesiologist or respiratory therapist, critical care nurse or emergency room nurse, pharmacist, social worker, and, if necessary, a neurosurgeon and/or transfusion
medicine specialist. This team works together to perform a primary survey following the ABCDE’s from the ATLS guidelines, which include:

- A: Airway maintenance with cervical spine precautions
- B: Breathing and ventilation to manage respiratory distress
- C: Circulation and hemorrhage control
- D: Disability and neurological evaluation
- E: Exposure and environmental control

The ABCDE’s often include various diagnostic studies that can be conducted in the trauma bay or in the operating room (OR), these include ultrasound, x-rays and routine hematologic investigations. An ultrasound focused abdominal sonography for trauma (FAST) exam is used to identify abnormal pericardial and intra-abdominal fluid. In contrast x-rays are used to identify life-threatening injuries in the head, chest, cervical spine, or pelvis. Other diagnostic studies used for trauma patients include complete blood count, serum electrolytes, creatinine, serum lactic acid, pregnancy tests for females of child bearing age and blood type or cross match for patients likely to require transfusion. Laboratory tests should only be conducted if clinical circumstances warrant investigation, for example, if the patient is on warfarin, they will need coagulation studies to determine management of hemorrhage.

The goal of the primary survey is to determine the patient’s life threatening injuries first and the appropriate intervention. Given the spectrum of injuries that present to the trauma bay patients may be directed to the operating room immediately, transferred to a different hospital for specialized care, admitted to the in-patient trauma ward or even discharge home after observation in the emergency department. Regardless once the acute management has been carried out all patients then require a secondary survey.

2.3.1.2 Secondary survey

The goal of a secondary survey is to identify any missed injuries and to detect any injuries that have a delayed presentation.

Understanding the MOI is especially important for identifying any potential missed injuries because each MOI is associated with a set of specific injuries. For example, patients involved in blunt trauma caused by a head on MVC wearing a seatbelt often yield injuries to the face (e.g., fractures, brain injury), lower extremities (e.g., fractures, acute compartment
syndrome), sternum and ribs (e.g., fractures, hemo/pneumothorax), in contrast to gun shots victims (penetrating injury) all require bullets extracted and counted \(^{31-33}\). Some injuries that may go missed could include, for example, distal extremity fractures \(^{34,35}\) from a head on MVA or rectal or ureteral injuries from penetrating abdominal injury \(^{36,37}\). In order to detect injuries like these, a detailed history, followed by a physical examination, and if needed, targeted diagnostic tests are performed. The detailed history should pay particular attention to the MOI, previous medical and surgical history, current medication, for example, warfarin as it can interfere with coagulation, and/or illicit drug use, and allergies. The physical examination consists of inspection and examination of the patient from head-to-toe. The information obtained from the history and physical exam directs any further diagnostic tests to be performed \(^{31}\).

**2.3.2 Traumatic Musculoskeletal Injuries and their Management**

The most common injuries sustained for TMsI include: blunt chest wall injuries for example a flail chest; penetrating or blunt abdominal injuries, such as splenic or liver laceration; and other blunt or penetrating musculoskeletal injuries, such as pelvis fractures or distal extremity fractures. Each injury type requires particular treatment and the most life-threatening injuries must be treated first. Therefore, some injuries may be treated immediately following the primary survey, that is they are taken directly to the OR for a surgical intervention, whereas other less life-threatening injuries may be treated following the secondary survey or later. Treatments can be broadly classified as surgical or non-surgical (conservative) \(^{31}\).

1. **Blunt Chest Wall Injuries**

Chest wall injuries (e.g., flail chest, sternal fracture, chest wall defect) are commonly result of blunt traumatic injury and managed conservatively. An essential part of conservative management is pain control. Inadequate pain management decreases the patient’s tolerance of chest wall movement, thus decreasing tidal volume and increasing the likelihood of compromised respiratory functioning resulting in complications such as atelectasis, pneumonia, and retained hemothorax.

Pain control can be achieved through interventions such as regional anesthesia, intravenous or oral pain medications (e.g., opioids, non-steroidal anti-inflammatory drugs). However, the use of regional anesthesia techniques (e.g., nerve block, central neuraxial block) are advised for these injuries. Regional anesthesia has the advantage of providing adequate pain
relief without respiratory depression seen with the use of opioids. It is recommended that patients with bilateral rib fractures, flail chest, or unstable rib fractures, receive a central neural axial block (i.e., continuous epidural infusion). Although this is an invasive procedure, it provides a wide area of pain relief without respiratory depression, resulting in better overall pain control, increased tidal volume, and decreased time needed on mechanical ventilation. In patients with unilateral rib fractures, however, pain could be managed with a paravertebral block. The paravertebral block has been shown to be as effective as the central neuraxial block; however, it produces a more localized area of analgesia and provides equivalent or superior respiratory function with fewer cardiovascular changes. It is also less invasive when there are fewer rib fractures to provide pain relief.

In addition to these regional anesthetic techniques, pain control can be achieved through intravenous or oral opioids in combination with acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs). Although opioids are used widely, their use in this population warrants caution because of their respiratory depressant effect, which can reduce cough, deep inspiration and increase risk of atelectasis. Furthermore, contraindications are also seen with COX-1 specific NSAIDs in patients with active hemorrhage, coagulopathy or renal impairment. COX-2 specific inhibitors do not affect platelet function and are therefore not contraindicated in patients with coagulopathy.

For some patients with extensive chest wall injuries, conservative management is not adequate. In this case surgical intervention is advised. Clinical indicators for surgical intervention include a failure to wean from mechanical ventilation, severe pain leading to poor chest wall movement, significant chest wall deformity or presence of tissue defect, chest wall instability, and significantly displaced ribs. There are a growing number of studies indicating that surgical intervention (i.e., stabilization) can improve respiratory function, decrease pain scores, and prevent pulmonary restriction. Despite the evidence, the Eastern Association for the Surgery of Trauma (EAST) only recommends that this type of surgery be performed at Level III trauma centres.

2. Blunt and Penetrating Abdominal Injuries

Abdominal injury includes injuries to organs (e.g., splenic, liver, and/ or renal, laceration, ruptured bowel) or vascular pedicles. Management of these injuries depends on the hemodynamic stability of the patient. Focused radiographic studies, such as FAST scan, or
diagnostic peritoneal tap and/or lavage (DPT/DPL), can identify the presence of hemoperitoneum. If hemoperitoneum is evident then an emergent laparotomy must be conducted. In addition physical exam identifying peritonitis or imaging revealing free air within the abdomen are also indications for immediate laparotomy. However, if there is no intraperitoneal hemorrhage present nor visceral perforation, conservative management is utilized and the patient is observed. There are other reasons to perform an emergent laparotomy including unexplained signs of blood loss resulting in an unstable patient who cannot be stabilized, clear and persistent signs of peritoneal irritation, evidence of a diaphragmatic rupture, or persistent and significant gastrointestinal blood seen in nasogastric drainage or vomitus.

In accordance with ATLS guidelines, patients with multiple injuries, such hemoperitoneum and pelvic fractures (e.g., ring disruptions, sacral fracture, acetabular fracture, or avulsion injuries) must have the most life-threatening injuries addressed first before proceeding to less life-threatening injuries. In the presence of hemoperitoneum and an unstable pelvic fracture, the hemorrhaging could be caused by a combination of the two injuries. Therefore, the pelvis must be wrapped first, using a sheet or a commercial pelvic binder, to stabilize the pelvis before the emergent laparotomy proceeds. The fractured pelvis can later be managed by a specialized orthopedic surgeon.

Post-operative pain control plays an important role in patient outcomes and mobilization following abdominal surgery. Due to the nature of having experienced a trauma, preemptive analgesia before a laparotomy is not often possible, even though it is preferable, however, other anesthetic techniques are effective.

Regardless of which pain control technique or combination of techniques is used, it is important to note that pain control is not standardized and needs to be tailored to the patient according to their individual needs (e.g., presence of other injuries, medical history, psychological well-being, age).

3. Blunt and Penetrating Extremity Injuries

Blunt or penetrating extremity injuries, such as fractures, degloving, and crush injuries, can be identified early during the primary survey if they are life threatening or during the secondary survey if they are non-life threatening. Extremity injuries may require surgical intervention or conservation non-operative treatment.
Extremity injuries classified as life threatening may include, for example, those that have external bleeding from the extremity. For injuries such as these, they must be managed as quickly as they can with the application of pressure to the bleeding area until surgical intervention is deemed appropriate. The presence of extremity injury is a major determinant of long-term functional recovery post trauma. If it is treated promptly and with appropriate interventions the probability of disability can be greatly reduced. However, management of extremity injury is dependent on whether the patient is hemodynamically stable or not.

If the patient is hemodynamically unstable from other life-threatening injuries to the neck, chest, and abdomen, then the management of those life-threatening injuries takes precedence over the non-life threatening injured extremity. In these situations damage control of the extremity may not be possible, which could result in vascular and neural damage, necrotized tissue, and as a result possible amputation. There is no single way to predict amputation and every attempt to salvage the extremity must be made, which may require numerous surgeries.

On the other hand, if the patient is hemodynamically stable, measures can be taken to treat the non-life threatening extremity injury, such as surgical intervention. Surgical interventions may include damage control, like vascular ligation and vascular shunting, revascularization, nerve repair, soft tissue debridement (e.g., in patients with degloving injuries), irrigation and debridement with stabilization (e.g., in patients with open fractures), fixation (e.g., in patients with delocalized fractures), or extremity fasciotomy (e.g., as a result of crush injuries). Extremity injuries requiring conservative management may include splinting and observation of fracture union.

As with chest well injuries and abdominal injuries, pain control is important for patient recovery and must be tailored to the patients needs.

2.4 Factors Associated with chronic post-traumatic/ post-surgical pain

The development of PTSD, chronic pain, and pain disability is complex; however, the relationships between pre-existing, peri-traumatic (i.e., time immediately after trauma, during hospitalization for up to two weeks after injury) and post-traumatic variables may be explained through a modified diathesis – stress model of chronic pain involving a combination of shared vulnerability and mutual maintenance factors. This complex model can be seen in Figure 1,
where by shared psychological and biological vulnerabilities (diatheses) are presumed to place the individual at an increased risk of developing both persistent pain and PTSD following a traumatic injury. Proposed psychological vulnerabilities include sensitivity to pain traumatization (i.e. a propensity to develop anxiety-related somatic, cognitive, emotional, and behavioural responses to pain that resemble a traumatic stress reaction⁵⁴) and anxiety sensitivity (i.e. fear of the symptoms of anxiety due to the belief that they will lead to harmful physical, psychological and/or social consequences⁵⁴⁻⁵⁶). Proposed biological vulnerability factors include a low threshold for startle and pre-existing HPA axis sensitivity⁵⁷. These diatheses interact with TMsI, surgical intervention, and disease-related stressors (e.g., diabetes⁵⁸) which together feed into a mutual maintenance model⁵⁵ involving fear-avoidance symptoms of chronic pain⁵⁹ (i.e. pain experience, self-efficacy, a fear of pain, and pain catastrophizing) and symptoms of PTSD (i.e., re-experiencing, hyperarousal, avoidance, and emotional numbing⁵⁴). Because the two disorders show substantial symptom overlap, symptoms of one disorder (e.g., an exacerbation of pain) may trigger and maintain symptoms of the other disorder (e.g., intrusive thoughts, flashback, hyperarousal, and avoidance) and vice versa. The particular pattern of mutual maintenance will differ for each individual depending upon the nature of the traumatic stressor, as well as individual differences in the expression of somatic, cognitive, affective and behavioral factors. The result of these variables interacting is pain disability or pain that which interferes with ones life.

This thesis evaluated the purported contribution of each variable during the acute phase following traumatic injury.
Figure 1. Combined shared vulnerability and mutual maintenance model of disability in the context of traumatic injury. Single headed arrows indicate the direction of a temporal relationship between factors. Double-headed arrows indicate some of the possible association between factors. Not all possible relationships are shown. Reproduced with permission.
2.4.1 Acute Pain

International Association for the study of Pain (IASP) defines pain as an “unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage”\textsuperscript{60}. In the context of traumatic musculoskeletal injury, acute pain can be caused by the trauma or by surgical interventions such as those described previously. Pain is typically most intense immediately following tissue damage, which is marked by three main neurobiological responses including the initial nociceptive response to the injury, primary hyperalgesia, and secondary hyperalgesia. Ascending and descending mechanisms in the spinal cord and brain are thought to modulate pain as seen in Figure 2\textsuperscript{61,62}. Though the main focus of this thesis is the experience of pain, it is important to understand these neurobiological responses in order to appreciate the range of patient experiences following injury.
Figure 2. Nociception and ascending and descending pain modulation. (Source: http://www.acssurgery.com/acssurgery).
2.4.1.1 Peripheral Nerve Injury

In response to noxious stimuli, such as tissue damage from traumatic injury, free nerve endings (nociceptors) are activated initiating a cascade of events that result in pain. Nociceptors can respond to mechanical, chemical, or thermal stimuli. They are responsible for the transduction and transmission of the nociceptive stimuli. When the nociceptor is stimulated pronociceptive inflammatory molecules are immediately released from the damaged tissue cells, like blood cells (e.g., bradykinins, prostaglandins, histamine, serotonin, adenosine triphosphate) and immune cells (e.g., interleukins, interferons, tumor necrosis factor, substance P). The nociceptive mediators are released into the periphery. These molecules are involved in the production of peripheral hyperalgesia.

2.4.1.2 Primary Hyperalgesia

The release of nociceptor mediators at the site of injury activates afferent sensory neurons and sensitizes nociceptors within the damaged tissue and surrounding neurons. Clinically this response causes a lowered pain threshold in the affected area and is termed primary hyperalgesia. Nociceptive pain can be classified as visceral (e.g., organs) or parietal (e.g., skin, muscles, bones) based on the location of nociceptive activation. These types of pain are perceived differently, specifically visceral pain is perceived as episodic and is poorly located, whereas parietal pain is perceived as constant aching or throbbing pain that is very well localized.

Within the context of traumatic musculoskeletal injuries, pain is often parietal (e.g., a fractured tibia), however some injuries can cause both visceral and parietal, for example thoracic pain caused by rib fractures.

Primary hyperalgesia is caused sensory afferent neurons firing in visceral or parietal areas. These afferents can be categorized as Aβ, Aδ, or C-fibers. Generally, Aβ neurons are involved in pain modulation, while Aδ and C-fibers primarily transmit nociceptive signals. Specifically, Aβ fibers are myelinated neurons that quickly transmit non-nociceptive signals (conduction velocity of 35 to 75 m/s) to the substantia gelatinosa of the dorsal horn of the spinal cord. These fibers are responsible for proprioception and are involved in pain modulation by inhibiting nociceptive input. Aδ fibers are also large myelinated neurons, however, they are slightly slower than Aβ and transmit nociceptive signals at 5-30 m/s to the dorsal horn of the
spinal cord. They are also responsible for the first pain sensation after injury, which is described as sharp and quick, with the sensation felt exactly at the site of injury. The $\text{A}_\beta$ and $\text{A}_\delta$ fiber activation together allow for a quick withdrawal reflex. C-fibers, on the other hand, are unmyelinated and slow to transmit nociceptive signals. This results in second pain, or pain sensations that are dull, aching, and dispersed, which come after the first pain.

The intense activation of sensory afferents at the site of injury as well as the surrounding area cause the afferents to become sensitized, meaning that they are quick to fire and transmit signals to the spinal cord. Further there is a lack of inhibition in the injured area. Together these mechanisms make up primary hyperalgesia. When $\text{A}_\delta$ and C-fibers synapse at in the dorsal horn (laminae I, II, and V) of the spinal cord, they initiate pain modulation with a network of excitatory and inhibitory neurons $^{66,67}$. Ronald Melzack and Charles Patrick Wall proposed the Gate Control Theory of Pain in 1965 to explain the transmission of pain from sensory afferents to the spinal cord where these signals are modulated by small and large fibers $^{68,69}$. These fibers control the “gate” allowing some nociceptive signals to pass to the brain where pain is perceived while inhibiting other nociceptive signals thus closing the “gate”. Specifically, sensory afferents synapse in the substantia gelatinosa (SG) and transmission cells (T) in the dorsal horn of the spinal cord. As seen in Figure 3, the “gate” is housed in the SG where large fibers ($\text{A}_\beta$-fibers) inhibit the gate from opening and small fibers (C-fibers) facilitate the opening of the gate. The “gate” opens when there is an excess of small fiber activation and nociceptive activation overriding the large inhibitory fibers $^{69}$. This synaptic activity can also activate secondary neurons resulting in secondary hyperalgesia. Other descending fibers can modulate the opening and are discussed in more detail in the next section.
2.4.1.3. Secondary Hyperalgesia

Secondary hyperalgesia (sensitization) refers to neurophysiological changes within the central nervous system (CNS). Central sensitization can occur as a consequence of repeated firing of C-fibers and/ or tonic stimulation (temporal stimulation) or from nociceptive stimulation for a wide area of damaged tissue (spatial summation). This C-fiber activation results in secondary neurons in the spinal cord to increase their firing rate, prolong activation of N-methyl-D-aspartate (NMDA) receptors and, in turn, the perception of pain intensity increases \(^{67}\). Furthermore, this increased activation induces the transcription of expressed genes, such as \(c-fos\) and \(c-jun\), resulting in sensitization of nociceptors \(^{70}\). Secondary hyperalgesia may occur acutely, lasting seconds or days, however it may also persist beyond the healing time.

2.4.1.4 Pain Modulation and Central Nervous System Involvement

Second order neurons in the spinal cord transmit signals to the brain stem and the brain through the spinothalamic and spinorecticular tract. As its name suggests the spinothalamic tract sends nociceptive afferent signals from the dorsal horn of the spinal cord to the thalamus and to the primary and secondary somatosensory cortex (S1 and S2) \(^{62}\). This pathway is responsible for
creating a somatotopic representation of the painful stimuli. The spinoreticular tract, on the other hand, sends afferents to the medial thalamus and the nucleus raphe magnus (NRM) and the periaqueductal grey matter (PAG) and these afferents have wide receptive fields that may cover large areas of the body \(^{63,66,67}\). Once the afferents from the spinoreticular tract activate the thalamus, signals are sent to limbic structures and are hypothesized to be involved in the affective component of pain \(^{71}\). Enhanced sensitivity to pain, as seen with central sensitization, is postulated to be as a result of a combination between strong initial nociceptive response, temporal and spatial stimulation of nociceptive afferents, and modification of neural transmission in the dorsal horn of the spinal cord that project to the brain \(^{63,70}\).

Just as there are these excitatory mechanisms to transmit nociceptive signals to the brain, there are three main descending inhibitory mechanisms that modulate pain. The first of these mechanisms are found at the spinal level, which are the result of the selective activation of A\(\beta\) that inhibit interneurons in the substantia gelatinosa. The activation of these interneurons produces a localized analgesic effect and a reduction in the perception of pain \(^{72}\). The second type of modulation is known as diffuse noxious inhibitory control (DNIC). The DNIC theory purports that pain perceived from a noxious stimulus in a particular area can be inhibited by a stimulus in another area by producing a net analgesic effect \(^{62,73}\). There is conflicting evidence for the role of DNIC in acute pain, such as immediately following traumatic injury or post-operatively, however there is much support for it in chronic pain \(^{73}\). The last descending mechanism involves the CNS and stimulation of the PAG, which then inhibits the dorsal horn nociceptive neurons through relays in the RVM \(^{62}\). The PAG receives inputs from a number of higher order CNS structures, including the amygdala, medial prefrontal areas, hippocampus, as well as from ascending nociceptive input from the dorsal horn. The RVM on the other hand receives little direct information from the dorsal horn; instead its information primarily descends from the PAG and nucleus cuneiformis through serotonin containing neurons \(^{62,74}\). The RVM activates the release of norepinephrine to the spinal cord and therefore the PAG-RVM connection modulates the pain experience \(^{62,74}\). Further, the locus coeruleus is also involved in pain modulation by sending inhibitory signals through noradrenergic mechanisms \(^{74}\). Together these mechanisms work to decrease pain intensity and firing of nociceptive signals at the area of injury and spinal cord.
The experience of pain, however, is as a result of the conscious interpretation of these neurophysiologic changes involved in nociception and incorporates emotional responses, cognitive evaluations, and memories from previous painful experiences. Studies utilizing brain-imaging techniques, such as blood oxygen level dependent functional magnetic resonance imaging (BOLD FMRI), positron emission tomography (PET), and MRI, have identified distinct sets of brain regions that make up the cerebral signature of pain, formerly known as the “pain matrix” 75-77. Though it should be noted that the interpretation of nociception is not necessarily directly related to neurophysiological changes in the periphery (as pain can occur in the absence of nociceptive stimulation) 77. This cerebral signature consists S1, S2, thalamus, posterior parts of the insular cortex, anterior cingulate cortex, and prefrontal cortex 75,77.

The brain is a densely connected neural network that functions with many pathways. Similar to neuronal responses in the periphery, the brain is adaptive allowing for changes in neuronal activity in response to noxious stimuli 75. For example, the ventrolateral prefrontal cortex is negatively correlated with pain intensity indicating its role in pain perception and modulation. There is also mounting evidence from imaging studies on acute and chronic pain that provide insights into the pain experience and how individuals respond differently to seemingly similar noxious stimuli 75. This can be seen, for example, in patients with fibromyalgia where the amygdala and anterior insula are differentially activated for those with and without clinical depression 78. Further, unique chronic pain conditions appear to provide different neural network organization (e.g., osteoarthritis versus post hepatic neuralgia 77), however the mechanisms for directing neural changes remain to be elucidated 75. There are also no known studies that have investigated the neural changes from acute to chronic pain among patients with TMsI. However, it should be noted that the more sites associated with pain and at high levels of severity increase the likelihood for chronic pain 79.

2.4.2 Chronic Post-traumatic/ Post-surgical pain

While pain can be acute, lasting seconds or weeks, pain that persists beyond the time necessary for the healing of tissues is considered chronic (i.e., damaged tissue from traumatic injury or surgery will typically heal within three months) 60. Though chronic pain is traditionally defined by duration, the pain may be continuous or recurrent in addition to being of significant intensity that it interferes with a patient’s wellbeing, general functioning, and quality of life 60,80.
Throughout this thesis, chronic PTPS pain is defined as (1) pain that develops after traumatic injury or after surgical intervention in the wake of traumatic injury; (2) pain that has been present for at least two months; (3) other causes of pain have been ruled out (e.g., further surgical interventions have not occurred); and (4) the possibility that the pain is a continuation of a pre-existing problem should be ruled out.\textsuperscript{81,82} This definition has been criticized for the short duration of pain, given that the damage to the tissue causing pain also produces an inflammatory response that may continue beyond two months following trauma.\textsuperscript{83} However, the focus of this thesis is on the early stages of recovery following trauma and how pain and psychological distress either persist beyond the acute period or develop at some point during recovery.

### 2.4.2.1 Neuropathic Pain

Neuropathic pain (NeP) is another type of pain that arises specifically from a lesion (e.g., trauma) or pathological change (e.g., nerve damage caused by diabetes) affecting the peripheral or central somatosensory system depending on the type of nerve damaged.\textsuperscript{60,63,84} The most common cause of NeP is physical injury or trauma causing partial or full lesions in the nerve. The effects of this damage may be seen immediately following injury or months after the injury.\textsuperscript{80,85} Neurobiologically, NeP is marked by phenotypic changes to signaling mechanisms (i.e., sodium channels, potassium channels, and calcium channels) in afferent neurons causing abnormal firing of the afferent neuron.\textsuperscript{66} Clinically, NeP is described by patients as pain that starts spontaneously in the absence of a noxious stimulus or as an abnormal response to a non-painful stimulus and characterized by allodynia and/or hyperalgesia.\textsuperscript{84} Furthermore, this pain is also marked as moderate to severe pain intensity that is present during the acute stages following injury or surgery.\textsuperscript{86}

Although Nep can arise acutely following injury, assessment of NeP is more commonly studied months after initial injury. The rates of NeP are highest among patients undergoing thoracic surgery and breast surgeries, with prevalence as high as 34.5% and 31.0%, respectively.\textsuperscript{87} The prevalence of Nep among total hip arthroplasty/ total knee arthroplasty is 19.8%.\textsuperscript{63,85}

### 2.4.2.2 Epidemiology of chronic pain post traumatic musculoskeletal injury

Recently a large retrospective multicenter study revealed that the effect of traumatic injury requiring surgical intervention has deleterious effects for the majority of adult patients with 63% reporting pain one year following traumatic injury.\textsuperscript{6} Furthermore, 59% had pain in
more than three areas of their bodies. However among prospective longitudinal studies investigating persistent pain following traumatic musculoskeletal injury the rate of persistent pain is far more variable than seen in retrospective studies. Out of 11 prospective studies examined in a review by Rosenbloom and colleagues (2013), ten reported incidence of pain and pain intensity. Though these studies reported pain intensity or pain incidence, the time to follow-up varied from three to 84 months after traumatic injury and there was a large range in the proportion of patients reporting pain from 28% to 93%. The incidence of patients reporting pain decreased over time among each study.

The variability in incidence of pain following traumatic musculoskeletal injury is most attributable to (1) the various pain assessment measures used in each study and (2) to the time points at which the patients were assessed following their injuries. Rosenbloom et al evaluated the 11 studies and found that pain was assessed peri-traumatically (i.e. time immediately after trauma, during hospitalization for up to two weeks after injury) and at subsequent time points following injury. At each of the time points patients had pain evaluations using either a validated measure of pain intensity, pain presence/absence and/or as part of a more general quality of life questionnaire (Table 1). Six studies utilized validated measures to evaluate pain intensity. The measures included either a 10 cm or 100 mm Visual Analogue Scale (VAS) or a 0-10 point Numeric Rating Scale (NRS). Two of these six studies also used comprehensive measures of pain, including either the McGill Pain Questionnaire or McGill Pain Questionnaire Short-Form. Only one study used the Graded Chronic Pain Scale. Among the remaining five studies in this review, two studies used the bodily pain question from the SF-36, two studies used the SF-6, and one study asked participants if they had pain related to the trauma.

It is clear that a more standardized approach is needed for determining the magnitude of PTPS chronic pain and pain disability in adult patients following musculoskeletal injury. Furthermore, there are no current studies that have assessed PTPS chronic pain in Canada, nor are there any that have prospectively assessed acute posttraumatic musculoskeletal pain.
Table 1. Pain incidence and intensity at various times reported by the Rosenbloom et al 2013. Permission to reproduce this table was provided.

<table>
<thead>
<tr>
<th>Time Post-Injury</th>
<th>Study</th>
<th>Analgesic Medication Use (% patients)</th>
<th>Pain Measure Used</th>
<th>Pain Incidence (% patients)</th>
<th>Pain Score/Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial assessment (during hospitalization or at discharge)</td>
<td>Williamson (2009) 43</td>
<td>NR</td>
<td>NRS</td>
<td>48% (n = 619, 95% CI 45-51)</td>
<td>Moderate to severe</td>
</tr>
<tr>
<td></td>
<td>Norman (2008) 38</td>
<td>NR</td>
<td>VAS</td>
<td>NR</td>
<td>Mean 5.64 (SD = 2.46)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MPQ</td>
<td>NR</td>
<td>Mean 14.11 (SD = 10.15)</td>
</tr>
<tr>
<td></td>
<td>Michaels (2001) 42</td>
<td>NR</td>
<td>SF-36: Bodily pain (Answers standardized on a 100-point scale)</td>
<td>NR</td>
<td>81.8 (non-orthopedic injured patients); 80.9 (orthopedic injured patients)</td>
</tr>
<tr>
<td></td>
<td>Clay (2010) 90</td>
<td>NR</td>
<td>MPQ</td>
<td>77%</td>
<td>NR</td>
</tr>
<tr>
<td>3-4 Months</td>
<td>Mayou (2001) 36</td>
<td>NR</td>
<td>SF-6: Bodily pain</td>
<td>28% (n = 238)</td>
<td>Moderate, severe, or very severe pain</td>
</tr>
<tr>
<td></td>
<td>Clay (2010) 90</td>
<td>NR</td>
<td>MPQ</td>
<td>65% (n = 137)</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Norman (2008) 94</td>
<td>NR</td>
<td>VAS</td>
<td>NR</td>
<td>Mean 1.85 (SD=2.62)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MPQ</td>
<td>NR</td>
<td>Mean 2.86 (SD = 4.65)</td>
</tr>
<tr>
<td></td>
<td>Castillo (2006) 95</td>
<td>16.9 %</td>
<td>VAS</td>
<td>71.8%</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Holmes (2010) 37</td>
<td>NR</td>
<td>NRS</td>
<td>86 % (16% of which reported a level of pain at 5 or more)</td>
<td>Mean pain score 2.4 (SD = 2.1)</td>
</tr>
<tr>
<td></td>
<td>Aitken (2012) 96</td>
<td>NR</td>
<td>SF-36</td>
<td>93% (n = 113)</td>
<td>NR</td>
</tr>
<tr>
<td>6 Months</td>
<td>Williamson (2009) 88</td>
<td>NR</td>
<td>NRS</td>
<td>30% (n = 387, 95% CI: 28-33)</td>
<td></td>
</tr>
<tr>
<td>Time Post-Injury</td>
<td>Study</td>
<td>Analgesic Medication Use (% patients)</td>
<td>Pain Measure Used</td>
<td>Pain Incidence (% patients)</td>
<td>Pain Score/Intensity</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------</td>
<td>--------------------------------------</td>
<td>-------------------</td>
<td>-----------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>8 Months</td>
<td>Clay (2010) 90</td>
<td>NR</td>
<td>MPQ</td>
<td>54% (n = 81) (56.7% of which had moderate to high pain severity)</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>Michaels (2001) 89</td>
<td>NR</td>
<td>SF-36: Bodily pain (Answers standardized on a 100-point scale)</td>
<td>NR</td>
<td>56.2 (non-orthopedic injured patients); 44.6 (orthopedic injured patients)</td>
</tr>
<tr>
<td></td>
<td>Sanders (2008) 91</td>
<td>NR</td>
<td>VAS</td>
<td>NR</td>
<td>Mean 3.8 (SD = 2.9)</td>
</tr>
<tr>
<td></td>
<td>Norman (2008) 94</td>
<td>10</td>
<td>VAS</td>
<td>NR</td>
<td>Mean 1.57 (SD = 2.65)</td>
</tr>
<tr>
<td></td>
<td>Mayou (2001) 93</td>
<td>NR</td>
<td>SF-6: Bodily pain</td>
<td>22% (n = 171)</td>
<td>Moderate, severe, or very severe pain</td>
</tr>
<tr>
<td>12 Months</td>
<td>Michaels (2001) 89</td>
<td>Increased use of sedatives (20% of ortho vs 4% of non-ortho patients) and analgesics (30% of ortho vs 4% of non-ortho patients)</td>
<td>SF-36: Bodily pain</td>
<td>NR</td>
<td>79.0 (non-orthopedic injured patients); 66.5 (orthopedic injured patients)</td>
</tr>
<tr>
<td></td>
<td>Mayou (2002) 92</td>
<td>NR</td>
<td>SF-6: Bodily pain</td>
<td>21% (n = 104)</td>
<td>NR</td>
</tr>
<tr>
<td>36 Months</td>
<td>Jenewein (2009) 33</td>
<td>12.2% (n=11) of all patients; 27.5% (n=11) of patients who reported pain.</td>
<td>Yes/ No question on whether the patient had pain related to their trauma</td>
<td>44% (n=40)</td>
<td>NR</td>
</tr>
<tr>
<td>Time Post-Injury</td>
<td>Study</td>
<td>Analgesic Medication Use (% patients)</td>
<td>Pain Measure Used</td>
<td>Pain Incidence (% patients)</td>
<td>Pain Score/Intensity</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>-----------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>84 Months</td>
<td>Castillo (2006)</td>
<td>15% of patients treated with analgesics at 3 months had GPC level IV at 84 months versus 30% of these patients who were treated without analgesics( p = .019)</td>
<td>Graded Chronic Pain Questionnaire</td>
<td>77.1%</td>
<td>NR</td>
</tr>
</tbody>
</table>

* Clay et al. assessed pain at two weeks following traumatic injury.

NR, Not Reported; SD, standard deviation; NRS, Numeric Rating Scale; VAS, Visual Analogue Scale; SF, Short-Form; MPQ, McGill Pain Questionnaire; WOMAC, Western Ontario and McMaster Universities Arthritis.
2.4.3 Psychological factors associated with acute pain

2.4.3.1 Anxiety

Numerous studies have been conducted to examine the influence of anxiety related factors on the development and maintenance of chronic pain as well as their relationship with pain disability. As seen in Figure 1, the anxiety constructs associated with acute and chronic PTPS pain include; (1) anxiety sensitivity, (2) pain catastrophizing and pain anxiety, and (3) posttraumatic stress. A distinction should be made between anxiety disorders and anxiety constructs. Anxiety disorder is a broad term for a number of psychiatric diagnoses that all involve longstanding intense and abnormal anxiety with the resulting behaviors designed to protect the individual from experiencing these intense emotions. Although there are a proportion of patients who go on to be diagnosed with an anxiety disorder following TMsI, this thesis will focus on symptoms during the acute phase and their association with other acute factors that are thought to predict chronic PTPS pain, rather than the diagnosis of a disorder. More specifically, particular attention will be paid to posttraumatic stress disorder (PTSD) and its symptom clusters due to its co-morbidity with recovery from TMsI.

1. Anxiety Sensitivity. Anxiety sensitivity is a construct that has historically been examined as a factor in anxiety disorders, however, it has also been recognized as one factor that is associated with pain. Specifically, anxiety sensitivity refers to the fear of experiencing anxiety related symptoms, for example increased heart rate, racing thoughts, and the potential consequences associated with those symptoms (e.g., panic attack). Within the context of anxiety disorders, anxiety sensitivity has been shown to be involved in pre-clinical anxiety disorder impairment, where as within the context of chronic pain it is seen as a pre-disposing factor for the development of chronic pain and as a maintenance factor for established chronic pain.

2. Pain Catastrophizing and Pain Anxiety. Pain catastrophizing is described as the tendency to magnify the threat value of pain and to feel helpless in the context of pain. This construct is positively associated with both general anxiety and pain related fears (pain anxiety), as well as a predictor for acute post-operative pain and chronic post-operative pain. Furthermore, a recent meta-analysis revealed that pain catastrophizing is a highly predictive factor for acute and chronic pain following musculoskeletal surgeries over every
other type of surgery included in the analysis. The fear and anxiety responses to pain, hereafter called pain anxiety, are often studied within the context of fear avoidance models of chronic pain.

3. **Post-traumatic Stress.** The symptomatology of PTSD develops in response to a traumatic event or series of events where the individual’s life (or the life of a loved one) is perceived to be in danger causing intense feelings of helplessness, fear, and/or horror. PTSD is characterized by three persistent symptom clusters, including: (1) re-experiencing of the traumatic event (e.g., recurrent distressing dreams of the event); (2) avoidance of stimuli associated with the traumatic event and numbing of general responsiveness (e.g., efforts to avoid the places, activities or people that arouse recollections of the trauma); and (3) hyperarousal (e.g., difficulty falling or staying asleep, hypervigilence). These symptoms must cause significant distress or impairment and must be present for one-month and appear within six months of the traumatic event (see Table 2). Another commonly used definition of PTSD is found in the ICD-10 which similarly classifies PTSD (see Table 3) with less emphasis on the three symptoms clusters that are the focus of the DSM-IV TR. As the focus during the acute phase in on the psychological constructs, the DSM-IV TR definition of PTSD will be followed.

In the general population, the lifetime prevalence of PTSD is 7.8% and the 12-month prevalence rate is 3.5%. Prevalence rates for PTSD can differ based on the mode of assessment used for diagnosis or measurement of symptom severity. Studies which use self-administered questionnaires [e.g., Posttraumatic Stress Disorder Checklist] tend to have higher rates of PTSD than those that use clinical assessments [e.g., Clinician Administered Posttraumatic Stress Disorder Scale]. This difference may be attributed to a focus on symptomatology in self-administered questionnaires as opposed to an emphasis on the disability caused from the symptomatology used in clinical assessments. Regardless of measurement type, the prevalence rates of PTSD following motor vehicle accidents, Koren and colleagues (1999) found that 32% of the sample studied satisfied diagnostic criteria for PTSD 12 months after the accident. This is a large number compared to the estimation that 7-12% of the Canadian population experiencing a traumatic event go on to develop PTSD.
Table 2. DSM-IV TR Classification of Posttraumatic Stress Disorder.

1. The person has been exposed to a traumatic event in which both of the following were present:
   a. The person experienced, witnessed or was confronted with an event or events that involved actual or threatened death or serious injury, or threat to the physical integrity of self or others
   b. The person’s response involved intense fear, helplessness, or horror

2. The traumatic event is persistently re-experienced in one (or more) of the following ways:
   a. Recurrent and intrusive distressing recollections of the event including images, thoughts, and perceptions
   b. Recurrent distressing dreams of the event
   c. Acting or feeling as if the event were recurring
   d. Intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event
   e. Physiological reactivity on exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event

3. Avoidance of stimuli associated with the trauma and numbing of general responsiveness (not present before the trauma), as indicated by three or more:
   a. Efforts to avoid thoughts, feelings, or conversations related to the trauma
   b. Efforts to avoid places, activities, or people that arouse recollections of the trauma
   c. Inability to recall important aspects of the trauma
   d. Markedly diminished interest or participation in significant activities
   e. Feelings of detachment or estrangement from others
   f. Restricted range of affect
   g. Sense of foreshadowed future

4. Persistent symptoms of increased arousal (not present before the trauma) as indicated by two or more:
   a. Difficulty falling or staying asleep
   b. Irritability or angry outbursts
c. Difficulty concentrating
d. Hypervigilance
e. Exaggerated startle response

5. Duration of disturbances (criteria 2, 3, and 4) is more than one month.
6. The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.


1. The patient must have been exposed to a stressful situation or situation (either short or long lasting) of emotionally threatening or catastrophic nature, which would be likely to cause pervasive distress to almost anyone.
2. There must be persistent remembering or “reliving” of the stressor in intrusive “flashbacks”, vivid memories, or recurring dreams, or in experiencing distress when exposed to circumstances resembling or associated with the stressor.
3. The patient must exhibit an actual or preferred avoidance of circumstances resembling or associated with the stressor, which was not present before exposure to the stressor.
4. Either of the following must be present:
   a. Inability to recall, either partially or completely, some important aspects of the stressor
   b. Persistent symptoms of increased psychological sensitivity and arousal (not present before exposure to the stressor) shown by any two of the following:
      i. Difficulty falling or staying asleep
      ii. Irritability or outbursts of anger
      iii. Difficulty concentrating
      iv. Hypervigilance
      v. Exaggerated startle response
2.4.3.2 Depression

Depression is a psychiatric mood disorder and like anxiety constructs discussed in the previous section, this thesis will focus on symptoms of depression found in the classification of the disorder. The DSM-IV TR identifies depression by the presence of a depressive episode for no less than a two-week period with a lifetime absence of a manic or hypomanic episode\(^98\). At least four of the eight symptoms presented in Table 4 must be present for the duration of the depressive episode causing significant distress and impairment in daily function. For example, a person with depression may have a lost interest or pleasure in activities that are normally pleasurable, a loss of appetite, weight loss, and fatigue or loss of energy every day\(^98,105\).

However, this individual may not, for example, have a lack or emotional response to events that require an emotional response or have insomnia.

Worldwide, depression is a leading cause of disability and is projected to continue to be the leading cause in 2030\(^114\). The lifetime prevalence of major depression in adults in the United States is estimated at 17%\(^115\). Depression is often comorbid with other medical and psychiatric conditions\(^114\). Following TMsI, this co-morbidity is also the norm rather than the exception\(^25\).

The most common co-morbid psychiatric disorders following TMsI are PTSD and depression with prevalence rates of the two psychiatric conditions presenting co-morbidly ranging from seven to 53%\(^100,116-118\). Despite the high level of co-morbidity, depression is not commonly the focus of studies related to TMsI and is often studied as part of an ‘anxiety and depression’ construct\(^12,90,95\). However, of the few studies that do isolate depression as an outcome from TMsI, depression develops in 9-56% of patients who suffer from a TMsI. Furthermore, Toien and colleagues found that depressive symptoms remain stable over time\(^119\).
Table 4. DSM-IV TR criteria for depression.

1. At least five of the following symptoms must be present during a two-week period and represent a change from previous functioning: at least one of the symptoms is either 1) depressed mood or 2) loss of interest or pleasure.
   a. Depressed mood most of the day, nearly every day, as indicated either by subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful)
   b. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated either by subjective account or observation made by others)
   c. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day
   b. Insomnia or hypersomnia nearly every day
   c. Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down)
   d. Fatigue or loss of energy nearly every day
   e. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick)
   f. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others)
   g. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or specific plan for committing suicide

2. The symptoms do not meet criteria for a mixed episode.

3. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

4. The symptoms are not due to the direct physiological effects of a substance (e.g. a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism).

5. The symptoms are not better accounted for by bereavement, i.e., after the loss of a loved one, the symptoms persist for longer than 2 months or are characterized by marked
functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.

### 2.4.3.3 Associations between Anxiety Constructs and Depression

The model examining the roles of anxiety sensitivity, pain anxiety, and pain catastrophizing has largely been with chronic low back pain or chronic post-surgical pain. Few studies have examined the validity of this model among post-traumatic and post-surgical (PTPS) patients and none have examined its validity with acute PTPS pain. However, evidence from these populations show us that during the acute stages after TMsI, pain can be experienced as either as non-threatening or as threatening. When pain is experienced as non-threatening, patients are more likely to confront their pain and have adaptive responses to the pain and going on to resume normal activities they participating in prior to the injury. In essence, they do not go on to suffer from psychological distress or physical symptoms. On the other end of the spectrum when pain is perceived as threatening, an individual will respond with significant anxious responses to the pain (e.g., with pain catastrophizing and avoidance behaviours). This is thought to push individuals into a vicious cycle where pain is maintained by heightened muscle reactivity to pain, behavioural avoidance and escape, pain catastrophizing, anxieties related to the pain, and as a result physical deconditioning or pain disability. It is this cycle that may lead to perceptions of increased physical pain symptoms as well to perceive their health as poorer as a result of those symptoms.

It should be noted, however, that during the acute phase following surgery or injury, attention to pain and avoidance of activities that increase the pain or risk further injury are adaptive. Furthermore, there are few studies investigating how responses to pain after injury impact the development of posttraumatic stress symptoms. There is more evidence for this model months after injury.

Recently, Keogh and colleagues (2010) specifically investigated the relationship between pain catastrophizing, pain anxiety, and anxiety sensitivity and acute pain among patients with hand fractures. They concluded that pain catastrophizing was a strong predictor of current pain, pain anxiety was a predictor of task related pain, and, finally, that anxiety sensitivity was a
predictor for functional disability. Furthermore, they found that all three anxiety constructs accounted for some of the variance in pain intensity and pain disability; however, they indicated that the exact relationship was not able to be clarified given the small number of participants for the number of variables examined. This study shows that in the absence of chronic pain and typically co-morbid clinical anxiety and clinical depression, pain catastrophizing, pain anxiety, and anxiety sensitivity contribute to acute pain and therefore are not only associated with chronic pain. Given the importance of these factors in chronic pain and the budding evidence for their role in acute fracture pain, it is important to examine their influence on acute TMsi pain. Furthermore, in order to elucidate the role of posttraumatic stress with acute pain, anxiety sensitivity, pain anxiety, and pain catastrophizing these factors must be examined together rather than in isolation.
Chapter 3

Research Objectives and Hypotheses
3.1 Objectives

The overall objective of this study was to explore the relationship between acute pain and psychological factors following traumatic musculoskeletal injury, as well as determine the incidence of these factors. Specifically, the primary objectives included:

1. Determining the frequency and severity of acute pain, symptoms of anxiety, depression, and posttraumatic stress within two weeks following traumatic musculoskeletal injury.
2. Determining the association, if any, between pre-morbid factors (preexisting anxiety and depression, pre-morbid alcohol use, socioeconomic status), injury characteristics (mechanism of injury, injury severity, injury locations), in-hospital factors (analgesic consumption, use of multimodal analgesics, surgical intervention, length of stay in hospital), acute pain intensity, neuropathic pain, psychological factors (anxiety sensitivity, pain catastrophization, general anxiety, general depression), and posttraumatic stress symptoms.

3.2 Specific Hypotheses

The hypotheses of the primary objective include:

$H_{o1}$: Patients in this sample will have a higher incidence of anxiety, depression and post-traumatic stress symptoms than in the general population.

$H_{o2}$: Independently, pain intensity, pain anxiety, anxiety sensitivity, general anxiety, general depression, and pain catastrophizing will be positively associated (odds ratios >1.0) with post-traumatic stress symptoms.

$H_{o3}$: Independently, opioid consumption and pain self-efficacy will be negatively associated (odds ratios <1.0) with post-traumatic stress symptoms.

$H_{o4}$: As proposed model in Figure 1, current diseases (i.e. diagnoses of anxiety or depression), psychological vulnerabilities (i.e. anxiety sensitivity), pain catastrophizing, pain anxiety, post-traumatic stress, pain self-efficacy, and pain experience (i.e. pain intensity, neuropathic pain) will be associated.
Chapter 4

Methods
Ethics approval for this study granted through Sunnybrook Health Sciences Centre (SHSC; #072-2012), St. Michael’s Hospital (SMH; #12-266), and the University of Toronto (UofT; #28039) REBs prior to study commencement (Appendix A).

4.1 Project Design

This study employed a prospective, observational, cross-sectional design to investigate the frequency of pain (i.e. pain intensity and disability), anxiety (i.e. posttraumatic stress disorder symptoms, general anxiety symptoms) and depressive symptoms following traumatic musculoskeletal injury during hospitalization (within 14 days following injury). The standardized timeframe used to prospectively gather information allows for an in-depth evaluation of patients self-reporting of pain and symptoms of depression and anxiety directly following their injury. It is important to use a prospective design, as opposed to a retrospective design, to reduce the likelihood of forgetting and having errors in reporting of emotions and cognitions about the measured outcomes. This was especially important in this study population because, current practice at SHSC and SMH was to treat pain with opioid and other pain medications in-hospital. Such opioids are known to reduce memory consolidation. Therefore, through enrolling participants in a prospective, observational study collecting information soon after injury, the amount of participant recollection error was minimized and accuracy for recent events was maximized. Furthermore, the information collected on symptoms of anxiety and depression analyzed in this study are not commonly measured in clinical practice and thus would not be found in a patient’s chart, thereby eliminating the option of conducting a retrospective chart review. To reduce recollection issues, maximize accuracy in the data collected, ensure completeness of data collected, and to maintain a consistent timeframe from which the information was collected a prospective, observational cross-sectional design was felt to be the most appropriate design.
4.2 Participant Selection

4.2.1 Inclusion Criteria

Eligible participants for this study included: adults 18 years or older; who had experienced a TMsI (i.e. polytrauma, abdominal, chest, extremity, pelvic, or soft tissue trauma); who underwent the ATLS protocol on admission; and had a length of hospital stay ≥2 days.

4.2.2 Exclusion Criteria

Participants were excluded from study participation if they met one or more of the following criteria: had a Glasgow Coma Scale (GCS) motor ≤ 5 on admission or have documented acquired brain injury; had isolated fractures from standing (e.g., hip fracture); had spinal cord damage, burns, or self-injury; or who were not fluent in English (i.e., written and oral). All participants needed to have the capacity to consent and ability to read and understand the self-report questionnaires in order to fill them out.

4.2.3 Inclusion/Exclusion Rationale

This study included patients that were most likely to have reasonable recovery from their physical injuries and to go on to resume their life pre-TMsI. This excluded, for example, patients with severe acquired brain injury that, despite extensive neurorehabilitation, could not return to work and required continual care for the remainder of their lives. The reason for this patient sample was to best capture patients who could benefit from interventions aimed at decreasing the chances of succumbing to negative outcomes related to pain, including; anxiety, depression, and PTSD. Furthermore, although Toronto, Ontario is a multicultural region, the primary language used in the study hospital is English. The validated measures included in the questionnaire were written in English and not translated into other languages and, therefore, the sample excluded patients who did not speak or read English fluently.
4.3 Sample Size

Sample size was estimated based on data for the logistic regression analysis detailed in the data analysis section and was powered at .80. Using a data to parameter ratio of 10:1, a power = 0.8, and 10 factors (e.g., pre-existing co-morbid diagnoses, pre-morbid anxiety or depression, socioeconomic status, mechanism of injury, injury severity, injury location, analgesic consumption, multimodal pain medications, number of surgical intervention, length of stay in hospital, general depression, general anxiety, anxiety sensitivity, pain catastrophization, posttraumatic stress symptoms, self-efficacy) a sample size of 200 participants was estimated for data analysis.

4.4 Recruitment Rate

Adjustments to the sample size of patients approached for consent were made based on current recruitment rates at the Level 1 trauma centres in this study (SHSC and SMH). SHSC and SMH had other ongoing studies with target populations similar to this study. Therefore, other studies limited the sample of patients that could have been approached for two primary reasons: (1) other studies may have exclusion criteria that preclude patients from participating in more than one study; and (2) to avoid overburdening patients with research studies, some patients could not be approached. However, this study was observational and conflicts with the other ongoing studies were minimized, thereby, it was estimated that two-thirds (2/3) of eligible patients could have been approached for consent to participate in this study and that approximately one-fifth (1/5) of patients would have refused to participate. Based on all of these factors the final sample of patients estimated to be approached for participation was 246 \[ (0.80 \times 0.67) \times 207 = 107 \].

Based on the Trauma Registry and Hospital Trauma Statistics the two sites involved in recruitment, SHSC and SMH previously had approximately 450 trauma patients per year (6-10 patients per week) that had been treated for major orthopedic trauma and fit inclusion criteria for this study. We estimated that 3-6 patients could be recruited per week across the two centres for 14 months.
4.5 Sampling Procedure

Participants for this study were recruited from SHSC and SMH. These hospitals are classified as Level 1 trauma centres with each trauma patient being assessed and treated by the interdisciplinary trauma team (i.e. trauma team leader, anesthesia, orthopedic and general surgery, and emergency room nurses) following ATLS guidelines. The majority of trauma patients were transported via land or air ambulance to a trauma centre that has the medical resources and expertise to treat the patient – this included specialized orthopedic surgical consultation. Each patient who entered either SHSC or SMH in this way was screened for eligibility.

Eligibility for participation in this study was first investigated through screening hospital trauma admission lists. These lists provide medical record numbers (MRNs) for each admitted patient and the reason for admission. The MRN corresponds with an online database of medical information and can be used to further investigate patient injuries and plan of care (i.e. surgical versus conservative management). In conjunction with the student researcher, staff research personnel at each institution conducted this first stage of screening. Special permission was granted for the research student to view these lists because the admission lists were selectively provided only to particular REB approved research offices. Therefore, patients were identified for potential inclusion by these offices and the MRNs were passed onto the study specific research personnel. The second stage of screening was conducted by using patient MRNs to access information in the Electronic Personal Record (EPR) about exclusionary injuries sustained (i.e. burns, acquired brain and spinal cord injuries). The third stage of screening was conducted through the assessment of patient charts for other exclusion criteria, such as previous cognitive impairment (e.g., dementia), and mechanical fall from standing (e.g., elderly persons living in a long-term care facility who fell from standing position). This third stage occurred once patients arrived on the hospital wards (i.e. not in the critical care units).

As part of REB regulations, all research staff had to be introduced to potential participants by someone in their primary circle of care (e.g., nurse, physiotherapist). Therefore the final stage of assessment for eligibility and potentially consent were conducted during the first interaction between the study personnel and the potentially eligible participant. At this time
the patient’s level of understanding of the English language was assessed. The reason this stage occurred last was because information pertaining to language capacity may not have been documented in the patient chart. Therefore, the study personnel were trained to identify reading difficulties through asking patients if they felt comfortable answering questions by themselves and then if consented to participate, participants answered the questions. The study personnel then checked the answered questions for accuracy and any response biases, such as only positively or negatively answered questions.

Further due to patient acuity and injury severity, potential participants were only approached for inclusion once they were on the wards (i.e. not during critical care unit stay). Patients were recruited while they were in hospital and completed their initial assessment while in-hospital within 14 days of their injury.

To increase consistency and reliability between each introduction of research personnel to potential participants, unit staff was provided with introductory information about the study to inform potentially eligible participants under their care (Appendix B).

Once the research student was introduced to the potential participant, the research student would proceed to determine eligibility, as described previously, and consented the patient to participate. The research student performing this task followed the script found in Appendix C to provide all potential participants with the same information on the study. If the potential participant consented to participate, they signed the consent form (Appendix D) indicating a record of their agreeing to participate. As with all studies, consent is an ongoing process and the research student verified with the participant if they had further questions or concerns following the completion of the questionnaire.

4.6 Data Collection Procedures

4.6.1 Chart Review

The charts of patients who consented to participate were reviewed to obtain information on injury characteristics, surgical interventions, length of hospital stay, any medical complications with injuries, and pain interventions (Appendix E). As the ISS requires specialized
training to calculate, this information was separately obtained from the Trauma Registry Coordinator at SHSC (or SMH) who inputs all ISSs for every trauma patient seen at SHSC (or SMH) to the Ontario Trauma Registry.

4.6.2 Assessment

Demographic information was collected at the time of the initial in-hospital assessment and included date of birth, gender, race, annual income, education, existing medical conditions prior to injury, perceived health status prior to injury, frequency of alcohol or recreational drug consumption, presence of past or current anxiety or depression diagnoses, and disposition (medications prescribed, rehabilitation; Appendix F). An additional clinical variable hypothesized to be involved at the disease-related stressors level of this model was Body Mass Index (BMI). However, to the researchers knowledge there are no prospective longitudinal studies specifically including BMI in analysis and thus for the purposes of this thesis and model, BMI was categorized under general pre-TMsI health.

The main variables assessed in this project were presence of acute pain, depression, anxiety, and PTSS, as well as overall quality of life functioning. These outcomes were measured with the following validated measures (Appendix G). Generally psychological measures do not have natural dichotomies or cut off scores, rather they have points on the measure’s scale that maximize the sensitivity and specificity to positively identify the possibility of the presence of a disorder. Sensitivity refers to the proportion of participants with the disorder who are correctly identified by the test, whereas specificity is defined as the proportion of participants without the disorder who are correctly identified. Some of the measures described below have an experimentally determined cut off score identifying caseness or presence of a particular disorder’s signs and symptoms. However, these measures cannot confirm a diagnosis because formal diagnosis of a psychological disorder requires a full clinical assessment, which is time consuming and requires a registered psychologist or psychiatrist to conduct the assessment. Therefore, for the purposes of this thesis, caseness was explored.

1. Acute Pain

*Brief Pain Inventory – Short Form (BPI-SF)* is one of the most widely used scales for measuring pain in patients with a variety of pain disorders\(^\text{125}\). The BPI-SF is a 16-item, self-report
questionnaire that consists of a body diagram that patients use to mark the location of their pain, a question about pain treatments and medications, and one concerning the percentage of relief obtained. The BPI-SF uses an 11-point NRS (0-10) with end points labeled “no pain” and “pain as bad as you can imagine” to measure the intensity/severity of the “worst”, “least”, “average” and present (“now”) pain. Another 0-10 NRS (with end points labeled “does not interfere” and “completely interferes”) is used to measure the extent to which the pain interferes with seven daily activities, including general activity, mood, walking ability, work, relations with other people, sleep, and enjoyment of life. The BPI-SF has been well validated and widely used for patients while in-hospital as well as in the community. As pain is a common consequence of TMsI and the BPI-SF NRS scales have been used in the literature, it was, therefore, a good fit for the measurement of pain intensity and disability in patients following TMsI. However, there are specific questions in the BPI-SF that pertain to pain related disability (e.g., walking ability, general activity, and daily activities) and were thought to not be generalizable for in-hospital patients due to the extent of their injuries. For example, it was hypothesized that participants who injured their legs resulting in surgical intervention would not have been able to determine whether their inability to do general activity was because of any pain they were experiencing or because they were unable to walk immediately following surgery. Therefore, this study focused on the BPI-SF pain intensity subscales during acute care and explored the feasibility of the pain disability factor among these patients.

Self-report- Leeds Assessment of Neuropathic Symptoms and Signs (sLANSS) is a 7-item self-report measure designed to discriminate NeP from nociceptive pain. The sLANSS takes 5-10 minutes to complete. The sLANSS uses a body map to identify the location of pain and an 11-point numeric rating scale to rate ‘how bad their pain has been in the last week’. The body map and 11-point scale are referenced for the remaining seven yes/no questions that are used to dichotomize NeP from nociceptive pain. A score of 12 or more is considered to be neuropathic pain with a maximum score of 24. This cut off score has been shown to have a positive predictive value for NeP of 76% [95% confidence interval (CI) 66.8% to 84.2%] with a sensitivity of 74% (65.2% to 82.7%) and specificity of 76% (67.5% to 82.7%), when compared with classification by a pain specialist. The sLANSS has been validated for community settings, however, the sensitivity and specificity was lower than in clinical assessment. The sLANSS also has high internal consistency when completed without a specialist (α = .76) and
with a specialist (α = .81\(^{130}\)). Clinically it is important to understand the type of pain (i.e. neuropathic or nociceptive) that people have in response to TMsI to appropriately treat and manage their pain. Participants in this study who scored 12 or more on the sLANSS were given a label of ‘yes’ for symptoms of NeP and those scoring 11 or less were given a label of ‘no’ for the absence of NeP symptoms.

**Pain Self-Efficacy Questionnaire (PSEQ\(^{132}\))** is a 10-item Likert-type questionnaire, designed specifically for chronic pain, where patients are asked to rate their confidence to complete 10 activities of everyday life despite pain. The PSEQ takes five minutes to administer. The results obtained from a number of studies reveal that the PSEQ has strong psychometric properties\(^{132,133}\), including excellent internal consistency, Cronbach’s α coefficient is 0.92, good test-retest reliability over time, Pearson correlation .073, and validity\(^{132}\). The PSEQ was designed for chronic pain patients and has been predominantly tested in clinical populations with musculoskeletal diseases\(^{133}\), but more recently it has been used in acute care following TMsI\(^{134}\). Self-efficacy plays an important role in pain disability for many chronic pain conditions\(^{56}\); however, it is not clear what its role is in pain disability following TMsI and thus was included in this study.

**Pain Catastrophizing Scale (PCS).** Catastrophizing or catastrophic thinking refers to “an exaggerated negative ‘mental set’ brought to bear during actual or anticipated pain experience”\(^{135}\). The PCS\(^{136}\) was designed to evaluate catastrophic thinking in relation to pain through a 13 item self-report inventory and takes five minutes to complete. Participants completing this inventory are asked to reflect on past painful experiences and to indicate the degree to which they experience each of 13 thoughts or feelings when experiencing pain. Each item is rated on a 5-point rating scale with the end points 0 = not at all and 4 = all the time. The PCS yields a total score and three subscale scores assessing rumination (i.e., excessive focus on pain sensations), magnification (i.e. exaggerating the threat value of pain sensations) and helplessness (i.e. perceiving oneself as unable to cope with pain symptoms). The PCS has been shown to have high internal consistency (coefficient alphas: total PCS = .87, rumination = .87, magnification = .66, and helplessness = .78)\(^{136}\). The PCS has also been shown to predict pain intensity in patients with acute postoperative pain\(^{137}\) and pain related disability in chronic neuropathic pain patients even after controlling for pain severity\(^{138}\). The PCS was determined to be the best measure to
isolate pain catastrophizing in individuals who sustained a TMsI as well as to evaluate the contribution it has on psychological distress while in-hospital.

2. Depressive Symptomology

*The Hospital Anxiety and Depression Scale (HADS)*, \(^{139}\) is a widely used self-rating scale for measuring the symptoms of anxiety and depression among medical inpatients, outpatients and in the general population \(^{140}\). The HADS is a 14-item questionnaire that measures symptoms of anxiety (seven items) and depression (seven items) that takes between two and five minutes to fill out \(^{141}\). For each item, the participant is asked to select from among 4 possible choices (scored from 0 to 3) and to choose the one that best describes how they have been feeling over the past week. The HADS yields an anxiety (HADS-A) and a depression (HADS-D) subscale score. In general, the psychometric properties of the HADS are excellent. It has been administered in more than 700 studies to more than 35,000 individuals. Internal consistency for the anxiety and depression subscales show Chronbach alphas of between 0.80-0.93 for the anxiety subscale and between 0.81 and 0.90 for the depression subscale \(^{140,142}\). Concurrent validity of the HADS has been found to be a very good as measured by correlation coefficients of between 0.62 and 0.73 for the HADS-D with various well-validated depression scales (e.g., Beck Depression Inventory, SCL-90 Depression subscale) and correlation coefficients of between 0.49 and 0.81 for the HADS-A with various well-validated anxiety measures (e.g., Spielberger State-Trait Anxiety Inventory, SCL-90 Anxiety subscale) \(^{140,142}\). The HADS has demonstrated sensitivity to changes in symptoms of anxiety and depression associated with disease progression and response to therapeutic interventions in-hospital \(^{142}\). Cut off scores for “caseness” are available for both the depression and anxiety subscales. Identifying general symptoms of anxiety and depression following TMsI were needed as part of this study’s primary outcome, which was to determine the incidence of symptoms of anxiety and depression while in-hospital.

3. Anxiety and Pain Related Anxiety

*Pain Anxiety Symptoms Scale-Short form (PASS-SF)*; McCracken & Dhingra, 2002) is a 20-item measure that assesses four components of fear and anxiety responses to pain (i.e. cognitive, fear, escape/avoidance, physiological that takes five to 10 minutes to complete \(^{143}\). Analysis of the original 40-item PASS revealed four subscales, labeled “Cognitive”, “Escape and Avoidance”,
“Fear”, and “Physiological Anxiety”. McCracken and Dhingra\textsuperscript{143} found that these subscales retained good to excellent psychometric properties in the shortened version of the scale and concluded that it is a reliable and valid scale. Correlation coefficients for matching subscales between the original 40-item PASS and the 20-item short form for the subscales and total scores ranged from 0.93 to 0.97 showed excellent convergent validity. Internal consistency reliability estimates (Chronbach’s alpha) for the subscales and the total scores ranged from (0.75 to 0.91). Shortening of the questionnaire to 20 items seemed to have no effect on the scale’s validity as evidenced by very similar correlation coefficients for the long and short forms for pain, depression and pain disability. The identification of constructs directly linked to pain (i.e. cognitive, escape and avoidance, fear, and anxiety) were evaluated with the use of the PASS-SF. These factors were thought to contribute to the development of chronic pain following TMsI and thus they needed to be evaluated while in-hospital to determine their contribution to acute pain.

Anxiety Sensitivity Index -3 (ASI-3 \textsuperscript{144}) is an 18-item questionnaire that measures anxiety sensitivity or the fear of arousal-related sensations which come from the fear that these sensations will have adverse consequences\textsuperscript{145}. Participants rate their agreement with statements on a 5-point Likert scale (i.e. 0 meaning “very little” to 4 meaning “very much”). The ASI-3 consists of three subscales specifically related to fear of consequences from physical, cognitive, and social sensations. These subscales have good construct and factorial validity\textsuperscript{144,146}. The full ASI-3 has good internal consistency, Cronbach’s alpha .93, and with Cronbach’s alpha for each subscale as .80, .88, and 90\textsuperscript{146}. Overall, the ASI-3 has good reliability and validity\textsuperscript{144,146}. The ASI-3 was the ideal measure used to assess the role that anxiety sensitivity has as a vulnerability factor in acute pain and anxiety following TMsI while in-hospital.

4. Posttraumatic Stress Disorder Symptoms

Posttraumatic Stress Disorder Checklist – Civilian Version (PCL-C): Recent experimental evidence and theory support a link between PTSD and the experience of pain\textsuperscript{147}. The Posttraumatic Stress Disorder Checklist – Civilian Version (PCL-C) is a 17-item self-report measure\textsuperscript{148}. Items are based on the DSM-IV symptoms for Posttraumatic Stress Disorder. Participants completing PCL-C are asked to rate, on a six-point scale ranging from 1 = not at all to 5 = extremely, the extent to which they have been affected by each symptom over the past month. The PCL-C yields a total score and three subscale scores measuring symptoms of (1) re-
experiencing, (2) avoidance/numbing, and (3) hyper arousal. There is not a universal cut off score for distinguishing between patients without PTSD and those with PTSD. This is due to the variability in the populations that this tool is used in; for example, studies with veterans may use a cut off score of 50, whereas studies with people who are exposed to fewer stressful life experiences may have a cut off score as low as 30. The US Department of Veterans Affairs National Center for PTSD recommends a cut off score of 44 for people in specialized medical clinics, for example, in a traumatic brain injury clinic. To ensure that severe symptoms of PTSD were not missed among participants in this study, a conservative cut off score of 44 was used. The PCL-C has good test-retest reliability and validity. The PCL-C has been used in various hospitalized trauma patients with established reliability and validity and was therefore a good outcome measure for assessing acute symptoms of PTSD in the current study.

5. Quality of Life and General Functioning

*SF-8 Health Survey (SF-8)* is a questionnaire used to determine the health-related quality-of-life (HRQoL) on eight main domains, including: mental health, role-emotional, social functioning, vitality, general health, bodily pain, and role-physical, physical functioning. The SF-8, derived from the SF-36v2, is eight questions where patients rate each of the eight domains on 5- and 6-point Likert scales ranging from not at all to extremely, and none to severe. The SF-36v2 and the SF-8 are correlated well and the SF-8 has strong test-retest reliability and validity. The SF-8 has also been shown to be a valuable tool in assessing pain and physical function post-operatively. The SF-8 takes one to two minutes to complete. An overall quality of life measure was needed for assessing general functioning in participants in this study and has been widely used in various clinical populations.

4.6.3 Questionnaire Administration

During hospitalization (i.e. up to 14 days following TMIs) participants were asked to complete a questionnaire (Appendix G). The questionnaire was completed via pen-and-paper or by verbal interview. It was anticipated that there would be a large amount of variance in the time for questionnaire completion. The reason for this variation was because (1) participants in this study were recovering from TMIs and as a result management of their acute pain was often accomplished with the use of analgesic pain medication and (2) many participants had injuries that precluded rapid and dexterous movements as well as the ability to sit up for long periods of
time. To overcome some of the difficulties, participants were allowed adequate time to work at their own pace, and to increase consistency between participants, each participant was given 24-hours with the questionnaire unless they specified finishing at an earlier or later time.

4.7 Ethical Considerations

Ethics approval for this study granted through SHSC, SMH, and UofT REBs prior to study commencement (Appendix A).

This study had four main areas for ethical consideration including, (1) patient burden, (2) participant confidentiality, (3) cost of participating, and (4) psychological distress from answering questions in the questionnaire.

Academic teaching hospitals often have many clinical research studies (interventional and non-interventional studies) that are concurrently conducted and quite often target certain patient populations, such as trauma patients. Thus, in the case of this study, trauma patients meeting inclusion criteria for this study may have been eligible for others at the same time. Patient care always came first, therefore, to avoid burdening patients with multiple research personnel attempting to consent each patient, the research student (BR) for this study communicated with the other hospital research offices in each institution in order to coordinate when eligible patients were approached. Further, if patients consented to more than one study while they were in-hospital, the research student (BR) worked with other studies to prevent any confusion that patients may have had concerning their roles and responsibilities for the present study as compared to the other studies (e.g., when patients or their family members were confused BR would remind them of the details in the present study and, if that did not clear up the confusion, BR requested a member from the other studies to speak with them again).

In order to maintain participant confidentiality a number of steps were taken. Prior to the start of participant recruitment, the research student had privacy and confidentiality training on gaining participant consent, and on the building and maintaining of confidential study databases. All identifiable information (e.g., master list) was stored on a password protected master list linking the participant information with the study identification number. This list could not be inappropriately released and was kept in each research institute within a secured and encrypted computer within a locked office to which only research personnel had access. Additionally, all
questionnaires were designed so that participants need not write their name or any other identifying information, instead each consenting participant received a random study number. The research student helped participants understand that they should not write their name on the documents because they are given a study number. Furthermore, a data sharing agreement was formulated and utilized so that the datasets from the two academic hospitals involved in this study could be amalgamated for full analysis.

The final point of ethical consideration for this study was concerning the sensitive nature of the questions in the questionnaire. Some participants may have found these questions difficult to answer causing psychological discomfort. This discomfort could have come from the circumstances that caused their inclusion in this study (e.g., the trauma) and recognition of any psychological distress the patients already felt from their traumatic injury. If either the patient or a person in their primary circle of care revealed that the patient was in distress, or had suicidal ideation, while answering the questions from this study, then the research student would discuss whether the participants wanted to withdraw from the study and contacted the project principal investigator (Dr. Colin McCartney) for clinical guidance on the need for intervention, if any (e.g., contacting the attending physician). Therefore, to address these potential issues of psychological distress, the research student was trained to identify such symptoms within the questionnaires and within telephone conversations. While the validated measures in this study aid in the overall psychological assessment of patients, the decision for further investigation was managed by clinical judgment by a qualified psychiatrist if this was perceived as needed.

4.8 Statistical Analysis

Statistical analysis was primarily conducted using SPSS 21.0. SAS v9.3 was used to perform the logistic regression portion of the analysis.

4.8.1 Descriptive Statistics

Differences between the sites (SHSC and SMH) were evaluated through bivariate analyses. Specifically, independent samples t-tests were used to compare variables (age, socioeconomic status, injury severity, length of stay in hospital, number of surgeries) and chi-
squared statistics were used for categorical data (sex, pre-morbid psychological diagnoses, pre-morbid medical conditions).

Data for demographic variables were summarized using counts, percentages, measures of central tendency (average, median, and mode), and measure of sample variation, for example, standard deviation and range. Parametric statistics (average, standard deviation) were used for interval and ratio data, while non-parametric statistics (median, range) were used for nominal and ordinal data. All variables were examined using tests of skew and kurtosis, as well as through scatter plots to identify outliers.

Qualitative content analysis was employed for measures that included items requiring participant to describe something. For example, the PCL-C asked participants to describe the stressful life event that they were referring to while answering the questionnaire. These descriptions were summarized into categories as dictated by the participant’s text.

4.8.2 Site Differences

Independent t-tests were used to analyze any differences between SHSC and SMH on participant characteristics (age, socioeconomic status, injury severity score) and medical interventions (injury severity score, number of surgical procedures, number of injured regions, oral morphine given, and length of stay in hospital).

4.8.3 Logistic Regression

To evaluate the relationships between variables, a logistic regression analysis was employed. This allowed the researcher to examine the strength of multiple predictor variables on the likelihood of a patient having symptoms of posttraumatic stress while in hospital. The predictor variables included can be see in Table 5 along with methods for categorizing variables in the logistic regression model.

Each predictor variable was run in a bivariate regression analysis with posttraumatic stress as the binomial outcome variable. Due to the large number of variables included in this model, variance inflation factors (VIF) were assessed to determine collinearity between the independent variables. VIFs specifically assess how much the variance of an estimated regression coefficient increases if the independent variables are correlated. For the purposes of this thesis, a VIF of above five was considered indicative of multicollinearity, and collinear variables were examined to determine inclusion in the model. If multicollinearity was found, the
variable with the most literature supporting its contribution to overall model and more specifically to posttraumatic stress was therefore included. All the significant variables were then put into the model and non-significant predictors were excluded. The model was evaluated based on (1) its overall significance tests against the null hypothesis using the chi square statistic ($H_0$: all of the predictor variables in the logistic regression take the value of zero), (2) significance of each predictor variable (confidence intervals, p-value), (3) descriptive and inferential goodness-of-fit as measured by the Akaike Information Criterion (AIC), and, finally, (4) predicted probabilities. If a predictor variable failed to remain significant in the model, the variable was removed and the model was tested again. AICs were used to compare models, where a lower number indicated better model fit.
Table 5. Predictive variables for in-hospital posttraumatic stress following traumatic musculoskeletal injury.

<table>
<thead>
<tr>
<th>Predictive Variables</th>
<th>Variable Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-morbid conditions</td>
<td>No = 0; Yes = 1</td>
</tr>
<tr>
<td>Pre-existing anxiety/depression</td>
<td>Never = 0; Monthly or less = 1; 2 – 4 times a month = 2; 2 – 3 times a week = 3; 4 or more times a week = 4</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>Average of income and educational status with scores ranging from 0 to 5: Income scores range on a scale of: 0 = &lt;$24,999; 1 = $25,000 – 44,999; 2 = $45,000 – 64,999; 3 = $65,000 – 84,999; 4 = $85,000 – 104,999; 5 = &gt;$105,000. Education scores range on a scale of: 0 = None; 1 = Elementary School; 2 = High school; 3 = College/ University Degree; 4 = Medical Degree/ Doctorate; 5 = Other</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>Male = 0, Female = 1</td>
</tr>
<tr>
<td>Injury severity</td>
<td>Injury Severity Score</td>
</tr>
<tr>
<td>Number of injured regions</td>
<td>Each injured body region (axial/ pelvis, chest/ abdomen, head/ face, upper extremity, lower extremity) was given a value of 1 adding up to a possible total of 5</td>
</tr>
<tr>
<td>Oral morphine analgesic consumption</td>
<td>mg</td>
</tr>
<tr>
<td>Multimodal pain management</td>
<td>Each class of pain medication received a value of 1, scores ranged between 0 and 5 (0 = no pain medications)</td>
</tr>
<tr>
<td>Number of surgical interventions</td>
<td>Whole numbers</td>
</tr>
<tr>
<td>Measure</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Length of stay in hospital</td>
<td>Days</td>
</tr>
<tr>
<td>Neuropathic pain</td>
<td>sLANSS continuous measure</td>
</tr>
<tr>
<td>Pain Intensity</td>
<td>BPI Pain Intensity subscale (average score 0 – 10)</td>
</tr>
<tr>
<td>General anxiety</td>
<td>HADS Anxiety Subscale (0 – 21)</td>
</tr>
<tr>
<td>General depression</td>
<td>HADS Depression Subscale (0 – 21)</td>
</tr>
<tr>
<td>Anxiety sensitivity</td>
<td>ASI3 Total Score (0 – 72)</td>
</tr>
<tr>
<td>Pain catastrophizing</td>
<td>PCS Total Score (0 – 52)</td>
</tr>
<tr>
<td>Pain self-efficacy</td>
<td>PSEQ Total Score (0 – 60)</td>
</tr>
<tr>
<td>Pain Anxiety</td>
<td>PASS – 20 Total Score (20 – 100)</td>
</tr>
</tbody>
</table>

sLANSS, Self-report- Leeds Assessment of Neuropathic Symptoms and Signs; BPI, Brief Pain Inventory; HADS, Hospital Anxiety and Depression Scale; ASI, Anxiety Sensitivity Index-3; PCS, Pain Catastrophizing Scale; PSEQ, Pain Self-Efficacy Questionnaire; PASS-20, Pain Anxiety Symptoms Scale-Short form
Chapter 5

Results
5.1 Study Recruitment and Questionnaire Completion

Recruitment for this study was conducted between May 2012 and July 2013. A total of 2360 patients from Sunnybrook Health Sciences (SHSC) and St. Michael’s Hospital (SMH) were screened for inclusion in this study. As seen in Figure 4, the main reasons for exclusion were due to: non-trauma related injury (e.g., pathological fracture); the traumatic injuries resulting in acquired brain injury; mechanical falls from standing; and a patient’s stay being less than two days in hospital. Three hundred forty eight patients were eligible for inclusion and 244 (70.1%) patients consented to participate. As described previously, each patient was approached through a health care professional in the patient’s primary circle of care. At that stage 104 patients refused to participate are documented in Table 6. Of the 244 consenting participants, 205 completed the in-hospital questionnaire. The remaining 39 participants did not complete the questionnaire for reasons related to discharge, for example, being repatriated to a rehabilitation facility or hospital closer to their home, or feeling overwhelmed, or stated the questionnaire package was too long or confusing. The majority of those that did not complete the questionnaire once consented did not provide a reason.
Figure 4. CONSORT Flow of Participants.

Total Screened  
\( n=2617 \)

- Non-trauma \( n=729 \)
- ABI \( n=436 \)
- <2 days LOS \( n=318 \)
- Fall from standing \( n=293 \)
- <18 years of age \( n=63 \)
- Spinal cord injury \( n=58 \)
- Self-inflicted \( n=42 \)
- Deceased/ palliative \( n=59 \)
- English not first language \( n=56 \)
- Missed \( n=84 \)
- Study conflict \( n=31 \)
- Previous cognitive impairment \( n=31 \)
- Burn \( n=6 \)
- GCS motor <6 \( n=5 \)
- Other \( n=58 \)

Total Eligible for Approach  
\( n=348 \)

Refused at nurse \( n=44 \)
- Discharge related reasons \( n=8 \)
- None provided \( n=16 \)
- Overwhelmed \( n=14 \)
- Privacy Concerns \( n=4 \)
- Study Conflict \( n=7 \)
- Other \( n=11 \)

Total Consented  
\( n=244 \)

Discharge Related Reasons \( n=15 \)
- Too long and confusing \( n=1 \)
- Overwhelmed \( n=6 \)
- None provided \( n=17 \)

Total Completed Initial Assessment  
\( n=205 \)
Table 6. Reasons for refusal to participate.

<table>
<thead>
<tr>
<th>Reasons for refusal to participate</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refused at person in primary circle of care</td>
<td>44</td>
</tr>
<tr>
<td>Discharge Related Reasons (e.g., leaving sooner than anticipated, needing time to prepare for rehabilitation, repatriated quickly)</td>
<td>8</td>
</tr>
<tr>
<td>Not available in 3 months</td>
<td>0</td>
</tr>
<tr>
<td>None Provided</td>
<td>16</td>
</tr>
<tr>
<td>Privacy Concerns</td>
<td>4</td>
</tr>
<tr>
<td>Study Conflict</td>
<td>7</td>
</tr>
<tr>
<td>Overwhelmed with repercussions from their trauma (e.g., death of a family member in trauma)</td>
<td>14</td>
</tr>
<tr>
<td>Other: Not interested/ unwilling/ angry with hospital/ did not think they had anything to contribute/ anticipated full recovery/ in too much pain</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reasons for withdrawal or not completing the questionnaire</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge Related Reasons</td>
<td>13</td>
</tr>
<tr>
<td>Patient wanted to go home</td>
<td>2</td>
</tr>
<tr>
<td>Too long and confusing</td>
<td>1</td>
</tr>
<tr>
<td>Overwhelmed</td>
<td>7</td>
</tr>
<tr>
<td>None Provided/ Other (took a very long time with forms, declined after fiancé said no, patient wanted to go home, in too much pain, went back to critical care for a month)</td>
<td>16</td>
</tr>
</tbody>
</table>
5.2 Site Differences

There were no significant differences between the two sites with respect to participants’ sex, age, socioeconomic status, injury severity score, number of surgical procedures, number of injured regions, oral morphine consumption, nor length of stay in hospital. Therefore, the two samples were combined and analyzed together.

5.3 Questionnaire Completion

Participants consented to participate in this study on average 7.14 days (SD = 7.03, Range 2 - 52) following their traumatic injury. Participants took on average 1.42 days (SD = .91; Range 1-6 days) to complete the survey and reported that it took approximately 40 minutes to complete, however, many participants revealed that they had to complete it in small segments due to unpredictable events, such as needing to participate in a physiotherapy session, visitor arrival, transfers to other areas in the hospital for diagnostic testing (e.g., x-ray), or needing breaks due to feelings of physical discomfort from their injuries.

5.4 Participant Characteristics

The mean age of participants was 43.02 (SD = 17.90) with ages ranging from 18 to 19 years and 68% (n = 139) were male. Patients were primarily Caucasian (32.2%), African-Canadians, or Asians (Table 7). Prior to their traumatic injury, 21.4% (n = 41) reported having had a diagnosis of anxiety and/or depression, and 7.29% (n = 14) had chronic pain. Overall participants rated their pre-injury health status as “Good” (Median = 3, Mode = 4) on a scale five-point scale with 0 indicating “Poor” and 4 indicating “Excellent.” Participants reported having an alcoholic beverage two to four times a month on average (median = 2). Most participants did not report using recreational drugs (median = 0). See Table 5 for variable definition.
Table 7. Participant Demographics.

<table>
<thead>
<tr>
<th></th>
<th>n (%)</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Male)</td>
<td>139 (67.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>145 (32.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-Black</td>
<td>16 (3.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>19 (4.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>6 (1.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native</td>
<td>2 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td>43.02 (17.90)</td>
<td>18 - 89</td>
</tr>
<tr>
<td>(years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Socioeconomic Status</strong></td>
<td></td>
<td>2.2 (.99)</td>
<td>0.5 - 5</td>
</tr>
<tr>
<td>(average of income and education)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Medical History</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety and/or Depression</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(previous of diagnosis)</td>
<td>41 (21.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic Pain</td>
<td>14 (7.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alcohol Consumption</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(average per week/month)</td>
<td></td>
<td>2 (3)</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Recreational</td>
<td></td>
<td>0 (0)</td>
<td>0 - 4</td>
</tr>
<tr>
<td><strong>Drug Consumption</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(average per week/month)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Health</td>
<td>3 (4)</td>
<td>0 - 4</td>
<td></td>
</tr>
</tbody>
</table>

M, mean; SD, Standard Deviation
5.5 Injury Characteristics

As seen in Figure 5, there were a variety of mechanisms of injury for these participants including vehicle collisions in 28% (MVC), industrial accidents, motorcycle collisions, pedestrian versus motorized vehicles, falls, assaults, such as gunshot wounds and stabbings, bicycle accidents, and recreational accidents, such as all-terrain vehicle accidents.

The mean injury severity score was 16.57 (SD = 8.97, range 0 – 45). Participants injured on average 2.02 (SD = 0.96, range 1-5) body areas. The distribution of injured body regions is depicted in Figure 6 and includes multiple or isolated injuries to the chest/abdomen, head/face, axial/pelvic region, upper extremities, and/or lower extremities. As such, surgical interventions included, for example, irrigation and debridement for open fractures and wounds, external or internal fixation for displaced fractures, emergency laparotomies to repair liver or spleen lacerations or splenectomy, and chest tube insertions for hemopneumothoraces. Participants had on average 1.18 (SD = 1.32) operations and stayed in hospital an average of 13.16 (SD = 50.20) days (see Table 8). One participant stayed in hospital for 131 days due to medical complications related to prior comorbid diagnoses including end stage renal disease and a need for hemodialysis.
Figure 5. Mechanisms of Injury for participants.

- Motor Vehicle Collision (n=57)
- Motorcycle (n=22)
- Pedestrian (n=22)
- Fall (n=28)
- Industrial (n=21)
- Bicycle (n=10)
- Recreational (n=10)
- Assault (n=24)
- Recreational Motor Vehicle Collision (n=11)

Figure 6. Injured body regions.

<table>
<thead>
<tr>
<th>Body Region</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/ Face</td>
<td>42</td>
</tr>
<tr>
<td>Chest/ Abdomen</td>
<td>123</td>
</tr>
<tr>
<td>Axial/ Spine</td>
<td>105</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>66</td>
</tr>
<tr>
<td>Lower Extremity</td>
<td>85</td>
</tr>
</tbody>
</table>
Table 8. Trauma injury characteristics.

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISS</td>
<td>16.57 (8.97)</td>
<td>0 - 45</td>
</tr>
<tr>
<td>Number of Operations</td>
<td>1.18 (1.32)</td>
<td>0 - 9</td>
</tr>
<tr>
<td>LOS</td>
<td>13.16 (15.20)</td>
<td>2 - 131</td>
</tr>
</tbody>
</table>

ISS, Injury Severity Score; LOS, Length of Stay in Hospital

5.6 Pain Severity and Pain Characteristics

Participants reported an average pain intensity of 5.40 (SD = 1.86, Range 0-10) as measured by the BPI-SF Pain Severity Subscale. A large proportion of participants (n = 162, 80.20%) reported pain within the moderate to severe range (i.e. pain ratings equivalent to four or greater), however the distribution of pain intensity scores in this sample maintained a normal distribution as shown in Figure 7. Pain interference was reported as an average of 7.07 (SD = 2.33, Range 0 -10) on a scale of 0 (No interference) to 10 (Completed Interference). However, many participants reported that they were unable to discern whether the interference came from pain or being in hospital and the restrictions placed on their movements as prescribed by their physician.

Neuropathic pain affected 49.02% (n = 100) of all participants while in hospital with an average neuropathic pain score of 11.28 (SD = 7.11, Range 0 – 24) as measured by the sLANSS. Of those with moderate to severe pain (n = 162), 88 participants (54.32%) also had neuropathic pain. In total, 43.56% of the total sample had neuropathic pain and pain intensity ratings of four or more.
5.7 Pain Management

Most participants were followed by the acute pain service (APS) at the time they completed the questionnaire (64.88%, n = 133) and the majority (78.05%, n = 160) were on a multimodal pain medication regimen, meaning that they were concurrently prescribed two or more classes of pain medications. Table 9 shows that 91% of patients were on opioid medications and 71% were on acetaminophen among other pain medications. NSAIDs used in this sample were primarily Celecoxib®, however, one participant had Ibuprofen, and one participant had Naproxen®.
Table 9. Daily analgesic consumption at the time that participants completed the study questionnaire.

<table>
<thead>
<tr>
<th>Drug</th>
<th>n (%)</th>
<th>M (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids (Morphine Oral Equivalent)</td>
<td>187 (91.2)</td>
<td>117.6 (141.0)</td>
<td>0 - 948</td>
</tr>
<tr>
<td>Gabapentin®</td>
<td>60 (29.3)</td>
<td>186.3 (376.5)</td>
<td>0 - 2700</td>
</tr>
<tr>
<td>Pregabalin®</td>
<td>6 (2.9)</td>
<td>4.39 (29.5)</td>
<td>0 - 300</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>147 (71.7)</td>
<td>1836.1 (1625.9)</td>
<td>0 - 6600</td>
</tr>
<tr>
<td>NSAID (Celecoxib®)</td>
<td>79 (38.5)</td>
<td>131.2 (194.7)</td>
<td>0 - 800</td>
</tr>
</tbody>
</table>

NSAID, Non-Steroidal Anti-Inflammatory Drug

A subgroup analysis was conducted to evaluate pain management among participants with a high score on the sLANSS indicative for symptoms of neuropathic pain and who had moderate to severe pain (n = 88). Sixty-five percent (n = 58) of these participants were followed by the APS and 38.64% (n = 34) were on a pain medication classified for neuropathic pain. Specifically, 35.23% (n = 31) were on Gabapentin® with an average daily dose of 716.7mg (SD = 527.5) and three participants were on Pregabalin® with an average daily dose of 166.7mg (SD = 125.8).

### 5.8 Symptoms of Anxiety and Anxiety Sensitivity

Fifty-three percent of participants (53.7%, n = 110) reported caseness symptoms of general anxiety. The mean score was 8.6 (SD = 4.8, Range 0 – 21). The mean score for anxiety sensitivity or fear of arousal-related sensations that are believed to cause adverse consequences was 19.5 (SD = 16.3). This indicates that there was a low score of anxiety sensitivity, however the range of scores were as low as zero and as high as 72. Participants reported on average a score of 52.2 (SD = 20.1, Range 0 – 100) on a measure of fearful and anxious responses to pain. Participants reported a mean of 6.4 (SD = 4.4, Range 0 – 17) pain catastrophizing symptoms.
5.9 Symptoms of Posttraumatic Stress

Posttraumatic stress symptoms were measured using the PCL-C and caseness cut off score was determined to be 44. One hundred, ninety-four participants (94.6%) answered this portion of the questionnaire and of those that answered, the mean score was 36.0 (SD = 15.8, Median = 32, Range 17 – 82). The distribution of responses was positively skewed (Figure 8). Fifty-three (27.3%) participants scored within caseness for symptoms of posttraumatic stress. Participants were provided with a space to describe what stressful life experiences they were referring to when answering the questionnaire and these qualitative responses were coded and summarized. The majority of participants (50.0%, n = 35) reported that they were referring to the trauma that caused their hospitalizations, for example, a “car accident”, “motorcycle accident”, “getting stabbed”, “getting robbed”, and “losing my girlfriend”. One participant reported that it was “losing [his] foot” that was stressful. Three participants reported that it was “being in the hospital” that was stressful for them, including one that said, “taking medications”. Two participants were worrying about the future, such as stressed “to be in a vehicle again” and “knowing that [he] is now disabled”. Nine participants cited stressful experiences unrelated to the current reason for hospitalization, for example, previous “military experience”, “wife passing away”, and “relationships with others”. The remaining participants chose not to answer this question.
5.10 Symptoms of Depression

Just less than half of the participants (48.3%, n = 99) report caseness symptoms of depression with a mean score of 7.4 (SD = 4.3, Range 0 – 18).

5.11 Associations with Symptoms of Posttraumatic Stress

The outcome variable for the logistic regression model was posttraumatic stress as measured by the PCL-C. Due to the positive skew on this variable, the PCL-C was originally split into two groups based on previous literature for cut off points which included $0 \leq 43$ (n =
The rates for symptoms of PTSD in this sample (27.3%) are consistent with previous studies investigating PTSD following traumatic injuries. However, the researcher split the variable into two groups based on the median (Median = 32) to provide a more equal distribution of the scores between groups. As the US Department of Veterans Affairs National Center for PTSD outlines in their instructions for using the PCL-C, a cut off score as low as 30 can be used in civilian populations. The distribution for the group with the fewer symptoms of posttraumatic stress as indicated by lower scores consisted of 92 patients with a mean score of 22.90 (SD = 4.40) and the distribution for the higher scoring group (n = 101) with more posttraumatic stress symptoms had a mean score of 47.83 (SD = 12.67). The distribution of this outcome indicates that the final logistic regression model can have 10 variables included.

The bivariate analysis (Table 10) revealed that pain intensity (p < .001), neuropathic pain (p < .001), general anxiety (p < .001), general depression (p < .001), anxiety sensitivity (p < .001), pain anxiety (p < .001), pain catastrophizing (p < .001), pain self-efficacy (p = .0009), and age (p = .031) were significantly associated with posttraumatic stress. A positive association was seen in all significant variables except, age and pain self-efficacy. These significant positive associations indicated that for every unit increase in the predictor variable there were increased odds for having posttraumatic stress symptoms. For example, for every unit increase in neuropathic pain, there was a 1.135 increase in the odds of being in the higher posttraumatic stress symptoms group. However, a significant negative association was found in age and in pain self-efficacy, such that each unit increase in age and in pain self-efficacy, the odds of having symptoms of posttraumatic stress decreased.
Table 10. Bivariate associations between predictor variables and posttraumatic stress symptoms. Outcome variable split at the median with symptoms of posttraumatic stress group represented as 1.

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>df</th>
<th>Wald Chi-Square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-existing anxiety/depression</td>
<td>1.911</td>
<td>0.921 - 3.966</td>
<td>1</td>
<td>3.027</td>
<td>0.0812</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>1.457</td>
<td>0.834</td>
</tr>
<tr>
<td>1 (monthly or less)</td>
<td>1.647</td>
<td>0.567 - 4.785</td>
<td>1</td>
<td>0.84</td>
<td>0.3595</td>
</tr>
<tr>
<td>2 (2 – 4 times a month)</td>
<td>1.123</td>
<td>0.402 - 3.138</td>
<td>1</td>
<td>0.049</td>
<td>0.8253</td>
</tr>
<tr>
<td>3 (2-3 times a week)</td>
<td>0.95</td>
<td>0.355 - 2.544</td>
<td>1</td>
<td>0.01</td>
<td>0.9187</td>
</tr>
<tr>
<td>4 (4 or more times a week)</td>
<td>1</td>
<td>0.339 - 2.953</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Sex</td>
<td>0.962</td>
<td>0.523 - 1.771</td>
<td>1</td>
<td>0.0154</td>
<td>0.901</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>0.895</td>
<td>0.655 - 1.223</td>
<td>1</td>
<td>0.487</td>
<td>0.485</td>
</tr>
<tr>
<td>Age</td>
<td>0.982</td>
<td>0.967 - 0.998</td>
<td>1</td>
<td>4.661</td>
<td>0.031</td>
</tr>
<tr>
<td>Injury severity</td>
<td>0.994</td>
<td>0.962 - 1.026</td>
<td>1</td>
<td>0.152</td>
<td>0.697</td>
</tr>
<tr>
<td>Number of injured regions</td>
<td>1.212</td>
<td>0.897 - 1.638</td>
<td>1</td>
<td>1.567</td>
<td>0.211</td>
</tr>
<tr>
<td>Oral morphine analgesic consumption</td>
<td>1.002</td>
<td>1.000 - 1.004</td>
<td>1</td>
<td>2.364</td>
<td>0.124</td>
</tr>
</tbody>
</table>
Due to the large number of significant predictor variables a test for multicollinearity was conducted. There were no variance inflation factor scores above five, therefore the significant variables (pain intensity, neuropathic pain, general anxiety, general depression, anxiety sensitivity, pain anxiety, pain catastrophizing, pain self-efficacy, age) as well as sex, ISS, oral morphine consumption, and SES were put into the initial model. Demographic information and injury severity were forced in the model because of their clinical relevance and support in the literature for its confounding effects on pain and psychological diagnoses. This model was overall significant, $\chi^2(13) = 93.65, p < .0001$, with an AIC of 166.65, however, only neuropathic pain, general anxiety, pain anxiety, and pain catastrophizing maintained their significant association with posttraumatic stress symptoms. The non-significant predictor variables were excluded from the final model, with the exception of pain intensity because its role immediately following traumatic injury and demographic variables including age, socioeconomic status, and ISS. The final model was significant, $\chi^2(8) = 92.450, p < .0001$, with an AIC of 157.803. The lower AIC in the final model indicates a better fit. As seen in Table 11, neuropathic pain ($p = .011$), general anxiety ($p = .006$), pain anxiety ($p = .003$), and pain catastrophizing ($p = .029$) were significant. For example, for every unit increase in general anxiety, the odds of having
higher symptoms of posttraumatic stress were 1.174. Similar pattern of odds were seen in pain anxiety, general anxiety and pain catastrophizing.

Table 11. Odds ratios of predictor variables on posttraumatic stress for the final model.

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>df</th>
<th>Wald</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Limit</td>
<td>Upper Limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>0.940</td>
<td>0.604</td>
<td>1.464</td>
<td>1</td>
<td>0.074</td>
</tr>
<tr>
<td>Age</td>
<td>0.990</td>
<td>0.966</td>
<td>1.016</td>
<td>1</td>
<td>0.557</td>
</tr>
<tr>
<td>Injury severity</td>
<td>0.973</td>
<td>0.929</td>
<td>1.020</td>
<td>1</td>
<td>1.268</td>
</tr>
<tr>
<td>Pain Intensity</td>
<td>0.940</td>
<td>0.701</td>
<td>1.180</td>
<td>1</td>
<td>0.510</td>
</tr>
<tr>
<td>Neuropathic pain</td>
<td>1.091</td>
<td>1.020</td>
<td>1.168</td>
<td>1</td>
<td>6.471</td>
</tr>
<tr>
<td>General anxiety</td>
<td>1.174</td>
<td>1.046</td>
<td>1.318</td>
<td>1</td>
<td>7.401</td>
</tr>
<tr>
<td>Pain catastrophizing</td>
<td>1.170</td>
<td>1.016</td>
<td>1.348</td>
<td>1</td>
<td>4.743</td>
</tr>
<tr>
<td>Pain Anxiety</td>
<td>1.055</td>
<td>1.018</td>
<td>1.094</td>
<td>1</td>
<td>8.684</td>
</tr>
</tbody>
</table>

df, degrees of freedom
Chapter 6

Discussion
6.1 Main Conclusions

The first objective of this study was to determine the incidence and severity of in-hospital pain and psychological distress following musculoskeletal traumatic injury. This was examined in a sample of 205 patients with severe musculoskeletal injuries who were recruited from two large urban trauma centres in Toronto, Ontario. Patients were on average 43 years of age (SD = 17.90) and male. The majority of patients injured more than one body region and many required surgical interventions.

Not surprisingly, the majority of patients had moderate to severe pain while in hospital and 65% of all patients were being followed by the acute pain service. Three quarters of the patients were on a multimodal pain regimen and 91% of patients were on an opioid-based medication. Although many of the patients were treated with internationally recommended methods for pain management, this study reveals that there remains a problem with pain management after trauma and a need for more information on pain characteristics and potentially mediating variables in order to understand how to manage acute pain following traumatic injury.

One area gaining attention in the literature is acute neuropathic pain and its role immediately following traumatic injury or surgery. The results from this study support the involvement of neuropathic pain in acute pain and psychological distress. According to the IASP’s 2012 definition of neuropathic pain, neuropathic pain is caused by a lesion or disease of the somatosensory nervous system (SNS). Kehlet and colleagues (2006) assert that a lesion to the SNS could also occur after direct injury to nerves. The damage to the SNS, therefore, causes sensory loss in combination with hypersensitivity, or pain, to a particular area. Though these definitions do not include a timeframe on the development of neuropathic pain, Boogard and colleagues (2011) defined chronic postsurgical neuropathic pain as pain that develops after surgery, pain that is present in the operating area, and which persists for more than three months. In the current study, 43.56% of patients had symptoms indicating neuropathic pain and who also had moderate to severe pain. This finding agrees with our first hypothesis indicating that the symptoms of neuropathic pain are higher in this sample than in the general population. However, as this study used the self-report Short-form Leeds Assessment of Neuropathic Symptoms and Signs (sLANSS) to measure acute neuropathic pain and a full diagnostic assessment was not performed, the incidence of acute symptoms of neuropathic pain should be interpreted with caution. Interestingly, only 38.64% of patients with neuropathic pain were treated with...
antineuropathic pain medications such as Gabapentin® or Pregabalin® indicating a gap in our management of these patients. There is emerging evidence suggesting that patients treated with neuropathic pain medicine, such as Pregabalin®, prior to total hip arthroplasty surgery and for three weeks following surgery have reduced pain intensity and improved physical function post-operatively. The results from the current study and Carmichael and colleagues’ (2013) study raise questions as to whether (1) there is a need for appropriate screening for acute neuropathic pain in this patient population, (2) what effects, if any, acute neuropathic pain has on the development of chronic post-traumatic/ post-surgical pain, and (3) what is the best course of pain management for these patients?

As predicted in the first hypothesis, the rates for symptoms of anxiety, depression, and post-traumatic stress are higher during this acute period than the general population with just over half of the patients reporting symptoms of general anxiety within the range for caseness and 27% of patients having caseness scores of posttraumatic stress with the majority reporting that the reason for their stress was directly related to their recent injury. These high rates of posttraumatic stress symptoms may indicate a diagnosis of acute stress syndrome due the presence of symptoms for more than two days. Though a full diagnostic test was not possible for the purposes of this thesis and the symptoms were measured within two weeks post-injury, the same symptom clusters that mark acute stress disorder (ASD) also identify PTSD, these clusters include re-experiencing, avoidance, emotional numbing, and hyperarousal. Previous studies have identified a range between 13 and 42% of civilians who had a traumatic injury go on to develop PTSD and even lower rates have been reported in the Canadian general population at 7-12%. Although higher reports of PTSD are found in questionnaire-based studies, the results from this study identified nearly a third of the patients have symptoms of ASD, which is well beyond the previously reported levels in Canada and at the higher range worldwide. Furthermore, anxiety sensitivity and pain catastrophizing, psychological factors known to be associated with both pain and PTSD, were also significantly associated with both acute pain and symptoms of PTSD. Though depression is commonly associated with pain disability months after injury, only a few studies have investigated the presence of depression early after injury. Nearly half of the patients in the current study had symptoms of depression, which is much higher than other studies report. Cumulatively, these indicators of depressive symptomatology and anxiety related distress highlight the importance for investigating anxiety...
during the acute stage following traumatic musculoskeletal injury and possibly treating the symptoms earlier.

The second objective of this study was to examine the association between pre-morbid factors, injury related factors, current symptoms of anxiety and depression on symptoms of PTSD following traumatic musculoskeletal injury. As seen in Figure 1, this objective examines all of the factors with the exception of pain disability on to symptoms of PTSD. This final step of the theoretical model (i.e. ‘Disability’) was not included because of the difficulties with assessing disability so early on after injury and thus will be assessed in future studies. Therefore, the researcher utilized a logistic regression model to determine the impact of multiple independent factors on the presence of posttraumatic stress symptoms (or visually the inner circle of symptoms in the model). Specifically, the multiple independent factors included pre-morbid factors (preexisting anxiety and depression, pre-morbid alcohol use, socioeconomic status), injury characteristics (mechanism of injury, injury severity, injury locations), in-hospital factors (analgesic consumption, use of multimodal analgesics, surgical intervention, length of stay in hospital), acute pain intensity, neuropathic pain, psychological factors (anxiety sensitivity, pain catastrophizing, general anxiety, general depression) in bivariate logistic regressions with symptoms of posttraumatic stress. In agreement with the second hypothesis, pain intensity, pain anxiety, anxiety sensitivity, general anxiety, general depression, and pain catastrophizing were positively associated with acute posttraumatic stress symptoms at the bivariate level. Further, pain self-efficacy was negatively associated with acute post-traumatic stress symptoms as predicted in hypothesis number three, but opioid consumption was not significantly associated.

The final hypothesis was that the model with independent factors would be associated with acute symptoms of PTSD and would mimic that of the model in Figure 1. Therefore, the factors included in hypothesized model were those analyzed at the bivariate level. The multivariate logistic regression in this study, however, excluded non-significant factors found in the bivariate analysis and included four controlling variables including demographic factors as well as pain intensity. Thus the final model included four significant independent factors associated with severe acute symptoms of PTSD following traumatic injury, specifically these included neuropathic pain, general anxiety, pain catastrophizing, and pain anxiety, while controlling for pain intensity, socioeconomic status, injury severity, and age.
A particularly surprising feature of this model was that oral morphine consumption was not significantly associated with symptoms of PTSD as tested in the bivariate logistic regression or in the multivariate logistic regression. This was contrary to the third hypothesis proposed in this thesis and contrary to Bryant and colleagues (2009) study that looked at the interactive effects of morphine and pain on PTSD development and severity to find that pain and mild traumatic brain injury had strong predictive value for PTSD, while acute administration of morphine acted as a protective factor therefore lessening the severity of the PTSD symptoms. One potential explanation for the difference between Bryant et al.’s (2009) study and the current these is that while morphine may be protective from severe symptoms of PTSD, when it is evaluated in conjunction with other predictors of PTSD, such as other anxiety constructs (e.g., anxiety sensitivity, pain catastrophizing) and in the presence of neuropathic pain, morphine loses its significant role in protecting individuals from acute symptoms of severe PTSD. Another potential explanation for the non-significant associations between both pain intensity and oral morphine consumption variables on symptoms of post-traumatic stress may lie in the inherent complications with treating pain in trauma patients. These complications are reflected in the sample evaluated in this study. For example, nerve blocks, such as epidurals, are recommended for pain relief with multiple injury sites, however, there are contraindications for epidural placement, such as coagulopathy and spinal fractures. Furthermore, many of these patients were awaiting surgical interventions or who were intubated and ventilated and therefore could not have oral medication posing complications with traditional pain management and the use of non-opioid based pain medications. The variety of injuries seen in this study led to tailored treatment protocols to the patients’ specific needs.

A pain characteristic that was not hypothesized to be significantly associated with symptoms of post-traumatic stress disorder was neuropathic pain. Neuropathic pain maintained its significant association both in the bivariate logistic regression model and the multivariate logistic regression model including pain anxiety, pain catastrophizing, and general anxiety. This suggests that the impact of acute neuropathic pain has a role in increasing the risk of having acute symptoms of post-traumatic stress disorder over and above the intense acute pain following TMsI. This may be a product of treating nociceptive pain with, for example, opioids, acetaminophen, and non-steroid anti-inflammatory medications in this sample and not adequately treating neuropathic pain with, for example, Gabapentin®.
The results from this study also show that pain and symptoms of anxiety are risk factors of symptoms for post-traumatic stress. Norman and colleagues’ (2008) work in patients without head injury support this notion. In their study, Norman et al (2008) found that initial high pain intensity was an independent predictor of PTSD within 48 hours of trauma and four and eight months after injury. However, when they added acute stress disorder (ASD) into their statistical model, PTSD was best predicted by ASD at four and eight months post-TMsl. The influence of acute pain intensity in Norman and colleagues (2010) study appears to be similar to the results from this study: independent of all other factors, pain intensity was significantly and positively associated with post-traumatic stress symptoms, but when it was placed in the model with other variables, such as anxiety, its influence on acute symptoms of post-traumatic stress were lost. Additional studies investigating anxiety factors after a traumatic event have found that patients with high levels of anxiety sensitivity were more likely to have severe symptoms of post-traumatic stress. In the current study, symptoms of anxiety sensitivity were significantly associated with symptoms of post-traumatic stress at the bivariate level, however, when put in the logistic regression, the significance was no longer present. Overall, it is important to note that the relationship between pain, anxiety, and PTSD appears to be dynamic and reciprocal and does support the model in Figure 1.

6.2 Study Advantages

This is first Canadian study to investigate acute posttraumatic pain and symptoms of psychological distress following trauma among a large sample of patients who were recruited prospectively from two urban trauma centres. Patients were either transferred from surrounding rural communities or transported directly from local neighbourhoods. Each patient was treated with standard Canadian medical protocols for traumatic musculoskeletal injury. Therefore this sample allows for results that are generalizable to Southern Ontario under pragmatic conditions and may help to identify modifiable factors that could alleviate acute stress and pain. The study design also allows for information about patients pain and psychological outcomes to be measured at the time they are experiencing them, thus providing important insights into how acute pain and psychological factors affect the symptoms of acute posttraumatic stress.
6.3 Study Limitations

Although this study has many advantages, this study is not without its limitations inherent in the measures used to examine posttraumatic stress and neuropathic pain. Although the each of the measures used to assess symptoms of pain and posttraumatic stress disorder were validated self-report questionnaires \(^{109,130}\), diagnoses require clinical judgment from trained experts, which necessitates many hours of time with patients. The focus of this thesis was to examine the association between factors that have previously been studied independent of one another, rather than to formulate diagnoses. Furthermore, the diagnosis of posttraumatic stress disorder can only be made after the symptoms are present for at least one month following the traumatic event.

Unfortunately, over the course of this study, it was discovered that the Short-form Leeds Assessment of Neuropathic Symptoms and Signs might not have been the best measure for identifying neuropathic pain for in-hospital patients. Three of the questions required patients to see or touch the “painful area”. Many of these patients had their injured areas covered with dressings and/or casts rendering these questions unanswerable. Often they were left blank or with the words “can’t see” beside the question. However, this was only a problem for a minority of patients and the majority of patients scored above the neuropathic pain cut off despite missing answers. This limitation highlights the potential underreporting of neuropathic pain in this sample and in general the presence of acute neuropathic pain symptoms in this population.

Fourteen patients refused to consent to take part in the study because they felt overwhelmed. An additional seven patients originally consented to participate, but then subsequently withdrew consent because they were feeling overwhelmed, having too “too much pain”, or who found it difficult to answer the questions while in hospital. This indicates the potential for a sampling bias towards patients with less severe psychological symptomatology. Due to the large amount of missing data, it was not possible to conduct any analyses on the seven patients who withdrew consent. Therefore, the researcher was not able to determine if there was any difference between those who participated and those who did not. However, given that 90% of the patients in this sample had moderate to severe pain, nearly 60% had severe symptoms of general anxiety, 30% had symptoms of posttraumatic stress, and just less than half of the patients had severe symptoms of depression, one could conclude that the sample included patients with severe psychological outcomes.
One further limitation of this study was that a median split was used for the posttraumatic stress outcome variable in the logistic regression model. A median split was used to best capture all of the data and therefore may bias the results to the sample used in this study. A cut off score of 44 is traditionally used as a marker for diagnosing posttraumatic stress disorder \(^{129}\), however as this study assesses the acute symptomatology of PTSD following injury, it is possible that having a lower threshold for symptoms of PTSD allows for more sensitive results and thus the likelihood for predicting future PTSD will be stronger.

6.4 Conclusions and Future Directions

This prospective, cross-sectional study reveals that a large number of patients have moderate to severe acute pain and a subset of these patients have symptoms of acute neuropathic pain that is not well managed following traumatic musculoskeletal injury. Further, neuropathic pain, general anxiety, pain anxiety, and pain catastrophizing are significantly associated with severe symptoms of posttraumatic stress. Future studies should prospectively examine the influence of these acute factors on the development of chronic pain and posttraumatic stress disorder following injury. It is important to understand the psychological mechanisms (e.g., psychological vulnerability, mutual maintenance of chronic pain) that can interact with the trauma to produce long-term distress. If the factors significantly related to acute distress remain significant in longitudinal studies, then the development of appropriate and timely interventions may modify the course of persistent pain and psychological distress. For example, screening for neuropathic pain and treating aggressively with medications such as Gabapentin\(^\text{®}\) or Pregabalin\(^\text{®}\) following traumatic injury. This may assist in reducing the incidence of chronic posttraumatic/ post-surgical pain and the development of psychological co-morbid disorders, which could decrease the overall burden of persistent pain and psychological distress in those who have experienced trauma related injuries.
References


78. Giesecke T, Gracely RH, Williams DA, Geisser ME, Petzke FW, Clauw DJ. The relationship between depression, clinical pain, and experimental


155. Bost JE, Williams BA, Bottegal MT, Dang Q, Rubio DM. The 8-item Short-Form Health Survey and the physical comfort composite score of the quality of recovery 40-item scale provide the most responsive assessments of pain, physical function, and mental function during the first 4 days after ambulatory knee surgery with regional anesthesia. Anesthesia and analgesia. Dec 2007;105(6):1693-1700, table of contents.


Appendix A: REB Approval Letters
To: Dr. Colin McCartney  
Anesthesia  
Room M3 200

From: Dr. Philip Hébert

Date: March 28, 2012

Subject: Pain and Psychological Outcomes Following Musculoskeletal Trauma

Project Identification Number: 072-2012  
Approval Date: March 28, 2012  
Expiry Date: March 28, 2013

The Research Ethics Board of Sunnybrook Health Sciences Centre has conducted a Delegated Board review of the research protocol referenced above and approved the involvement of human subjects on the above captioned date. The quorum for approval did not involve any member associated with this project.

The approval of this study includes the following documents:

- Protocol Version 1 dated March 11, 2012
- Informed Consent Form Version 1 dated January 11, 2012
- Appendix A: Initial Demographic Questionnaire Version 1 dated March 11, 2012
- Appendix B: Version 1 dated March 11, 2012
  - SF-8 Health Survey
  - Brief Pain Inventory (Short Form)
  - The S-LANSS Pain Scale
  - HADS
  - ASI-3
  - PASS-20
  - PCS
  - PCL-C
  - PSEQ
  - SFTS
- Appendix C: Data Collection Tool Version 1 dated March 11, 2012

All correspondence with the REB must include the assigned Project Identification Number. The REB requires immediate notification of all internal serious adverse events and significant deviations. Study continuation beyond one year requires submission of a renewal form prior to the expiry date or a study completion report must be received to close the file with the REB.

The Research Ethics Board of Sunnybrook Health Sciences Centre Operates in Compliance with the Tri-Council Policy Statement 2nd edition, ICH GCP Guidelines, Part C Division 5 of the Food and Drug Regulations, Part 4 of the Natural Health Products Regulations, and Part 3 of the Medical Devices Regulations. All Health Canada regulated trials at Sunnybrook are conducted by a Qualified Investigator.

Fully affiliated with the University of Toronto
All REB approved studies may be subject to review by the Sunnybrook Quality Assurance and Education Program and, as Principal Investigator, you are responsible for the ethical conduct of this study. Approval by the Sunnybrook REB entails compliance with current legislation outlined in the Ontario Personal Health Information Protection Act (PHIPA) and all policies and guidelines established by Sunnybrook. All applicable contracts and agreements must be submitted to Sunnybrook Legal Services before this research may be initiated.

Philip C. Hébert, MD PhD FCFPC
Chair, Research Ethics Board

OR

Miriam Shuchman, MD
Vice-Chair, Research Ethics Board
August 10, 2012

Dr. Colin McCartney
DEPT OF ANAESTHESIA
FACULTY OF MEDICINE

Ms. Brittany Rosenbloom
DEPT OF ANAESTHESIA
FACULTY OF MEDICINE

Dear Dr. McCartney and Ms. Brittany Rosenbloom,

Re: Administrative Approval of your research protocol entitled, "Pain and psychological outcomes after musculoskeletal trauma"

We are writing to advise you that the Office of Research Ethics (ORE) has granted administrative approval to the above-named research protocol. The level of approval is based on the following role(s) of the University of Toronto (University), as you have identified with your submission and administered under the terms and conditions of the affiliation agreement between the University and the associated TAHSN hospital:

- Graduate Student research - hospital-based only
- Storage or analysis of De-identified Personal Information (data)

This approval does not substitute for ethics approval, which has been obtained from your hospital Research Ethics Board (REB). Please note that you do not need to submit Annual Renewals, Study Completion Reports or Amendments to the ORE unless the involvement of the University changes so that ethics review is required. Please contact the ORE to determine whether a particular change to the University’s involvement requires ethics review.

Best wishes for the successful completion of your research.

Yours sincerely,

[Signature]
January 29, 2013

Ms. Sonya Canzian,
Trauma and Neurosurgery Program,
St Michael's Hospital

Dear Ms. Canzian,

Re: REB# 12-265 - Pain and Psychological Outcomes after Musculoskeletal Trauma

<table>
<thead>
<tr>
<th>REB APPROVAL:</th>
<th>Original Approval Date</th>
<th>Annual/Interval Review Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>January 29, 2013</td>
<td>January 29, 2014</td>
</tr>
</tbody>
</table>

Thank you for your application submitted on September 06, 2012. The above noted study has been reviewed through an expedited/delegated process (not by Full Board review). The views of the St. Michael's Hospital (SMH) Research Ethics Board (REB) have been documented and resolved.

The REB approves the study as it is found to comply with relevant research ethics guidelines, as well as the Ontario Personal Health Information Protection Act (PHIPA), 2004. The REB hereby issues approval for the above named study for a period of 12 months from the date of this letter. Continuation beyond that date will require further review of REB approval. In addition, the following documents have been reviewed and are hereby approved:

1. Protocol version submitted on September 06, 2012
2. Consent Form version dated January 25, 2013
3. Letter of Appreciation
4. Initial Demographic Questionnaire version 2 dated October 14, 2012

Furthermore, the following documents have been received and are acknowledged:

1. SF-8 Health Survey
2. S-LANSS Pain Scale
3. ASI-3
4. PASS-20
5. PCS Questionnaire
6. PCL-C
7. PEoQ
8. SPTS
10. Sunnybrook Health Sciences Centre REB Approval Letter dated March 28, 2012

During the course of this investigation, any significant deviations from the approved protocol and/or unanticipated developments or significant adverse events should immediately be brought to the attention of the REB.

Please note that if a Clinical Trial Agreement is required, it must be submitted to the Office of Research Administration for review and approval. Any additional institutionals approvals must be coordinated and approved through the Office of Research Administration prior to initiation of this research. All drug dispensing must be coordinated through the Research Pharmacy at 416-864-5413.

Dr. Sonya Canzian [REB# 12-265]
The St. Michael's Hospital (SMH) Research Ethics Board (REB) operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans, the Ontario Personal Health Information Protection Act, 2004, and ICH Good Clinical Practice Consolidated Guideline E6, Health Canada Part C Division 5 of the Food and Drug Regulations, Part 4 of the Natural Health Product Regulations, and the Medical Devices regulations. Furthermore, all investigational drug trials at SMH are conducted by Qualified Investigators (as defined in the latter document).

With best wishes

Dr. Bob Hyland
Chair, Research Ethics Board

Dr. Brenda McDowell
Vice Chair, Research Ethics Board
Appendix B

Introduction Letter of Study to Participating Hospital Units

Do you have a trauma patient?  
The following study may be of interest:

PAIN AND PSYCHOLOGICAL OUTCOMES FOLLOWING MUSCULOSKELETAL TRAUMA

Study Aim: The primary aim of this study is to look at pain and trauma as well as psychological variables. The findings from this study will help build future interventions to prevent long-term pain and distress.

Design: Observational, prospective, longitudinal.

Protocol: During hospitalization in ward participants will be asked to provide demographic type information, as well as validated measures of pain, function, disability and psychological stress. Information on in hospital surgical or procedural interventions, length of hospital stay, etc will be obtained from medical charts.
The validated measures on pain and psychology will also be collected at three other time points over the course of the year following injury (3-, 6-, and 12-months post injury).

Participant Eligibility:
Inclusion Criteria: Adults over the age of 18 years, who have experiences a traumatic injury, and who had a length of hospital stay ≥ 2 days.

Exclusion Criteria: Patients with Glasgow Coma Scale (GCS) motor ≤5 on admission, isolated hip fractures from standing, spinal cord damage, or self-injury will be excluded.

We can approach the patient for consent and drop off the survey material.
Appendix C

Script for Consenting Patients

Consenting Script for Research Personnel

**Script for someone in the primary circle of care to say when introducing the study:**
Hi Mr/ Mrs X, X (Farida or Brittany or Kelly) is here from anesthesia research and would like to talk with you about a study that you may be eligible to participate in. The study is about pain and psychological outcomes after injuries. Could they come in and tell you more about this?

If clear to approach, start consenting patient following this script:

**Script for verbally telling potential participants about the study and consent:**

NB. All the information here is summarized and can be elaborated on as needed, like in the consent. Potential participants and participants can ask questions at any time.

We (I) are (am) here from the research department because we would like to ask you to consider participating in a research study. A research study is a way of gathering information about something that is not well understood.

You are being asked to consider participating in this study because you have experienced a trauma resulting in an injury or multiple injuries to your body. This study is being done to find out more information on people’s experience with pain and psychological factors, like anxiety and mood, after having had an injury or multiple injuries from a traumatic incident, like a car accident, fall, assault, or workplace accident.

The reason we are doing this study is because we need to know more about what factors, like the type of injuries you have had or what your pain is like, contribute to better or worse outcomes during recovery. In finding this information from current patients, we will hopefully be able to do more research to find ways to help other people who have had experiences like yours.

To accomplish these goals we would ask you to complete four (4) questionnaires at four (4) time points within the 12 months following your injury. The first set of questionnaires will be completed while in hospital and the remaining three (3) sets of questionnaires can be completed at home.

It is anticipated that about 240 people will participate in this study at about 2 centres throughout Toronto.
If you decide to participate you will complete, you will complete a demographic questionnaire as well as 4 short questionnaires. This will take approximately a total of 20-50 minutes to complete. The length of time depends on whether you take breaks to rest. These questionnaires do not need to be filled out all at once. We will leave the questionnaire with you for about 24 hours so you can do it at your leisure. Myself or a member of the research team (Brittany or Farida or Kelly) will be available if you have any questions about the questionnaires and will come to see how you are doing with it tomorrow.

**NB. If potential participant has either lost their glasses in the traumatic incident or is incapable of writing because of, for example, two fractured arms, you may say:**

“If you need help with writing the answers to these questions, I or a member of the research team can help you fill out the questions.”

In 3-months time I or a member of the research team will contact you via telephone to remind you of this study and discuss your preferred method of completing the questionnaire. For example, through e-mail or mail or over the phone.

This will be repeated at 6-months and 12-months after your injury.

We also ask your permission to collect information from your medical chart on the types of injuries you have and the pain medications you are on while you are in hospital.

Participation in this study will not involve any additional costs to you.

You will not be paid to participate in this study.

There are no medical risks to you from participating in this study, but taking part in this study may make you feel uncomfortable. You may refuse to answer questions or stop your participation in the study at any time if you experience any discomfort. You may or may not benefit directly from participating in this study. Your participation may or may not help other people who have experienced traumas resulting in injury in the future.

You can also choose to end your participation at any time without having to provide a reason. If you choose to withdraw, your choice will not have any effect on your current or future medical treatment or health care.

If you withdraw your consent, the information about you and the questionnaires that you completed before you left the study will still be used. No new information about you will be collected without your permission.
All information you provide us will be kept confidential and stored in a locked office, on encrypted and secure servers.

You have the right to be informed of the results of this study once the entire study is complete. If you would like to be informed of the results of this study, please provide your name, address and telephone number to Dr. Colin McCartney at the Department of Anesthesia.

Please read this consent carefully and ask any questions you may have. You may have this form and all information concerning the study explained to you. You may take as much time as you wish to decide whether or not to participate. The study staff will tell you if there are any study timelines for making your decision. Please ask the study staff or one of the investigator(s) to clarify anything you do not understand or would like to know more about. Make sure all your questions are answered to your satisfaction before deciding whether to participate in this research study.

Participating in this study is your choice (voluntary). You have the right to choose not to participate, or to stop participating in this study at any time.
Appendix D

Consent forms for Sunnybrook Health Sciences Centre and St. Michael’s Hospital

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Full Study Title: Pain and psychological outcomes after musculoskeletal trauma

Principal Investigator: Dr. Colin McCartney

Sponsor: This study is being funded by Department of Anesthesia funds.

INFORMED CONSENT

You are being asked to consider participating in a research study. A research study is a way of gathering information on a treatment, procedure or medical device or to answer a question about something that is not well understood.

This form explains the purpose of this research study, provides information about the study, the procedures, possible risks and benefits, and the rights of participants.

Please read this form carefully and ask any questions you may have. You may have this form and all information concerning the study explained to you. If you wish, someone may be available to verbally translate this form into your preferred language. You may take as much time as you wish to decide whether or not to participate. The study staff will tell you if there are any study timelines for making your decision. Please ask the study staff or one of the investigator(s) to clarify anything you do not understand or would like to know more about. Make sure all your questions are answered to your satisfaction before deciding whether to participate in this research study.
Participating in this study is your choice (voluntary). You have the right to choose not to participate, or to stop participating in this study at any time.

INTRODUCTION

You are being asked to consider participating in this study because you have experienced a trauma resulting in an injury or multiple injuries to your body.

At present there are no Canadian statistics that indicate the number of patients that may have persistent pain and psychological distress after a traumatic injury. There is also little known about who might be as risk for these poor outcomes. The purpose of this study is to explore the level of persistent pain and psychological distress, for example, anxiety, depression, and posttraumatic stress symptoms, among patients after a traumatic injury. We also aim to identify the factors that increase the risk for developing persistent pain and psychological distress.

In identifying the risk factors that lead to poor outcomes, future research studies can develop early interventions to prevent or manage poor outcomes. This may assist in increasing quality of life and return to work, which could decrease the overall burden of persistent pain and psychological distress in those experiences trauma related injuries.

WHY IS THIS STUDY BEING DONE?

The purpose of this study is to explore persistent pain and psychological outcomes amongst patients who experienced a traumatic event leading to injury. We will also explore the protective factors and risk factors associated with the outcomes following traumatic injury. This will be accomplished through a series of questionnaires over 4 time points 12 months following your injury.

WHAT WILL HAPPEN DURING THIS STUDY?

During this study you will complete a series of questionnaires at four (4) time points within the 12 months following your injury. The first set of questionnaires will be completed while in hospital and the remaining three (3) sets of questionnaires can be completed at home.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

It is anticipated that about 240 people will participate in this study at about 2 centres throughout Toronto. About 120 people will participate in this study at Sunnybrook. The length of this study for participants is 12 months. The entire study is expected to take about 2 years to complete and the results should be known in 3 years.
WHAT ARE THE RESPONSIBILITIES OF STUDY PARTICIPANTS?

If you decide to participate in this study you will be asked to do the following:

During the first week after your injury, you will complete a demographic questionnaire as well as 4 short questionnaires. This will take approximately a total of 20-50 minutes to complete. These questionnaires do not need to be filled out all at once. They may be filled out at any point during your first week of recovery. A member of the research team will be available if you have any questions about the questionnaires.

At 3-months after your injury, a member of the research team will contact you via telephone to remind you of this study and that you will be mailed a set of questionnaires to complete. These questionnaires will be similar to the first set that you completed during hospitalization. They will take approximately 20 to 50 minutes of your time to complete. These questionnaires do not need to be filled out all at once. They may be filled out at any point within one (1) week after receiving the package. Inside the package you will also receive a stamped envelope for you to mail the questionnaires back to Brittany Rosenbloom at the Department of Anesthesia, M3-200, Sunnybrook HSC. You do not need to pay for postage.

This will be repeated at 6-months and 12-months after your injury.

WHAT ARE THE RISKS OR HARMS OF PARTICIPATING IN THIS STUDY?

There are no medical risks to you from participating in this study, but taking part in this study may make you feel uncomfortable. You may refuse to answer questions or stop your participation in the study at any time if you experience any discomfort.

You will be told about any new information that might reasonably affect your willingness to continue to participate in this study as soon as the information becomes available to the study staff.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

You may or may not benefit directly from participating in this study. Your participation may or may not help other people who have experienced traumas resulting in injury in the future.

CAN PARTICIPATION IN THIS STUDY END EARLY?

You can also choose to end your participation at any time without having to provide a reason. If you choose to withdraw, your choice will not have any effect on your current or future medical treatment or health care.
If you withdraw voluntarily from the study, you are encouraged to contact Brittany Rosenbloom in the Department of Anesthesia at 416 480 4864. You may be asked questions about your experience with the study.

If you withdraw your consent, the information about you and the questionnaires that you completed before you left the study will still be used. No new information about you will be collected without your permission.

**WHAT ARE THE COSTS OF PARTICIPATING IN THIS STUDY?**

Participation in this study will not involve any additional costs to you.

By signing this consent form, you do not give up any of your legal rights.

**ARE STUDY PARTICIPANTS PAID TO PARTICIPATE IN THIS STUDY?**

You will not be paid to participate in this study.

**HOW WILL MY INFORMATION BE KEPT CONFIDENTIAL?**

You have the right to have any information about you and your health that is collected, used or disclosed for this study to be handled in a confidential manner.

If you decide to participate in this study, the investigator(s) and study staff will look at your personal health information and collect only the information they need for this study. "Personal health information" is health information about you that could identify you because it includes information such as your:

- name,
- address,
- telephone number,
- date of birth,
- new and existing medical records, or
- the types, dates and results of various tests and procedures.

You have the right to access, review and request changes to your personal health information.

The following people may come to the hospital to look at your personal health information to check that the information collected for the study is correct and to make sure the study followed the required laws and guidelines:

- Representatives of the Sunnybrook Research Ethics Board, a group of people who oversee the ethical conduct of research studies at Sunnybrook; and

Access to your personal health information will take place under the supervision of the Principal Investigator.
“Study data” is health information about you that is collected for the study, but that does not directly identify you. Any study data about you that is sent outside of the hospital will have a code and will not contain your name or address, or any information that directly identifies you.

Study data that is sent outside of the hospital will be used for the research purposes explained in this consent form.

The investigator(s), study staff and the other people listed above will keep the information they see or receive about you confidential, to the extent permitted by applicable laws. Even though the risk of identifying you from the study data is very small, it can never be completely eliminated.

The Principal Investigator will keep any personal health information about you in a secure and confidential location for 5 years and then destroy it according to Sunnybrook policy.

When the results of this study are published, your identity will not be disclosed.

You have the right to be informed of the results of this study once the entire study is complete. If you would like to be informed of the results of this study, please provide your name, address and telephone number to Dr. Colin McCartney at the Department of Anesthesia.

DO THE INVESTIGATORS HAVE ANY CONFLICTS OF INTEREST?

There are no conflicts of interest to declare related to this study.

WHAT ARE THE RIGHTS OF PARTICIPANTS IN A RESEARCH STUDY?

You have the right to receive all significant information that could help you make a decision about participating in this study. You also have the right to ask questions about this study and your rights as a research participant, and to have them answered to your satisfaction, before you make any decision. You also have the right to ask questions and to receive answers throughout this study.

If you have any questions about this study you may contact the person in charge of this study, Dr. Colin McCartney, at the Department of Anesthesia, Sunnybrook Health Sciences Centre.

If you have questions about your rights as a research participant or any ethical issues related to this study that you wish to discuss with someone not directly involved with the
study, you may call Dr. Philip C. Hébert, Chair of the Sunnybrook Research Ethics Board at (416) 480-4276.

DOCUMENTATION OF INFORMED CONSENT

You will be given a copy of this informed consent form after it has been signed and dated by you and the study staff.

Full Study Title: Pain and psychological outcomes after musculoskeletal trauma

Name of Participant: ______________________________________________________________

Participant/Substitute decision-maker

By signing this form, I confirm that:
• This research study has been fully explained to me and all of my questions answered to my satisfaction
• I understand the requirements of participating in this research study
• I have been informed of the risks and benefits, if any, of participating in this research study
• I have been informed of any alternatives to participating in this research study
• I have been informed of the rights of research participants
• I have read each page of this form
• I authorize access to my personal health information, medical record and research study data as explained in this form
• I have agreed, or agree to allow the person I am responsible for, to participate in this research study
• This informed consent document may be placed in my medical records

___________________________  ___________________________  ____________________
Name of participant (print)    Signature                      Date
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Full Study Title: Pain and psychological outcomes after musculoskeletal trauma

Global Principal Investigator:
Colin McCartney, MBChB, FRCA, FCARSCI, FRCPC
Associate Professor, Department of Anesthesia
Sunnybrook Health Sciences Centre, M3-200
2075 Bayview Avenue,
Toronto, Ontario, Canada
Tel: 416-480-4964

Principal Investigator:
Sonya Canzian
Program Director, Trauma and Neurosurgery Program
Mondays to Fridays 8:00 am - 4:00 pm. Tel: 416-864-5725

Co-Investigator:
Brittany Rosenbloom, Masters Candidate
Institute of Medical Science, University of Toronto

Sponsor: Department of Anaesthesia funds at Sunnybrook Health Sciences Centre.

Conflict of Interest: This is a student project as part of the Masters training in Biomedical Sciences at the Institute of Medical Science, University of Toronto.

Before agreeing to take part in this research study, it is important that you read the information in this research consent form. It includes details we think you need to know in order to decide if you wish to take part in the study. If you have any questions, ask a study doctor or study staff. You should not sign this form until you are sure you understand the information. All research is voluntary. You may also wish to discuss the study with your family doctor, a family member or close friend. If you decide to take part in the study, it is important that you are completely truthful about your health history and any medications you are taking. This will help prevent unnecessary harm to you.
PURPOSE OF RESEARCH
You are being asked to consider participating in this study because you have experienced a trauma resulting in an injury or multiple injuries to your body.

The purpose of this study is to explore outcomes like pain, anxiety, and depression, in patients who have experienced a traumatic event leading to injury. We want to find out what factors protect patients from having poorer outcomes, like persistent pain, and what puts patients at risk for having poor outcomes after traumatic injury. This will be accomplished through questionnaires given at 4 time points over the course of 12 months following your injury.

This study is being conducted because at present there are no Canadian statistics that indicate the number of patients that may have persistent pain, anxiety, or depression after a traumatic injury. There is also little known about who might be at risk for these poor outcomes. The purpose of this study is to explore the level of persistent pain and anxiety, and depression among patients who have experienced a traumatic injury. We also aim to identify which factors increase the risk of developing persistent pain, anxiety, and depression.

In identifying the risk factors that lead to poor outcomes, future research studies can develop early interventions to prevent or manage poor outcomes. This may assist in increasing quality of life and return to work, which could decrease the overall burden of poor outcomes in those experiences trauma related injuries.

DESCRIPTION OF RESEARCH
This study is being conducted at St. Michael’s Hospital and Sunnybrook Health Sciences Centre. It is anticipated that a total of 200 people will participate. About 100 people will participate in this study at St. Michael’s Hospital. The entire study is expected to take about 2 years to complete and the results should be known in 3 years.

If you consent to participate in this study, your participation will last about 1 year. You will only be asked to fill out a set of questionnaires at 4 set time points during the year you are in the study. The questionnaires will ask you about:
Your current quality of life
Your experiences with pain
Your current level of anxiety
Your mood
Personal questions about your life before your traumatic injury

It will take you about 30 minutes to 1 hour to complete the set of questionnaires. You have the choice to fill them all out at one time or choose to complete them separately.
You will fill up your first set of questionnaires during the first week after your injury, while you are still in hospital.

During your hospitalization, a member of the study team will collect information from your patient chart on the type of injury or injuries you have, any surgical procedures you have had, and any medications you have been given for pain.

You will be asked to complete the same set of questionnaires at 3, 6 and 12 months after your traumatic injury. A member of the study team will be calling you to remind you about this. The questionnaires can be mailed to you or e-mail to you. If you choose to fill out hardcopies of the questionnaires, you will be provided with an envelope and postage to mail the questionnaires back to the study members.

No additional tests or treatments will be done.

**RISKS OR HARMS OF PARTICIPATING IN THIS STUDY**
There are no medical risks to you from participating in this study, but taking part in this study may make you feel uncomfortable. You may refuse to answer questions or stop your participation in the study at any time if you experience any discomfort.

You will be told about any new information that might reasonably affect your willingness to continue to participate in this study as soon as the information becomes available to the study staff.

**PROTECTING YOUR HEALTH INFORMATION**
If you decide to participate in this study, the investigator(s) and study staff from St. Michael’s Hospital will look at your personal health information and collect only the information they need for this study. “Personal health information” is health information about you that could identify you because it includes information such as your;

- name,
- address,
- telephone number,
- date of birth,
- new and existing medical records, or
- the types, dates and results of various tests and procedures.

Information collected about you for this study will be de-identified. This means your study data will be identified only by a unique study ID number. Deidentified data will be transferred electronically transferred to the main study site at Sunnybrook Health Sciences Centre. The transfer of this information will be done through an encrypted and secure storage device. This means that any information identifying who you are will be removed before it is transferred to Sunnybrook. Therefore all information transferred on this device will not have any
identifying information. All hardcopies of the information that you provide will be stored at St. Michael’s Hospital.

You have the right to access, review and request changes to your personal health information.

Your study data may be looked at by representatives of the St. Michael’s Hospital Research Ethics Board, to make sure the study follows the required laws and guidelines

- Access to your personal health information will take place under the supervision of the Principal Investigator.

The investigator(s), study staff and the other people listed above will keep the information they see or receive about you confidential, to the extent permitted by applicable laws. Even though the risk of identifying you from the study data is very small, it can never be completely eliminated.

The Principal Investigator will keep any personal health information about you in a secure and confidential location for 5 years and then destroy it according to St. Michael’s Hospital policy.

When the results of this study are published, your identity will not be disclosed.

STUDY RESULTS
You have the right to be informed of the results of this study once the entire study is complete. If you would like to be informed of the results of this study, please contact Dr. Colin McCartney (contact information can be found on page 1)

POTENTIAL COSTS OF PARTICIPATING IN THIS STUDY
Participation in this study will not involve any additional costs to you. By signing this consent form, you do not give up any of your legal rights.

STUDY PARTICIPANTS PAID TO PARTICIPATE IN THIS STUDY?
You will not be paid to participate in this study.

POTENTIAL BENEFITS OF PARTICIPATING IN THIS STUDY
You will not benefit directly from being in this study. However, results from this study may further medical or scientific knowledge to help other people who have experienced traumas resulting in injury in the future.

PARTICIPATION AND WITHDRAWAL
Participation in any research study is voluntary. If you choose not to participate, you and your family will continue to have access to customary care at St. Michael’s Hospital. If you decide to participate in this study you can change your mind without giving a reason, and you may withdraw from the study at any time.
without any effect on the care you and your family will receive at St. Michael’s Hospital.

If you withdraw voluntarily from the study, you are encouraged to contact Brittany Rosenbloom in the Department of Anaesthesia at 416 480 4864. You may be asked questions about your experience with the study.

If you withdraw your consent, the information about you and the questionnaires that you completed before you left the study will still be used. No new information about you will be collected without your permission.

**NEW FINDINGS OR INFORMATION**
We may learn new things during the study that you may need to know. We can also learn about things that might make you want to stop participating in the study. If so, you will be notified about any new information in a timely manner. You may also be asked to sign a new consent form discussing these new findings if you decide to continue in the research study.

**RESEARCH ETHICS BOARD CONTACT**
If you have any questions regarding your rights as a research participant, you may contact Bob Hyland, Chair of the St. Michael’s Hospital Research Ethics Board at 416-864-6060 ext. 2557 during business hours.

**STUDY CONTACT**
If you have any questions about the study, you may contact the study investigator, Sonya Canzian at 416-864-6060 x 5725
DOCUMENTATION OF INFORMED CONSENT

Full Study Title: Pain and psychological outcomes after musculoskeletal trauma

The research study has been explained to me, and my questions have been answered to my satisfaction. I have been informed of the alternatives to participation in this study. I have the right not to participate and the right to withdraw without affecting the quality of medical care at St. Michael’s Hospital for me and for other members of my family. As well, the potential harms and benefits (if any) of participating in this research study have been explained to me.

I have been told that I have not waived my legal rights nor released the investigators, sponsors, or involved institutions from their legal and professional responsibilities. I know that I may ask now, or in the future, any questions I have about the study. I have been told that records relating to me and my care will be kept confidential and that no information will be disclosed without my permission unless required by law. I have been given sufficient time to read the above information. I consent to participate. I have been told I will be given a signed copy of this consent form.

Name of participant (print) ___________________ Signature ___________________ Date __________

I have explained to the above Participant the nature and purpose, the potential benefits, and possible risks associated with participation in this research study. I have answered all questions that have been raised about the study.

Name of Person Obtaining Consent ___________________ Signature of Person Obtaining Consent ___________________ Date/Time ___________________

Study Personnel Position: ____________________________________________

Witness required: ☐ Yes ☐ No

Name of Witness (print) ___________________ Signature ___________________ Date __________
Appendix E: Data Collection Tool

Data Collection Tool

Pain Prevalence in the Trauma Population

| Date of Consent: _____ | Sex: _____ | Age: _____ | ISS (if avail)*: _____ |

Injury Date: ________________

Length of stay: ________________

List of Injuries at time of admission:

________________________________________________________

________________________________________________________

________________________________________________________

List of Surgeries and/or Procedures (in chronological order):

________________________________________________________

________________________________________________________

________________________________________________________

List of any medical complications associated with injury:

________________________________________________________

________________________________________________________

________________________________________________________
Medication or pain interventions on day of assessment:

<table>
<thead>
<tr>
<th>Medication:</th>
<th>Date of Enrollment:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pain Team Following;
- [ ] None
- [ ] APS
- [ ] Palliative
- [ ] Chronic

Person deceased in the traumatic incident that was the reason for the participant’s current hospitalization;
- [ ] Yes
- [ ] No
# Appendix F: Study Questionnaire

## SF-8 Health Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overall, how would you rate your health in the past 4 weeks?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. During the past 4 weeks, how much did physical health problems limit your usual physical activities (such as walking or climbing stairs)?</td>
<td>Not at all</td>
<td>Very little</td>
<td>Somewhat</td>
<td>Quite a lot</td>
<td>Could not do physical activities</td>
<td></td>
</tr>
<tr>
<td>3. During the past 4 weeks, how much difficulty did you have doing your daily work, both at home and away from home, because of your physical health?</td>
<td>Not at all</td>
<td>Very little</td>
<td>Somewhat</td>
<td>Quite a lot</td>
<td>Could not do daily work</td>
<td></td>
</tr>
<tr>
<td>4. How much bodily pain have you had in the past 4 weeks?</td>
<td>None</td>
<td>Very mild</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
<td>Very severe</td>
</tr>
<tr>
<td>5. During the past 4 weeks, how much energy did you have?</td>
<td>Very much</td>
<td>Quite a lot</td>
<td>Some</td>
<td>A little</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>6. During the past 4 weeks, how much did your physical health or emotional problems limit your usual social activities with family or friends?</td>
<td>Not at all</td>
<td>Very little</td>
<td>Somewhat</td>
<td>Quite a lot</td>
<td>Could not do social activities</td>
<td></td>
</tr>
<tr>
<td>7. During the past 4 weeks, how much have you been bothered by emotional problems (such as feeling anxious, depressed or irritable)?</td>
<td>Not at all</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Quite a lot</td>
<td>Extremely</td>
<td></td>
</tr>
<tr>
<td>8. During the past 4 weeks, how much did personal or emotional problems keep you from doing your usual work, school or other daily activities?</td>
<td>Not at all</td>
<td>Very little</td>
<td>Somewhat</td>
<td>Quite a lot</td>
<td>Could not do daily activities</td>
<td></td>
</tr>
</tbody>
</table>
**Brief Pain Inventory (Short Form)**

1. Throughout our lives, most of us have had pain from time to time (such as minor headaches, sprains, and toothaches). Have you had pain other than these everyday kinds of pain during the last week?
   - ☐ Yes
   - ☐ No

2. On the diagram, shade in the areas where you feel pain. Put an X on the area that hurts the most.

3. Please rate your pain by circling the one number that best describes your pain at its **worst** in the last week.

   0  1  2  3  4  5  6  7  8  9  10

   No Pain  Pain as bad as you can imagine
4. Please rate your pain by circling the one number that best describes your pain at its least in the last week.

   0  1  2  3  4  5  6  7  8  9  10

   No Pain                                      Pain as bad as you can imagine

5. Please rate your pain by circling the one number that best describes your pain on the average.

   0  1  2  3  4  5  6  7  8  9  10

   No Pain                                      Pain as bad as you can imagine

6. Please rate your pain by circling the one number that tells how much pain you have right now.

   0  1  2  3  4  5  6  7  8  9  10

   No Pain                                      Pain as bad as you can imagine

7. What treatments or medications are you receiving for your pain? Please check all that apply. If you know the dose of the medication and how often you take it, please specify.

   □ Hydromorphone (HM Contin)
   □ Oxycodone
   □ Percocet
   □ Hydromorphone (Dilaudid)
   □ Morphine
   □ Tylenol
   □ Ibuprofen/ Advil/ Aleve
   □ Aspirin
   □ Ice/ heat
   □ Physiotherapy
   □ Exercise (e.g. yoga, walking)
   □ Acupuncture
   □ Massage
   □ Other, please explain (ex. Gabapentin, nortriptyline)
8. In the last week, how much relief have pain treatments or medications provided? Please circle the one percentage that most shows how much relief you have received.

<table>
<thead>
<tr>
<th>No Relief</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100% Complete Relief</th>
</tr>
</thead>
</table>

9. Circle the one number that describes how much, during the past week, pain has interfered with your:

**A. General Activity**

<table>
<thead>
<tr>
<th>Does not Interfere</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Completely Interferes</th>
</tr>
</thead>
</table>

**B. Mood**

<table>
<thead>
<tr>
<th>Does not Interfere</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Completely Interferes</th>
</tr>
</thead>
</table>

**C. Walking Ability**

<table>
<thead>
<tr>
<th>Does not Interfere</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Completely Interferes</th>
</tr>
</thead>
</table>

**D. Normal Work (includes both work outside the home and housework)**

<table>
<thead>
<tr>
<th>Does not Interfere</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Completely Interferes</th>
</tr>
</thead>
</table>

**E. Relations with other people**

<table>
<thead>
<tr>
<th>Does not Interfere</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Completely Interferes</th>
</tr>
</thead>
</table>
### F. Sleep

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Does not Interfere</td>
<td>Completely Interferes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### G. Enjoyment of life

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Does not Interfere</td>
<td>Completely Interferes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The S-LANSS Pain Scale

Earlier you were asked to identify where the most pain was on a diagram. The next questions refer to the pain that you identified there. Think about how your pain that you showed in the diagram has felt over the last week. Please circle the descriptions that best match your pain. These descriptions may, or may not, match your pain no matter how severe it feels.

Only circle the response that describes your pain.

1) In the area where you have pain, do you also have ‘pins and needles’, tingling or prickling sensations?
   a) NO – I don’t get these sensations
   b) YES - I get these sensations often

2) Does the painful area change colour (perhaps looks mottled or more red) when the pain is particularly bad?
   a) NO - My pain does not affect the colour of my skin
   b) YES - I've noticed that the pain does make my skin look different from normal

3) Does your pain make the skin abnormally sensitive to touch? Getting unpleasant sensations or pain when lightly stroking the skin might describe this.
   a) NO – The pain does not make my skin in that area abnormally sensitive to touch
   b) YES - My skin in that area is particularly sensitive to touch

4) Does your pain come on suddenly and in bursts for no apparent reason when you are completely still. Words like ‘electric shocks’, jumping and bursting describe these sensations.
   a) NO - My pain doesn't really feel like this
   b) YES - I get these sensations quite a lot

5) In the area where you have pain, does your skin feel unusually hot like a burning pain?
   a) NO – I don't have burning pain
   b) YES - I get burning pain often

6) Gently rub the painful area with your index finger and then rub a non-painful area (for example, an area of skin further away or on the opposite side from the painful area). How does this rubbing feel in the painful area?
   a) The painful area feels no different from the non-painful area
   b) I feel discomfort, like pins and needles, tingling or burning in the painful area that is different from the non-painful area

7) Gently press on the painful area with your finger tip then gently press in the same way onto a non-painful area (the same non-painful area that you chose in the last question). How does this feel in the painful area?
   a) The painful area feels no different from the non-painful area
   b) I feel numbness or tenderness in the painful area that is different from the non-painful area
**HADS**

Health care professionals are aware that emotions play an important part in most illnesses. If your health care professional knows about these feelings he or she will be able to help you more. **Read each item below and place a check (✓) in the box beside the reply which comes closest to how you have been feeling in the past week.**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. I feel tense or “wound up”</strong></td>
<td><strong>8. I feel as if I am slowed down</strong></td>
</tr>
<tr>
<td>□ Most of the time</td>
<td>□ Nearly all the time</td>
</tr>
<tr>
<td>□ A lot of time</td>
<td>□ Very often</td>
</tr>
<tr>
<td>□ From time to time</td>
<td>□ Sometimes</td>
</tr>
<tr>
<td>□ Not at all</td>
<td>□ Not at all</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. I still enjoy the things I used to enjoy</strong></td>
<td><strong>9. I get a sort of frightened feeling like “butterflies” in the stomach</strong></td>
</tr>
<tr>
<td>□ Definitely as much</td>
<td>□ Not at all</td>
</tr>
<tr>
<td>□ Not quite so much</td>
<td>□ Occasionally</td>
</tr>
<tr>
<td>□ Only a little</td>
<td>□ Quite often</td>
</tr>
<tr>
<td>□ Hardly at all</td>
<td>□ Very often</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. I get sort of frightened feeling as if something awful is about to happen</strong></td>
<td><strong>10. I have lost interest in my appearance</strong></td>
</tr>
<tr>
<td>□ Very definitely and quite badly</td>
<td>□ Definitely</td>
</tr>
<tr>
<td>□ Yes, but not too badly</td>
<td>□ I don’t take as much care as I should</td>
</tr>
<tr>
<td>□ A little, but it doesn’t worry me</td>
<td>□ I may not take quite much care</td>
</tr>
<tr>
<td>□ Not at all</td>
<td>□ I take just as much care as ever</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. I can laugh and see the funny side of things</strong></td>
<td><strong>11. I feel restless as if I have to be on the move</strong></td>
</tr>
<tr>
<td>□ As much as I always could</td>
<td>□ Very much indeed</td>
</tr>
<tr>
<td>□ Not quite so much now</td>
<td>□ Quite a lot</td>
</tr>
<tr>
<td>□ Definitely not so much now</td>
<td>□ Not very much</td>
</tr>
<tr>
<td>□ Not at all</td>
<td>□ Not at all</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. Worrying thoughts go through my mind</strong></td>
<td><strong>12. I look forward with enjoyment to things</strong></td>
</tr>
<tr>
<td>□ A great deal of the time</td>
<td>□ As much as I ever did</td>
</tr>
<tr>
<td>□ A lot of the time</td>
<td>□ Rather less than I used to</td>
</tr>
<tr>
<td>□ Not too often</td>
<td>□ Definitely less than I used to</td>
</tr>
<tr>
<td>□ Very little</td>
<td>□ Hardly at all</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6. I feel cheerful</strong></td>
<td><strong>13. I get sudden feeling of panic</strong></td>
</tr>
<tr>
<td>□ Never</td>
<td>□ Very often indeed</td>
</tr>
<tr>
<td>□ Not often</td>
<td>□ Quite often</td>
</tr>
<tr>
<td>□ Sometimes</td>
<td>□ Not very often</td>
</tr>
<tr>
<td>□ Most of the time</td>
<td>□ Not at all</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1.</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>0</td>
</tr>
<tr>
<td>10.</td>
<td>0</td>
</tr>
<tr>
<td>11.</td>
<td>0</td>
</tr>
</tbody>
</table>

**ASI-3**

Please circle the number that best corresponds to how much you agree with each item. If any items concern something that you have never experienced (e.g., fainting in public), then answer on the basis of how you think you might feel if you had such an experience. Otherwise, answer all items on the basis of your own experience. Be careful to circle only one number for each item and please answer all items.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Never</th>
<th></th>
<th></th>
<th>Always</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I can’t think straight when in pain</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>During painful episodes, it is difficult for me to think of anything besides the pain</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>When I hurt, I think about pain constantly</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>I find it hard to concentrate when I hurt</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>I worry when I am in pain</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>I go immediately to bed when I feel severe pain</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

PASS-20

<table>
<thead>
<tr>
<th></th>
<th>Very little</th>
<th>A little</th>
<th>Some</th>
<th>Much</th>
<th>Very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never</td>
<td>Always</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>-------</td>
<td>--------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I will stop any activity as soon as I sense pain coming on</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>As soon as pain comes on, I take medication to reduce it</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>I avoid important activities when I hurt</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>I try to avoid activities that cause pain</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I think that if my pain gets too severe it will never decrease</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>When I feel pain, I am afraid that something terrible will happen</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>When I feel pain, I think I might be seriously ill</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Pain sensations are terrifying</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>When pain comes on strong, I think that I might become paralyzed or more disabled</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>I begin trembling when engaged in an activity that causes pain</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Pain seems to cause my heart to pound or race</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>When I sense pain, I feel dizzy or faint</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Pain makes me nauseous</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>I find it difficult to calm my body down after periods of pain</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When answering the following questions, please reflect on your pain and indicate the degree to which you experience these thoughts and feelings when experiencing the pain.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I worry all the time about whether the pain will end.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>2. I feel I can’t go on.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>3. It’s terrible and I think it’s never going to get any better.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>4. It’s awful and I feel that it overwhelms me.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>5. I feel I can’t stand it any more.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>6. I become afraid that the pain may get worse.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>7. I think of other painful experiences.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>8. I anxiously want the pain to go away.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>9. I can’t seem to keep it out of my mind.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>10. I keep thinking about how much it hurts.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>11. I keep thinking about how badly I want the pain to stop.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>12. There is nothing I can do to reduce the intensity of the pain.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
<tr>
<td>13. I wonder whether something serious may happen.</td>
<td>None of the time</td>
<td>A little bit of the time</td>
<td>Sometimes</td>
<td>Often</td>
<td>All of the time</td>
</tr>
</tbody>
</table>
**PCL-C**

Instructions: Below is a list of problems and complaints that people sometimes have in response to stressful life experiences. Please indicate how much you have been bothered by that problem in the past month. Please rate as 1 for not at all; 2 a little bit; 3 moderately; 4 quite a bit; and 5 would be extremely.

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Repeated, disturbing memories, thoughts, or images of a stressful experience from the past?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Repeated, disturbing dreams of a stressful experience from the past?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Suddenly acting or feeling as if a stressful experience from the past were happening again (as if you were reliving it)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Feeling very upset when something reminded you of a stressful experience from the past?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience from the past?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Avoiding thinking about or talking about a stressful experience from the past or avoiding having feelings related to it?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Avoiding activities or situations because they reminded you of a stressful experience from the past?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Trouble remembering important parts of a stressful experience from the past?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Loss of interest in activities that you used to enjoy?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Feeling distant or cut off from people?</td>
<td>Not at all</td>
<td>A little bit</td>
<td>Moderately</td>
<td>Quite a bit</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------</td>
<td>------------</td>
<td>-------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Feeling emotionally numb or being unable to have loving feelings for those close to you?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Feeling as if your future somehow will be cut short?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Trouble falling or staying asleep?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Feeling irritable or having angry outbursts?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Having difficulty concentrating?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Being &quot;super alert&quot; or watchful or on guard?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Feeling jumpy or easily startled?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17.</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Please list the stressful life experience(s) you were referring to when completing the above questions:

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________
Please rate how confident you are that you can do the following things at present, despite the pain. To indicate your answer circle one of the numbers on the scale under each item, where 0 = not at all confident and 6 = completely confident.

For example:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
</tr>
</tbody>
</table>

Remember, this questionnaire is not asking whether or not you have been doing these things, but rather how confident you are that you can do them at present, despite the pain.

1. I can enjoy things, despite the pain.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
</tr>
</tbody>
</table>

2. I can do most of the household chores (e.g. tidying-up, washing dishes, etc.), despite the pain.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
</tr>
</tbody>
</table>

3. I can socialise with my friends or family members as often as I used to do, despite the pain.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
</tr>
</tbody>
</table>

4. I can cope with my pain in most situations.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td></td>
</tr>
</tbody>
</table>

5. I can do some form of work, despite the pain. (“work” includes housework, paid and unpaid work).

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
<td>Confident</td>
</tr>
</tbody>
</table>
6. I can still do many of the things I enjoy doing, such as hobbies or leisure activity, despite pain.

   0 1 2 3 4 5 6
   Not at all       Completely
   Confident       Confident

7. I can cope with my pain without medication.

   0 1 2 3 4 5 6
   Not at all       Completely
   Confident       Confident

8. I can still accomplish most of my goals in life, despite the pain.

   0 1 2 3 4 5 6
   Not at all       Completely
   Confident       Confident

9. I can live a normal lifestyle, despite the pain.

   0 1 2 3 4 5 6
   Not at all       Completely
   Confident       Confident

10. I can gradually become more active, despite the pain.

    0 1 2 3 4 5 6
    Not at all       Completely
    Confident       Confident
**SPTS**

INSTRUCTIONS: The statements listed below describe beliefs, thoughts, feelings and actions that people have or do when they are in physical pain (i.e., when a part of their body hurts). Read each statement carefully and place a check mark (✓) in the box that best reflects how true that statement is for you.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I am in pain, it keeps me awake at night.</td>
<td>Not at all true</td>
<td>Slightly true</td>
<td>Somewhat true</td>
<td>Very true</td>
</tr>
<tr>
<td>2. When I am in pain, everything I see or do reminds me of the pain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. It scares me when I feel faint.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. When I feel pain, I'm scared that it's the beginning of a terrible problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Pain seems to bother me more than it does other people.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. When I feel pain, I think about it even when I don't mean to.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Other people notice when I tremble or feel shaky.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. When I'm in pain, I feel distant from people even when I'm talking to them.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. As soon as the pain comes on, I take medications to reduce it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. It embarrasses me when my stomach growls.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not at all true</td>
<td>Slightly true</td>
<td>Somewhat true</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>----------------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>11. When I'm in pain, things don't feel real.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I feel sick to my stomach when I am in pain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Pain sensations terrify me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I try to avoid activities that cause pain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. It scares me when I tremble or feel shaky.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I can't stand pain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>