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Characteristics of Patients with Lower Extremity Trauma with Improved and Not Improved Pain During Hospitalization: A pilot study

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Abstract

Background—Up to 62% of patients report chronic pain at the injury site 6–12 months after blunt trauma, with pain from lower extremity fractures exceeding that from other sites. High pain intensity at time of injury is a risk factor for chronic pain, but it is not clear what patient characteristics influence the pain intensity level during the immediate hospitalization following injury.

Aim—The purpose of this pilot study was to determine the feasibility of collecting pain scores from medical records, to calculate pain trajectories, and to determine whether it is possible to examine patient characteristics by classifying them into those whose pain improved and those whose pain did not improve.

Design—This descriptive study retrospectively reviewed medical records of 18 randomly chosen patients admitted to an academic trauma center.

Methods—Patient characteristics and pain scores were collected from electronic and handwritten medical records.

Results—The pain trajectories calculated from routinely collected pain scores during the in-patient stay showed that for 44% of the patients the pain improved during the hospitalization, for

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Conflicts of interest: none

39% the pain remained the same and for 17% the pain worsened. Variables age, smoking, weight, abbreviated injury scores, length of hospital stay, mean pain score and opioid equianalgesic dose differed based on pain trajectory.

Conclusion—While patient characteristics differed based on pain trajectory, any significant effects seen from individual tests should be considered tentative, given the number of analyses conducted on this data set. However, feasibility and significance of conducting a larger study has been established.

Keywords

pain trajectory; patient characteristic; chart review; trauma; retrospective

Background

Trauma is a major source of chronic pain (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006) and constitutes a large portion of the \$600 billion of annual pain-related healthcare costs (Institute of Medicine (US) Committee on Advancing Pain Research, Care, and Education (IOM), 2011). Up to 62% of patients report chronic pain at the site of injury six to twelve months after blunt trauma (Jenewein et al., 2009; Williamson et al., 2009), with pain from lower extremity fractures exceeding that from other injury sites (Rivara et al., 2008; Williamson et al., 2009). Patients with trauma-related chronic pain have a higher incidence of physical disability and post-traumatic stress disorder, miss more days of work, and seek medical care more frequently compared to those without chronic pain (Jenewein et al., 2009). In addition they report high levels of pain intensity, anxiety, and depression (Stålnacke, 2011) and a large proportion (87%) state that pain interferes with their daily activities (Clay et al., 2010). While the exact mechanism underlying the development of chronic pain following trauma is unclear, some of the risk factors for chronic pain following injury are older age, untreated anxiety and depression, female gender, fewer years of education and high pain intensity at time of injury (Clay, Dip, Watson, Dip, & Hons, 2012; Holmes et al., 2010; Rivara et al., 2008; Rosenbloom, Khan, McCartney, & Katz, 2013).

Factors associated with the development of chronic pain can be classified into groups of pre-hospital and in-hospital patient characteristics. Gender, age, anxiety, depression and education are pre-hospital patient characteristics that cannot be modified at the time of injury, but are useful to identify patients at risk of developing chronic pain. Other pre-hospital patient characteristics that have been associated with chronic pain are, race, income, education and urban/rural living (IOM, 2011). Some protective factors include physical activity, normal weight and adequate treatment of pain (IOM, 2011).

A modifiable in-hospital risk factor is acute pain as pharmacological and non-pharmacological treatments can effectively reduce acute pain (Berben et al., 2008) at the time of injury. However, approximately 70% of patients report pain during hospitalization (Jabusch, Lewthwaite, Mandzuk, Schnell-Hoehn, & Wheeler, 2015) and nearly 59% of fracture patients report moderate to severe pain at the time of discharge from the emergency department (Archer, Castillo, Wegener, Abraham, & Obremskey, 2012). Further, a considerable number (25 - 30%) do not receive any pain medication while in the emergency

department (Brown, Klein, Lewis, Johnston, & Cummings, 2003; Ware, Epps, Clark, & Chatterjee, 2012a). The mean pain score during hospitalization following injury has been reported to be higher for trauma patients who had chronic pain at 4 months ($M = 7.5$ versus 5.5) (Trevino, Harl, Deroon-Cassini, Brasel, & Litwack, 2014) and 12 months ($M = 5.3$ versus 3.8) (Holmes et al., 2010). A weakness of the mean pain score is that it is a condensed measure of central tendency and does not provide information on whether there ever is resolution of pain prior to discharge.

An alternative approach to using the mean pain score for comparison is to view pain scores as longitudinal data and apply growth curve modeling to calculate an individual pain trajectory of each patient's pain scores. Plotting pain scores over time and the associated slope allows the classification of patients into three groups: 1) those whose pain resolved over time (negative trajectory), 2) those whose pain was maintained at a constant level (flat trajectory), and 3) those whose pain worsened over time (positive trajectory) (Chapman, Donaldson, Davis, & Bradshaw, 2011). These categories can then be used to predict whether patients will or will not develop chronic pain, particularly when associated with pre- and in-hospital patient characteristics.

The purposes of this pilot study were to 1) determine which pain assessment tools were used, 2) where pain scores were recorded across electronic and handwritten medical records, 3) assess the frequency of missing data, 4) estimate the variance of pain and 5) assess the feasibility of using growth curve modeling to calculate pain trajectories. The goal was to determine whether it is possible to examine lower extremity trauma patient characteristic differences by classifying patients into those whose pain improved during hospitalization compared with those whose pain did not improve. This was done in advance of a larger study examining the intensity, duration, and timing effects of acute pain after lower extremity trauma and its role in the development of chronic pain.

Methods

Design and Sample

This was a descriptive retrospective chart review on patients admitted to a large academic urban trauma center. Helicopters and ambulances bring over 8,000 injured patients per year to this integrated trauma center with over 100 inpatient beds dedicated to emergency surgery, resuscitation, intensive care, and acute surgical care and treatment of trauma patients.

Using a random number generator, a random selection of patients from the trauma hospital's registry was chosen for further screening. To be eligible, a patient had to present with at least one blunt lower extremity trauma, be at least 21 years and older, have an Abbreviated Injury Scale (AIS) score of 1-5 for lower extremities and < 3 for other body systems and date of admission between September 17, 2011 and September 17, 2013. While the AIS score ranks injuries anatomically on a scale of one to six with one being minor and six unsurvivable (Trauma.org, n.d.), the total number of AIS scores a patient receives depends on the number of injuries sustained. Patients were excluded if they had a first listed diagnosis of hip fracture and/or admitted more than 24 hours after injury. To attain a 10%

sample size from a random sample of 200 patients, 20 patient charts were chosen for review. Two investigators (M.G. and C.R.) reviewed the list of eligible patients, selecting subjects with a variety of medical diagnoses and dates of admission to ensure variability in the data collection. IRB approval was obtained.

Data collection

Medical records were accessed on secure computers and data were entered directly into a Qualtrics database. Qualtrics Labs (2250 N. University Pkwy, 48-C, Provo, UT 84604) is a web-based software program where data is encrypted, password protected and maintained on their servers at a state-of-the-art storage facility. The medical records were available as electronic records and as handwritten progress notes that had been scanned and uploaded. Data were collected from admission to discharge for each patient.

Variables

Baseline patient characteristics consisted of age, gender, race, length of stay, mechanism of injury and AIS scores. Variables collected from the electronic medical record included admission blood toxicology screen for alcohol and drugs, smoking history, height, weight, detailed pain assessment, acute pain management services consult and pre- and post-treatment pain scores associated with the administration of analgesic medication. In the detailed pain assessment, patients chose the variable that most closely corresponded to the pain related question such as what provokes and relieves the pain, what is the quality, frequency, current, least, worst and goal of pain. Name and amount of medication administered for pain were obtained from the trauma resuscitation unit (area of stabilization immediately on arrival to trauma center) electronic medication administration record (eMAR) (inpatient hospitalization), and patient controlled analgesia flowsheets (inpatient hospitalization). Handwritten pain scores were obtained from the trauma resuscitation unit flowsheet and the inpatient patient care daily record. The date and time stamp associated with each pain score was also available for collection.

Mean pain scores were categorized into four pain categories: 1) no pain, pain score 0; 2) mild pain, pain scores 1 – 3; 3) moderate pain, pain scores 4 – 6; and 4) severe pain, pain scores 7 – 10. Body mass index was calculated from height and weight and patients were categorized into normal, overweight and obese categories according to Centers for Disease Control and Prevention guidelines (2014).

To be able to compare the amount of opioid medication received by each patient, the intravenous (IV) morphine equivalence was calculated using an on-line opioid analgesic converter (Globalrph, 2014) and double-checked using cross multiplication $[x \text{ mg of morphine IV} / \text{mg of current opioid}] * [\text{multiplied with equianalgesic factor of morphine IV} / \text{equianalgesic factor of current opioid}]$ (McPherson, 2009).

Data analysis

Analyses were conducted using SPSS 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Summary statistics included the mean, standard deviation, and range for continuous variables and frequencies and proportions for categorical variables.

Growth curve modeling was applied to explore within- and between-patient patterns of change. The level-1 analysis revealed how pain changed over time for each individual patient (Curran, Obeidat, & Losardo, 2011; Singer & Willett, 2003). The level-2 analysis focused on between-patient differences and was used to analyze which predictors were associated with certain patterns of change (Curran, 2011; Singer & Willett, 2003). Growth curve modeling requires a minimum of three data collection points, a continuous outcome, and the same instrument for data collection over time; it accommodates diverse data collection schedules, unique number of waves and is capable of including cases with partially missing data (Singer & Willett, 2003). Therefore, it is well suited to analyze the data in this study.

The pain trajectory for this study was created using pain scores collected during routine patient assessment to capture pain scores when patients were in pain as well as not in pain. For the pain trajectory, the intercept was the first pain score documented in the inpatient patient care daily record and the estimated slope or rate of change was the pain score course during hospitalization until discharge. Ordinary least squares, a statistical technique that tries to find the function that most closely approximates the data, was chosen to fit a linear change model (straight line) to depict individual trajectories. The intercept and slope were modeled as random effects. Based on previous literature examining trajectories in patients with postoperative pain (Althaus, Arránz Becker, & Neugebauer, 2014; Chapman et al., 2011) and pain following discharge from the emergency room (Chapman, Fosnocht, & Donaldson, 2012), a 50% confidence interval was created around each pain trajectory. If the 50% confidence interval included zero, the patient was classified as having a flat pain trajectory and categorized into the no change in pain group. Patients with a negative pain trajectory were classified as having improved pain and patients with a positive pain trajectory had worsened pain. Patients with no change in pain and worsened pain were grouped as having no improvement in pain.

Results

The registry had a total of 978 eligible patients for the 2-year time period. From a random sample of 200 patients, 20 charts were chosen for closer review, but two patients were excluded from analysis as they had been intubated and pain scores were not collected using the numeric pain rating scale. The final analysis was conducted on 18 patients that met the inclusion and exclusion criteria.

Patient characteristics

Patient characteristics, which had no missing values, are presented in Table 1. The youngest patient was 22 years old and the oldest was 66 years old. More patients were white (67%) and male (72%). The most common mechanism of injury was: motor vehicle and motorcycle accidents (61%), falls (28%) and crush injuries (11%). The mean number of AIS scores by patient was 3.6 ($SD = 1.6$). The lowest number of AIS scores by patient was one and the highest was seven. The shortest length of stay was 1.7 days and the longest was 5.7 days with an average length of stay of 3.7 ($SD = 1.2$) days. All patients had a surgical procedure performed for their injury.

Detailed pain assessment

All but one patient in the study sample had a detailed pain assessment performed during their hospitalization (Table 2). Pain frequency was missing for one, least pain score was missing for five and worst pain score was missing for four patients. While the mean time to a detailed inpatient pain assessment from admission was 17.4 hours ($SD = 11.3$) with a range from 6 to 49 hours, most of the patients (78%) had a pain assessment done within 24 hours of inpatient admission. As for what provokes the pain, 41% of the patients reported movement, 35% of patients reported rest, 12% reported both movement and rest, and 12% reported none. For 47% of the patients the pain was present always or most of the time. The method that offered the most relief was medication, although two patients reported that nothing provided relief from the pain. Aching was the most frequently reported pain quality followed by throbbing, burning and heaviness. Other qualities that were reported were sharpness, shooting, tenderness and numbness. The mean for the least pain score at time of the detailed pain assessment in this sample was moderate ($M = 4.7$, $SD = 2.7$). Half of the patients (53%) had mild pain as their goal, while one-third (29%) expected their pain to be moderate.

Medications ordered and administered for pain

A total of 42 different providers prescribed medication for pain for the 18 patients in this sample. The number of prescriptions ordered by physicians (56%) and nurse practitioners (44%) was fairly evenly split. Of the prescribed pain medications, 67% were ordered as needed (PRN) for pain. The combination of route, dose, strength and time interval varied 50 different ways for acetaminophen, fentanyl, hydromorphone, morphine, MS Contin and oxycodone.

One patient did not have medications recorded in the trauma resuscitation unit flowsheet and the abstractor was unable to read the dosage for three medications, consequently they were coded missing. The most frequently administered pain medication in the trauma resuscitation unit was IV fentanyl. It was administered 55% of the time followed by hydromorphone IV (18%), morphine IV (12%) and oxycodone by mouth (PO) (2%) (Figure 1A). In the eMAR (inpatient unit), oxycodone was the most commonly (38%) administered medication for pain followed by hydromorphone IV/PO (21%), MS Contin PO (9%), Oxycontin PO (8%), acetaminophen PO (8%) and morphine IV/PO (5%) (Figure 1B).

Pain scores recorded in trauma resuscitation unit and eMAR

The final pain score before being transferred to the operating room or inpatient unit was documented on the trauma resuscitation unit flowsheet for 54% of the patients. The mean final pain score was 4.9 ($SD = 2.1$) with the lowest pain score being three and the highest ten. The mean overall pain score for patients in the trauma resuscitation unit was 7.3 ($SD = 2.0$). The lowest mean pain score for an individual patient was 5.0 ($SEM = 0.35$) and the highest was 10 ($SEM = 0$).

Medications administered for pain during the inpatient stay documented in the eMAR, showed that 5% of pre-treatment pain scores and 17% of post-treatment pain scores were missing. The post-treatment pain score was recorded on average one hour after the

administration of medication for pain. The mean pre-treatment pain score was 6.5 ($SD = 2.4$) with lowest individual mean pain score being 2.6 ($SEM = 0.5$) and the highest 9.6 ($SEM = 0.3$). For post-treatment pain scores, 29% of the time the response was recorded “patient asleep, respirations within normal limits and no pain noted”. As 49% of post-pain scores were either missing or not coded on a numeric pain rating scale, they were not analyzed for this study.

Pain trajectory

A total of 302 data points were available from the inpatient patient care daily record flowsheet to calculate the pain trajectory for 18 patients. The highest number of pain scores recorded for a patient was 39 and the lowest was three. A total of 11 pain scores in the inpatient patient care daily record were documented outside the numeric pain rating scale, seven as “denies” and four as “asleep”. Variables recorded as denies were recoded to zero and asleep to missing. The mean number of pain scores for the sample was 16.8 ($SD = 9.35$). The shortest time period from admission to first pain score recorded post transfer from the trauma resuscitation unit to the inpatient unit was 4.02 hours and the longest was 37.50 hours; the median was 17.05 and the interquartile range was 19.71. The time interval between pain scores varied from one to 28 hours; 59% of pain scores were recorded within four hours of each other and six (33%) patients had their pain assessed at least every four hours during their inpatient stay.

The mean, median and mode pain score for all patients was similar, the mean was 5.3 ($SD = 2.90$), and the median and mode was five. The lowest mean pain scores for an individual patient was 2.9 ($SEM = .56$) and the highest was 10 ($SEM = 0$) (Figure 2). Two patients had a pain score of 10 at each assessment point. Categorizing mean pain scores into no pain, mild pain, moderate pain and severe pain showed that the majority (89%) of patients had moderate to severe pain during their inpatient stay. The mean of the first pain score recorded for all patients was 6.2 ($SD = 2.77$) and the mean of the last pain score recorded was 4.6 ($SD = 3.28$). Only three patients had a pain score of zero at the last pain assessment point.

The estimated intercept for the sample was 6.04 and the estimated slope was $-.017$ (50% CI = $-.025, -.017$), indicating that for the average patient the pain at the beginning was moderate and improved throughout the hospitalization. Examining the pain trajectory for each individual patient showed much variability in intercept and slope (Figure 3A). For 44% of the patients the pain improved during the hospitalization, while for 39% the pain remained the same and for 17% the pain worsened over time. Graphing pain trajectories based on each patient’s mean pain score category showed patients with severe pain either had a positive pain trajectory or had reported a pain score of 10 at each assessment point. Patients with mild pain had negative pain trajectories. Patients with moderate pain had either positive, flat or negative pain trajectories (Figure 3B). A closer examination of patients with similar mean pain scores revealed that they could have either a positive, flat or negative pain trajectory (Figure 3C).

Improved and not improved pain patient characteristics

Pre- and in-hospital patient characteristics categorized according to whether patients' pain improved or did not improve during inpatient hospitalization are detailed in Table 3. In this sample, 57% of the men and 50% of the women, 64% of white and 60% of black or African American had no improvement in pain. Patients with no improvement in pain were younger (40 vs. 44 years), current smoker (75%), positive toxicology screen (62%), normal weight (71%) and higher number of AIS scores (3.9 vs. 3.3). Further analysis of those whose pain did not improve revealed that those whose pain worsened were the younger (30 years vs. 45 years), had higher AIS scores (4.7 vs. 3.6) and longer hospital stays (3.9 days vs. 3.2 days) compared to those whose pain remained the same. Of in-hospital factors those whose pain did not improve had slightly shorter hospital stay (3.4 days vs. 3.6 days), higher mean pain scores in the trauma resuscitation unit (8.3 vs. 6.4) and inpatient unit (6.4 vs. 4.6), and a higher opioid equianalgesic dose averaged over 24 hours (61.1 mg vs. 56.3 mg). Patients whose pain worsened had the highest opioid equianalgesic dose administered of the three groups ($M = 88.4$, $SD = 39.6$), the highest number of pain scores recorded ($M = 61$, $SD = 28.8$) and the longest time (hours) until a detailed pain assessment was completed from time of admission ($M = 31$, $SD = 25.5$).

Discussion

In this study 1) the numeric pain rating scale was used to assess pain intensity, 2) it was feasible to collect pain scores and associated date and time stamps from electronic and handwritten medical records, 3) there were few missing variables except for the post-treatment pain scores, 4) there was variability in pain scores and 5) it was possible to calculate pain trajectories from routine pain scores collected during the inpatient hospital stay.

In-hospital factors: pain trajectory

The mean pain intensity score and pain categories in this study indicated that a majority of this sample experienced moderate to severe pain during hospitalization, which corresponds to that reported from other studies (Berben et al., 2008b; Bernstein, Gallagher, Cabral, & Bijur, 2009; Gordon et al., 2002). The pain intensity score is useful for measuring the magnitude or strength a person ascribes the pain experience. The most frequently used measurement tool to assess pain is the numeric pain rating scale (The Joint Commission (TJC), 2011). A major benefit of the numeric pain rating scale is that it permits quantification of pain, which can then be used for statistical analyses, except, it does not take into consideration how long it takes to the pain to come to an end (Chapman et al., 2012). The calculated mean pain score from the numeric pain rating scale also makes it difficult to analyze between-patient pain scores as each person's pain score is influenced by past experiences with pain (Dionne, Bartoshuk, Mogil, & Witter, 2005); one patient's pain score of five might not be the same magnitude or strength as another patient's pain score of five. In this study the pain trajectory revealed that patients with similar mean pain scores experienced both improved and not improved pain, indicating that some interventions, individual characteristics or injury healing were effective at reducing pain over time, but this was not apparent when only examining the mean pain score. This is why growth curve

modeling is advantageous, as it allows comparisons between patients regardless of what the patient's mean pain score is. This modeling technique is also beneficial in that it accommodates diverse data collection schedules, unique number of waves and is capable of including cases with partially missing data (Singer & Willett, 2003). But as with mean pain scores, the more pain scores that are available for analysis, the more accurate the pain trajectory (Singer & Willett, 2003).

In-hospital factors: pain assessment

The Joint Commission (2011) Standard PC.01.02.07 states that every patient has the right to assessment and management of pain, but others have reported that pain assessment of hospitalized patients is sporadic and lingers around 52% to 59% (Brown et al., 2003; Ware, Epps, Clark, & Chatterjee, 2012b). In a report from The Joint Commission: The National Pharmaceutical Council (2001), the most common reason for the undertreatment of pain is the failure of clinicians to assess pain and pain relief. In a study of trauma patients in an emergency room, 60% of patients who had pain scores documented received analgesics compared to 33% of those who did not (Silka, 2004). However one study examining patients with fractures did not find a difference in the administration of analgesia between those with and without pain scores documented (Brown et al., 2003). In this study, every patient had his or her pain assessed and all but one patient had a detailed pain assessment completed.

In-hospital factors: pain medication

The higher morphine equivalence dose administered to patients whose pain worsened in this study resembles that of studies of postoperative pain where higher opioid use has been associated with greater pain intensity (Bot, Bekkers, Arnstein, Smith, & Ring, 2014). Higher analgesic use has also been found following surgery in patients who are younger, have emergency surgery, experience pre-operative pain and high anxiety (Ip, Abrishami, Peng, Wong, & Chung, 2009). Opioid-tolerance is another factor that has been associated with higher pain intensity scores (Low, Clarke, & Huh, 2012) and with an increased sensitivity to pain (Blay, Glover, Bothe, Lee, & Lamont, 2012). While higher morphine equivalence at time of injury has been associated with chronic pain (Holmes et al, 2010), further clinical and pre-clinical studies would be important to elucidate the underlying mechanism.

In the current study the percentage of patients whose pain did not improve was higher than what has been reported in patients with postsurgical pain following elective surgery (Althaus et al., 2014; Chapman et al., 2012). One important distinction between elective and post-trauma surgical procedures is that preemptive analgesia and education related to pain management can be administering prior surgery, but it is not always possible for trauma as injury is inherently unpredictable (Radresa et al., 2014). Consequently, the administration of analgesics necessarily occurs following traumatic injury so that the focus of pain control becomes more related to controlling pain that began prior to admission rather than preventing pain from occurring (Radresa et al., 2014).

Treatment bias can also result when patients with higher pain scores receive more aggressive pain treatment compared to patients with lower pain scores. In this study, some of the pain medication orders were based on the pain score reported by the patient, where a higher pain

scores would have resulted in a higher dose of pain medication and possibly better pain control. In addition, treating each pain score as a separate event treats the pain intensity, but not the resolution of pain (Chapman et al., 2012). With the use of electronic medical records, patients whose pain does not improve can be identified and interventions can be introduced early in the recovery period (Chapman et al., 2012).

Pre-hospital patient characteristics

This analysis did not test for differences in pre-hospital patient characteristics, but gender, race, age, smoking and opioid dependence have been associated with individual differences in pain (IOM, 2011). While women and older adults (Fillingim, 2005; Gibson & Farrell, 2004; Manson, 2010) have a higher pain prevalence for clinical pain conditions, Chapman et al. (2011) did find that women resolved their pain more quickly following elective surgery compared to men. Although black or African Americans (Rahim-Williams & Fillingim, 2012; Riley et al., 2014) show enhanced sensitivity to experimentally induced pain (Fillingim, 2005; Gibson & Farrell, 2004), no race differences have been found in regard to baseline pain scores (Bernstein et al., 2009) or in analgesic treatment of long-bone fractures (Bijur, Bérard, Esses, Calderon, & Gallagher, 2008; Fuentes, Kohn, & Neighbor, 1999; Ware et al., 2012). Other associations between factors such as older age and an increased pain threshold (Fillingim, 2005; Gibson & Farrell, 2004), or smoking and lower back pain (Ferreira, Beckenkamp, Maher, Hopper, & Ferreira, 2013), have been found. These studies and the results from the current investigation underscore the importance of analyzing specific patient characteristics (e.g. gender, race, age, smoking) associated with the development of chronic pain so that more can be learned about these important risk factors.

Limitations

Limitations associated with this study were that it did not include treatment administered by emergency medical services on route to the hospital or the amount of analgesia administered during surgical procedure or in the post anesthesia care unit. The small sample size and retrospective study design also makes it difficult to establish cause and effect. In addition, any significant effects seen from individual tests should be considered tentative, given the number of analyses conducted on this data set. As for calculating the pain trajectory, the higher the number of data collection points, the more accurate the trajectory and one patient in this study only had three pain scores recorded in the inpatient patient care daily record. Finally, post-treatment medication scores were not analyzed, which could reveal important information about the effectiveness of medication administered.

Implications for nursing education, practice and procedures

Nurses are involved in direct care of patients with acute/chronic pain; as such, they are in an excellent position to improve patient lives by providing high-quality patient care. Since assessment, treatment and re-assessment of pain is an integral function of nursing care, nurses can at an early stage determine whether pain treatment is adequate; if it is not, an alternate treatment can be initiated. Study findings can be used to address the importance of early and adequate acute pain treatment following trauma as well as treating the resolution of pain and not only the pain score at a specific time point. Nurses are in an excellent position to advance pain research as they are very well acquainted with pain assessment and

treatment and can draw on these skills to design interventions to alleviate pain. There is also potential for new trauma specific practice guidelines and standardized protocols that address pain treatment.

Conclusion

Despite the emphasis on frequent pain assessment and pain control in patient care, half of patients with LE trauma in this sample had no improvement or worsening pain during hospitalization. Further exploration of pre- and in-hospital patient characteristics are warranted as these may be predictive of in-hospital pain thus influencing pain management strategies Phase two of this study will follow patients after discharge to examine factors leading to chronic pain.

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Figure 1.

(A) Distribution of medications administered for pain during patient stay the trauma resuscitation unit. (B) Distribution of medications administered for pain during hospitalization following stabilization in the trauma resuscitation unit.

Figure 2.

Distribution of mean pain score by patient, mean (SEM). Pain scores collected from patient care daily record. NRS = numeric rating scale.

Figure 3.

Fitted OLS pain trajectories for each individual patient with lower extremity trauma calculated from pain scores recorded in the patient care daily record. (A) Much variability in intercept and slope for individual patients (B) Pain trajectories categorized by mean pain score category. Mild pain (pain score 1-3), moderate pain (pain score 4-6) and severe pain (pain score 7-10). (C) The mean pain score does not predict resolution of pain. Patients with similar mean pain scores can have positive, flat or negative pain trajectories during hospitalization.

Hours = time from first pain score recorded in patient care daily record.

NRS = numeric rating scale.

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Table 1
Descriptive Characteristics of Lower Extremity Trauma Patients (N = 18)

Characteristic	Total
Age, M (SD)	43 (14)
Male, n (%)	14 (78)
White, n (%)	12 (67)
Length of stay, M (SD)	3.7 (1.2)
Mechanism of injury, n (%)	
Fall	5 (28)
Motor vehicle ^a	11 (61)
Other ^b	2 (11)
Number of AIS scores, M (SD)	3.6 (1.6)

Note.

^aIncludes motor vehicle and motorcycle accidents,

^bStruck by object

Table 2
Detailed pain assessment (N = 17)

Variable	Total
Time to pain assessment, hours, M (SD)	17.4 (11.3)
Present pain, M (SD)	6.0 (2.8)
Least pain, M (SD)	4.7 (2.7)
Worst pain, M (SD)	8.8 (1.9)
Pain goal, n (%)	
No pain (0)	3 (18)
Mild pain (1-3)	9 (53)
Moderate pain (4-6)	5 (29)
Provokes the pain, n (%)	
At rest	6 (35)
Movement	7 (41)
At rest/movement	2 (12)
None	2 (12)
Relieves the pain, n (%)	
Medication	15 (88)
Pain quality, n (%)	
Aching	9 (53)
Pain frequency, n (%)	
Always/Most of the time	8 (47)

Table 3
Patient characteristics based improved and not improved pain

	Pain improved	Pain not improved		
Characteristic		Total	Pain the same	Pain worsened
Pre-hospital factors				
Gender, n (%)				
Male	6 (43)	8 (57)	6 (43)	2 (14)
Female	2 (50)	2 (50)	1 (25)	1 (25)
Race, n (%)				
White	4 (36)	7 (64)	5 (45)	2 (18)
Black	2 (40)	3 (60)	2 (40)	1 (20)
Other	2 (100)			
BMI, n (%)				
Normal	2 (29)	5 (71)	4 (57)	1 (14)
Overweight		2 (100)	1 (50)	1 (50)
Obese	6 (67)	3 (33)	2 (22)	1 (11)
Age, M (SD)	44 (13.5)	40 (15)	45 (15.3)	30 (8.5)
Number of AIS scores, M (SD)	3.3 (1.5)	3.9 (1.8)	3.6 (2.0)	4.7 (1.2)
Positive toxicology screen, n (%)	3 (38)	5 (62)	3 (38)	2 (24)
Current smoker, n (%)	1 (25)	3 (75)	1 (25)	2 (50)
In-hospital factors				
APMS consult, n (%)	3 (50)	3 (50)	2 (28)	1 (33)
Time between pain scores				
At least every four hours, n (%)	2 (33)	4 (67)	3 (75)	1 (25)
Some more than 4 hours, n (%)	6 (50)	6 (50)	4 (66)	2 (33)
PCA, n (%)	2 (67)	1 (33)		1 (33)
Length of stay, M (SD)	3.6 (1.3)	3.4 (1.0)	3.2 (0.8)	3.9 (1.4)
Time to detailed pain assessment (hours), M (SD)	16.1 (8.8)	18.4 (13.5)	14.9 (8.2)	31.0 (25.5)
Pain goal, M (SD)	3.3 (2.3)	1.8 (1.4)	1.6 (1.3)	3.0 (1.4)
TRU pain score, M (SD)	6.4 (0.9)	8.3 (1.4)	8.4 (1.6)	8.2 (0.9)
Pre-pain score, M (SD)	5.2 (1.3)	7.1 (1.4)	6.5 (2.5)	6.1 (1.3)
Routine Pain score, M (SD)	4.6 (1.4)	6.4 (2.2)	6.0 (2.8)	6.2 (2.2)
Mild	2 (100)			
Moderate	5 (42)	7 (58)	5 (72)	2 (28)
Severe	1 (25)	3 (75)	2 (67)	1 (33)
Number of pain scores, M (SD)	47.2 (19.9)	47.3 (21)	41.4 (15.9)	61.0 (28.8)
Intercept, M (SD)	7.8 (2.0)	6.4 (2.2)	6.8 (2.3)	5.4 (1.6)
Slope, M (SD)	−0.09 (.19)	−.007 (.04)	0.01 (.01)	0.03 (0.02)
Opioid equianalgesic per 24 hours, M (SD)	56.3 (30.6)	61.1 (28.5)	49.4 (12.7)	88.4 (39.6)

Note. AIS = Abbreviated Injury Scale. APMS = Acute Pain Management Services. PCA = Patient Controlled Analgesia. TRU = Trauma Resuscitation Unit.