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ORIGINAL RESEARCH

Analgesic Use Among Adults with a Trauma-Related Emergency Department Visit: A Retrospective Cohort Study from Alberta, Canada

Bill Sevcik · Kevin Lobay · Huong Luu · Karen J. B. Martins · Khanh Vu · Phuong Uyen Nguyen · Solmaz Bohlouli · Dean T. Eurich · Erica L. W. Lester · Tyler Williamson · Lawrence Richer · Scott W. Klarenbach

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ABSTRACT

Introduction: A better understanding of current acute pain-driven analgesic practices within the emergency department (ED) and upon discharge will provide foundational information in this area, as few studies have been conducted in Canada.

Methods: Administrative data were used to identify adults with a trauma-related ED visit in the Edmonton area in 2017/2018. Characteristics of the ED visit included time from initial contact to analgesic administration, type of analgesics dispensed during and upon being discharged home directly from the ED (≤ 7 days after), and patient characteristics.

Results: A total of 50,950 ED visits by 40,505 adults with trauma were included. Analgesics were administered in 24.2% of visits, of which non-opioids were dispensed in 77.0% and opioids were dispensed in 49.0%. Time to analgesic

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B. Sevcik · K. Lobay
Department of Emergency Medicine, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, AB, Canada

H. Luu · K. J. B. Martins · K. Vu
Real World Evidence Unit, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, AB, Canada

P. U. Nguyen
Centre for Health Informatics, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada

S. Bohlouli
Department of Medicine, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, AB, Canada

D. T. Eurich
School of Public Health, University of Alberta, Edmonton, AB, Canada

E. L. W. Lester
Department of Surgery, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, AB, Canada

T. Williamson
Department of Community Health Sciences, Centre for Health Informatics, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada

L. Richer
Department of Pediatrics, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, AB, Canada

S. W. Klarenbach (✉)
Department of Medicine and Real World Evidence Unit, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, AB, Canada
e-mail: swk@ualberta.ca

initiation occurred more than 2 h after first contact. Upon discharge, 11.5% received a non-opioid and 15.2% received an opioid analgesic, among whom 18.5% received a daily dose ≥ 50 morphine milligram equivalents (MME) and 30.2% received > 7 days of supply. Three hundred and seventeen adults newly met criteria for chronic opioid use after the ED visit, among whom 43.5% received an opioid dispensation upon discharge; of these individuals, 26.8% had a daily dose ≥ 50 MME and 65.9% received > 7 days of supply.

Conclusions: Findings can be used to inform optimization of analgesic pharmacotherapy practices for the treatment of acute pain, which may include reducing the time to initiation of analgesics in the ED, as well as close consideration of recommendations for acute pain management upon discharge to provide ideal patient-centered, evidence-informed care.

Keywords: Administrative data; Analgesia; Emergency department; Retrospective

Key Summary Points

Why carry out this study?

Pain is one of the most common presenting complaints by adults in the emergency department (ED). However, few studies have investigated analgesic practices within the ED in Canada.

This study answered the question of what are the current acute pain-driven analgesic practices within the ED and upon discharge for adults in Alberta, Canada.

What was learned from this study?

Analgesics were administered in 24.2% of trauma-related ED visits by adults, of which the majority were non-steroidal anti-inflammatory drugs, and time to analgesia initiation occurred more than 2 h after first contact in the ED.

Findings can be used to inform optimization of analgesic pharmacotherapy practices for the treatment of acute pain.

Further research into the continued development of non-opioid analgesics, as well as providing access to currently approved opioid alternatives will offer healthcare providers additional options for improved treatment of acute pain.

INTRODUCTION

Pain is the most common reason for seeking healthcare services and has been reported as the presenting complaint in up to 78% of emergency department (ED) visits [1]. Therefore, effective strategies for pain management are of great importance within this specific healthcare service [2]. Acute pain is commonly undertreated in the ED [3], and suboptimal management can result in adverse outcomes including the risk of progression to chronic pain [4]. According to the World Health Organization pain ladder, mild acute trauma-related pain can be managed with non-opioid analgesics such as non-steroidal anti-inflammatory drugs (NSAIDs), and opioids are suggested for moderate-to-severe acute trauma-related pain [5]. An understanding of opioid treatment recommendations in conjunction with safety concerns should be taken into consideration when using opioids to treat acute pain, as use can lead to tolerance and dependence, and in some cases, misuse [6]. Acute pain management also requires specific approaches for individuals with opioid and/or other addictions [7]. A better understanding of current acute pain-driven analgesic practices within the ED will provide foundational information in this area and may lead to the optimization of pain management strategies, as few studies have been conducted in Canada. Therefore, the objectives of this study were to describe the characteristics of adult trauma-related ED visits including types of analgesics administrated, analgesic use upon discharge, as well as patient characteristics.

METHODS

Study Design

This retrospective cohort study used administrative health data without any intervention and was reported according to the strengthening of the reporting of observational studies in epidemiology (STROBE) guidelines [8]. Ethics approval for this study was received from the University of Alberta institutional review board (Pro00096969). No participants were placed at risk as a result of the study, and informed consent was not required.

Data Source

Data from the National Ambulatory Care Reporting System (NACRS), Discharge Abstract Database (DAD), Practitioner Claims, Pharmaceutical Information Network (PIN), and the Drug Optimization, Sustainability, and Evaluation (DOSE) database were linked to the Population Registry that contains demographic information for all Albertans with Alberta Health Care Insurance Plan (AHCIP) coverage; all Alberta residents are eligible and over 99% participate. NACRS and DAD include information on all individuals discharged from facility-based ambulatory care clinics including EDs and hospitals, respectively; a most responsible diagnosis code and secondary codes are included. Practitioner Claims includes information on physician billing; up to three diagnostic codes can be listed per visit. PIN contains information on dispensed prescription medications from all community pharmacies. DOSE houses medication information from all hospital pharmacies and nine select ED sites located within the Edmonton area.

Cohort Selection

Eligibility criteria for the event-defined cohort included: (1) all ED visits by adults ($\geq$ 18 years) in Alberta between April 1, 2017 and March 31, 2018 (inclusion period) that contained a trauma diagnosis code in the primary diagnostic field and did not contain any exclusionary trauma diagnostic codes in any diagnostic field (see Table S1 in the electronic supplementary material), and (2) information from the ED site that the visit occurred was linkable to the DOSE database (i.e., the nine select ED sites located within the Edmonton area). Eligibility criteria for the subject-defined cohort included adults within the event-defined cohort who had AHCIP coverage for $\geq$ 2 years before and $\geq$ 1 year after their first trauma-related ED visit within the inclusion period (index ED visit). Cohorts were subgrouped according to mode of arrival to the ED (walk-in, ambulance) and the type of analgesic administered during the visit (both opioids and non-opioids, opioids only, non-opioids only, or none).

Measures

ED visit characteristics included the Canadian Triage and Acuity Scale (CTAS) level, trauma type and cause, as well as time from initial contact to analgesic administration, length of stay, and discharge destination. Characteristics of analgesics administered during the ED visit and dispensed $\leq$ 7 days after the index ED visit among those discharged home directly from the ED included route of administration, and drug class/name; opioids also included dose (morphine milligram equivalent [MME]), formulation, and days of supply [9]. Table S2 in the electronic supplementary material lists the analgesic drugs included.

Demographic characteristics on the index ED visit date included age, sex, and urban/rural residence. Clinical characteristics were determined during the 2-year pre-index period that included a Charlson Comorbidity Index (CCI) score, and health conditions associated with a high-risk of opioid use disorder (chronic pain, mental illness [depression, dementia, and schizophrenia], substance abuse, and physical illness [cerebrovascular disease, chronic heart failure, chronic pulmonary disease, diabetes, liver disease, migraine, renal disease, and rheumatoid arthritis/collagen vascular disease]) [10–13]; Table S3 in the electronic supplementary material details the case definitions [14–18]. Individuals who met chronic opioid

use criteria (≥ 90 consecutive days of supply of opioids within a 1-year period, excluding buprenorphine and methadone used for treatment of opioid use disorder) was also reported [15].

Statistical Analyses

Continuous variables were reported using summary statistics (mean and standard deviation [SD], median and interquartile range [IQR], or minimum and maximum [min/max]), and categorical variables were reported using counts and percentages. Analyses were performed using SAS 9.4 software.

RESULTS

Cohort Selection

Of the 299,005 trauma-related ED visits by adults that occurred during the inclusion period in Alberta, 50,950 occurred at the nine ED sites where medication administration data (DOSE) was available; 40,505 met the criteria for the subject-defined cohort (Fig. 1).

ED Visit Characteristics

Among trauma-related ED visits, the most common mode was walk-in (80.6%), 46.0% were classified as semi-urgent, and 38.2% were a musculoskeletal trauma type (Table 1). Analgesics were administered in 24.2% of visits that occurred a median of 133 min (5 min/1888 max) after first contact in the ED. Those that arrived by ambulance (compared with walk-in) had higher proportions with a CTAS level of urgent or higher (78.8 vs. 42.5%) and who received analgesics (33.7 vs. 21.9%). Table S4 in the electronic supplementary material details ED visit characteristics by subgroupings.

Among those that received analgesics during the trauma-related ED visit (Table 2), 77.0% received non-opioids and 49.0% received opioids (51.0% non-opioids only, 26.0% both non-opioids and opioids, and 23.0% opioids only; see Table S5 in the electronic supplementary material). NSAIDs were the most commonly administered analgesia (70.7% among those that received an analgesic; 91.8% among those that received a non-opioid analgesic), followed by oxycodone (19.4% among those that received an analgesic; 39.6% among those that received an opioid) and morphine (17.5% among those that received an analgesic; 35.8% among those that received an opioid). The median opioid MME dose dispensed in the ED was 19 (IQR 28) (walk-in: 15 [IQR 21]; ambulance: 30 [IQR 28]).

Baseline Subject Characteristics

On the index ED visit date, the overall average age was 45 (SD 20) years, 53.8% were male, and the vast majority lived in urban areas (90.2%; Table 3). Overall, subjects had a mean CCI score of 0.5 (SD 1.2), and common comorbidities of interest (> 10%) were chronic pain and depression. Those who arrived by ambulance (compared with walk-in) were more likely to be older (57 [SD 23] vs. 47 [SD 18] years of age), female (53.8 vs. 44.5%), and have a higher overall burden of disease (CCI score: 1.0 [SD 1.7] vs. 0.4 [SD 1.0]). Table S6 in the electronic supplementary material shows characteristics based on subgroupings.

Opioid Use Before and During the Index ED Visit

Individuals with opioid use (walk-in: 31.8–39.8 vs. 21.1–25.6%; ambulance: 36.6–43.9 vs. 30.7–30.8%), and those who met chronic opioid use criteria (walk-in: 14.9–17.2 vs. 9.6–10.0%; ambulance: 21.9–26.1 vs. 12.2–17.8%) during the 1-year period before the index ED visit were more likely to receive opioids during the index ED visit versus those that did not (see Table S7 in the electronic supplementary material).

Analgesic Medication Use Upon Discharge from the Index ED Visit

Table 4 details outpatient analgesic medication dispensations that occurred during the first 7 days after the index ED visit, among those

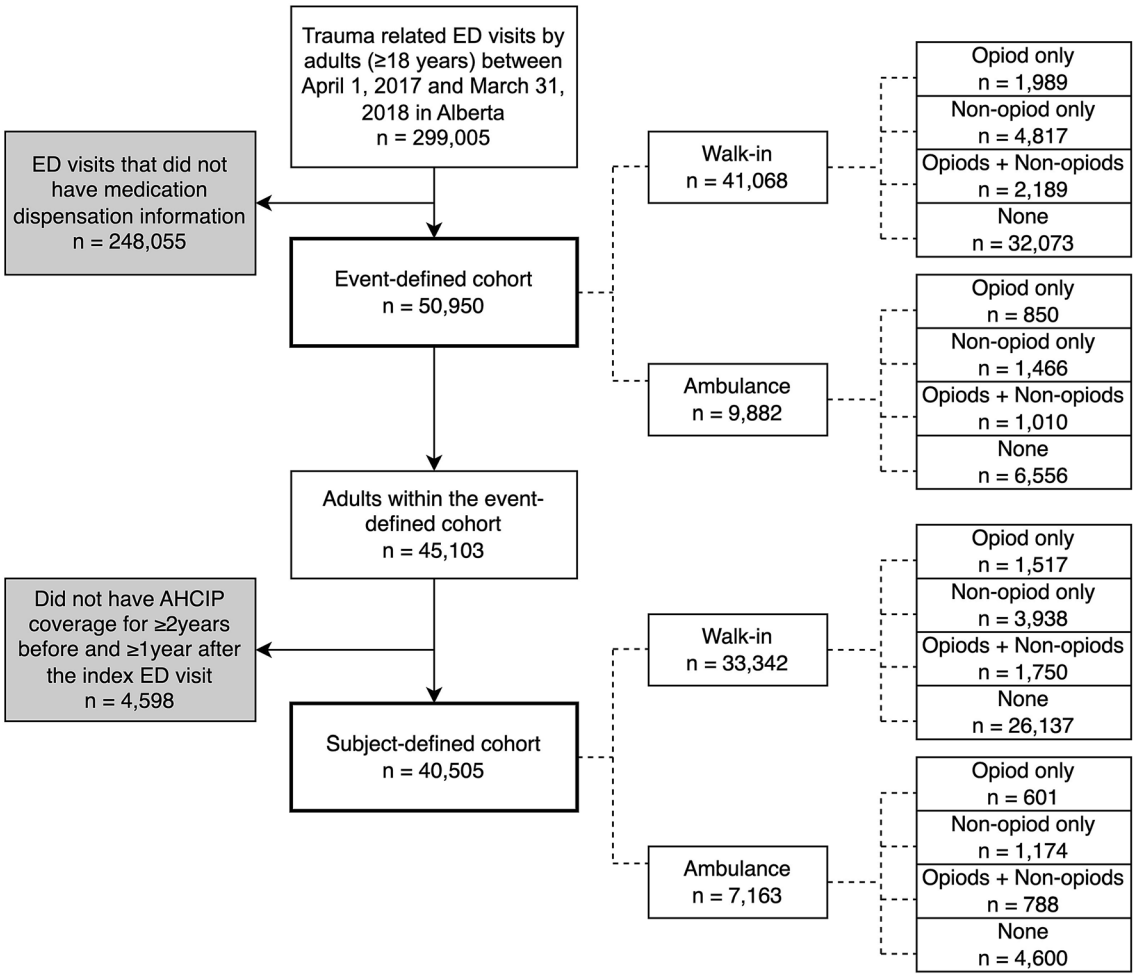

Fig. 1 Event-defined and subject-defined cohort selection. *AHCIP* Alberta Health Care Insurance Plan, *ED* emergency department

discharged home directly from the ED (86.7% of the subject-defined cohort). Among these individuals, 11.5% received ≥ 1 non-opioid analgesic, of which the vast majority received NSAIDs (90.2%), and 15.2% received ≥ 1 opioid dispensation. Among those that received an opioid dispensation, a median daily dose of 36 (IQR 20) MME with a 5 (IQR 7)-day supply was dispensed; 18.5% received ≥ 50 MME daily dose and 30.2% received > 7 days of supply. The vast majority of those with an opioid dispensation received an immediate-release formulation (98.1%) and an oral route of administration (99.0%); the most common types were codeine, tramadol, and oxycodone.

Those who met chronic opioid use criteria during the 1-year pre-index period (versus those that did not) had a higher proportion who received an opioid dispensation upon discharge 47.5 vs. 14.3%; Table 4). Among those who received an opioid dispensation upon discharge, those who met chronic opioid use criteria before the index ED visit (versus those that did not) had a higher proportion who received a daily dose ≥ 50 MME (37.0 vs. 16.8%) and > 7 days of supply (64.7 vs. 26.9%). Among 317 individuals who newly met chronic opioid use criteria during the 1-year period after being discharged home directly from the index ED visit, 43.5% received an opioid dispensation within the first 7 days; of these individuals,

Table 1 Trauma-related emergency department characteristics

	All visits	Mode of arrival to the ED	
	(*N* = 50,950)	Walk-in (*N* = 41,068)	Ambulance (*N* = 9882)
CTAS level, n (%)			
Resuscitation	203 (0.4%)	< 10 (NA)	197 (2.0%)
Emergent	4022 (7.9%)	> 2020 (> 4.9%)	1992 (20.2%)
Urgent	21,039 (41.3%)	15,441 (37.6%)	5598 (56.7%)
Semi-urgent	23,419 (46.0%)	21,378 (52.1%)	2041 (20.7%)
Non-urgent	2267 (4.5%)	2213 (5.4%)	54 (0.6%)
Trauma type, n (%)			
Musculoskeletal	19,462 (38.2%)	15,110 (36.8%)	4352 (44.0%)
Open wound, including amputation	11,730 (23.0%)	10,101 (24.6%)	1629 (16.5%)
Superficial	9586 (18.8%)	7898 (19.2%)	1688 (17.1%)
Other and unspecified	5440 (10.7%)	4638 (11.3%)	802 (8.1%)
Internal organ	3704 (7.3%)	2473 (6.0%)	1231 (12.5%)
Burn and corrosion	776 (1.5%)	651 (1.6%)	125 (1.3%)
Crushing	163 (0.3%)	150 (0.4%)	13 (0.1%)
Nerves and spinal cords	49 (0.1%)	29 (0.1%)	20 (0.2%)
Blood vessels	40 (0.1%)	18 (0%)	22 (0.2%)
Trauma cause (can be ≥ 1 per encounter), n (%)			
Unintentional fall	19,041 (37.4%)	13,755 (33.5%)	5286 (53.5%)
Mechanical forces	17,474 (34.3%)	16,522 (40.2%)	952 (9.6%)
Transport incidents	6072 (11.9%)	4023 (9.8%)	2049 (20.7%)
Natural or environmental factors	4902 (9.6%)	4401 (10.7%)	501 (5.1%)
Assault, excluding poisoning	2442 (4.8%)	1577 (3.8%)	865 (8.8%)
Fire or burn	703 (1.4%)	610 (1.5%)	93 (0.9%)
Self-harm, excluding poisoning	296 (0.6%)	172 (0.4%)	124 (1.3%)
Other, excluding poisoning	164 (0.3%)	94 (0.2%)	70 (0.7%)
Unintentional drowning and submersion	< 10 (N/A)	< 10 (N/A)	< 10 (N/A)
Suffocation	< 10 (N/A)	< 10 (N/A)	< 10 (N/A)
Analgesics			
Received an analgesic	12,321 (24.2%)	8995 (21.9%)	3326 (33.7%)
Time from first contact until analgesia, minutes			
Mean (SD)	160 (118)	152 (109)	180 (137)

Table 1 continued

	All visits	Mode of arrival to the ED	
	(*N* = 50,950)	Walk-in (*N* = 41,068)	Ambulance (*N* = 9882)
Median (min; max)	133 (5; 1888)	127 (5; 1813)	150 (6; 1888)
Length of stay, minutes			
Mean (SD)	227 (206)	193 (156)	371 (304)
Median; min; max	178 (0; 5676)	160 (0; 5548)	299 (1; 5676)
Discharge destination: n (%)			
Home without support	42,569 (83.6%)	37,218 (90.6%)	5351 (54.2%)
Admitted to inpatient facilities	4065 (8.0%)	880 (2.2%)	3185 (32.2%)
Left without being triaged/seen/treated	2359 (4.6%)	2051 (5.0%)	308 (3.1%)
Transferred to another acute care	661 (1.3%)	351 (0.9%)	310 (3.1%)
Home with support	726 (1.4%)	141 (0.3%)	585 (5.9%)
Other	529 (1.0%)	418 (1.0%)	111 (1.1%)
Transferred to non-acute care	24 (0.1%)	< 10 (N/A)	15 (0.2%)
Died	17 (0.0%)	< 10 (N/A)	17 (0.2%)

CTAS Canadian Triage and Acuity Scale, *ED* emergency department; *Min* minimum, *Max* maximum *N/A* not applicable, *SD* standard deviation

26.8% received a daily dose ≥ 50 MME and 65.9% received > 7 days of supply.

DISCUSSION

Using administrative data, adult trauma-related analgesic practices within Edmonton area EDs were characterized; analgesics were administered in 24.2% of visits, of which the majority were NSAIDs, and occurred more than 2 h after first contact in the ED. Those who met chronic opioid use criteria before the ED visit were more likely to receive opioids during and upon discharge from the ED than those who did not meet criteria. Among the 317 individuals who newly met chronic opioid use criteria after being discharged home directly from the index ED visit, 43.5% received an opioid dispensation upon discharge.

As outlined by Ahmadi et al. (2016), providing appropriate and timely pain management to trauma patients has been shown to be beneficial, including the promotion of early healing, reduction of physiological stress responses, shortened length of hospital stay, decreased risk of progression to chronic pain, and reduced rate of morbidity and mortality [4]. The British Royal College of Emergency Medicine states that patients with severe pain should have analgesics administered within 15-min of arrival to the ED or at triage, and those with moderate pain should have analgesics offered at triage [19]. However, the proportion of individuals that receive analgesics and the time to initial administration appears to vary widely. A large multicenter study that assessed pain management within USA and Canadian EDs found that 60% of patients who presented with moderate-to-severe pain received analgesics

Table 2 Analgesics administered during trauma-related emergency department visits

	All visits	Mode of arrival to the ED	
	(*N* = 50,950)	Walk-in (*N* = 41,068)	Ambulance (*N* = 9882)
Visits with ≥ 1 administration of any analgesic, *n* (%)	12,321 (24.2%)	8995 (21.9%)	3326 (33.7%)
Non-Opioids			
Visit with ≥ 1 administration of a non-opioid, *n* (%)	9482 (77.0%)	7016 (78.0%)	2476 (74.4%)
Route of administration			
Oral	4703 (49.6%)	3461 (49.3%)	1242 (50.2%)
Parenteral	5412 (57.1%)	3958 (56.4%)	1454 (58.7%)
Drug class			
Non-steroidal anti-inflammatory drugs	8707 (91.8%)	6474 (92.3%)	2233 (90.2%)
General anesthetics	1130 (11.9%)	798 (11.4%)	332 (13.4%)
Gabapentinoids	40 (0.4%)	18 (0.3%)	22 (0.9%)
Opioids			
Visit with ≥ 1 administration of an opioid, *n* (%)	6038 (49.0%)	4178 (46.4%)	1860 (55.9%)
Morphine milligram equivalent (median, IQR)	19 (21)	15 (21)	30 (28)
Formulation			
Immediate-release	6031 (99.9%)	4175 (99.9%)	1856 (99.8%)
Controlled release	22 (0.4%)	11 (0.3%)	11 (0.6%)
Route of administration			
Oral	3864 (64.0%)	2861 (68.5%)	1003 (53.9%)
Parenteral	3161 (52.4%)	1904 (45.6%)	1257 (67.6%)
Drug name			
Oxycodone	2390 (39.6%)	1787 (42.8%)	603 (32.5%)
Morphine	2162 (35.8%)	1343 (32.1%)	819 (44.1%)
Codeine	1163 (19.3%)	872 (20.9%)	291 (15.7%)
Hydromorphone	764 (12.7%)	407 (9.7%)	357 (19.3%)
Fentanyl	742 (12.3%)	449 (10.8%)	293 (15.8%)
Tramadol	182 (3.0%)	141 (3.4%)	41 (2.2%)
Methadone	< 10 (N/A)	< 10 (N/A)	< 10 (N/A)

ED emergency department; *IQR* interquartile range, *N/A* not applicable,

Table 3 Baseline characteristics of subjects who had a trauma-related emergency department visit

	All subjects	Mode of arrival to index ED visit	
	(*N* = 40,505)	Walk-in (*N* = 33,342)	Ambulance (*N* = 7163)
Demographic characteristics			
Age (years)			
Mean (SD)	45 (20)	43 (18)	57 (23)
Category, *n* (%)			
18–24	6267 (15.5%)	5599 (16.8%)	668 (9.3%)
25–34	8797 (21.7%)	7824 (23.5%)	973 (13.6%)
35–44	6901 (17.0%)	6075 (18.2%)	826 (11.5%)
45–54	5799 (14.3%)	4939 (14.8%)	860 (12.0%)
55–64	5439 (13.4%)	4509 (13.5%)	930 (13.0%)
≥ 65	7302 (18.0%)	4396 (13.2%)	2906 (40.6%)
Sex			
Male	21,797 (53.8%)	18,490 (55.5%)	3307 (46.2%)
Female	18,708 (46.2%)	14,852 (44.5%)	3856 (53.8%)
Residence location			
Urban	36,514 (90.2%)	30,074 (90.2%)	6440 (89.9%)
Rural	3991 (9.9%)	3268 (9.8%)	723 (10.1%)
Clinical characteristics			
Charlson Comorbidity Index			
Score			
Mean (SD)	0.5 (1.2)	0.4 (1.0)	1.0 (1.7)
Category, *n* (%)			
0 = no comorbid condition	30,391 (75.0%)	26,256 (78.8%)	4135 (57.7%)
1–2 = mild comorbidity	7994 (19.7%)	5936 (17.8%)	2058 (28.7%)
3–4 = moderate comorbidity	1369 (3.4%)	774 (2.3%)	595 (8.3%)
≥ 5 = severe comorbidity	751 (1.9%)	376 (1.1%)	375 (5.2%)
Pre-existing conditions of interest, *n* (%)			
Chronic pain	6971 (17.2%)	5073 (15.2%)	1898 (26.5%)
Depression	5930 (14.6%)	4427 (13.3%)	1503 (21.0%)
Diabetes	3936 (9.7%)	2607 (7.8%)	1329 (18.6%)
Chronic pulmonary disease	3678 (9.1%)	2686 (8.1%)	992 (13.9%)
Cancer	1710 (4.2%)	1238 (3.7%)	472 (6.6%)

Table 3 continued

	All subjects	Mode of arrival to index ED visit	
	(*N* = 40,505)	Walk-in (*N* = 33,342)	Ambulance (*N* = 7163)
Drug abuse	1560 (3.9%)	1059 (3.2%)	501 (7.0%)
Chronic opioid use	1246 (3.1%)	818 (2.5%)	428 (6.0%)
Dementia	1130 (2.8%)	312 (0.9%)	818 (11.4%)
Alcohol abuse	1142 (2.8%)	660 (2.0%)	482 (6.7%)
Migraine	968 (2.4%)	825 (2.5%)	143 (2.0%)
Chronic heart failure	770 (1.9%)	405 (1.2%)	365 (5.1%)
Liver disease	715 (1.8%)	476 (1.4%)	239 (3.3%)
Renal diseases	708 (1.8%)	407 (1.2%)	301 (4.2%)
Cerebrovascular disease	681 (1.7%)	354 (1.1%)	327 (4.6%)
Rheumatoid arthritis/collagen vascular diseases	676 (1.7%)	464 (1.4%)	212 (3.0%)
Schizophrenia	450 (1.1%)	271 (0.8%)	179 (2.5%)

ED emergency department, *SD* standard deviation

that were administered 90-min after arrival [3]. Woolner et al. (2020) reported that only 42% of adults who presented with musculoskeletal pain at a Toronto ED received analgesics, which occurred an average of 129 min after arrival; these measures improved after process enhancements [20]. Considering that the initiation of analgesia occurred a median of 133 min after first contact in the ED in the current study, a potential area for improvement may include strategies to reduce this time; prehospital analgesic administration by paramedics was not available for the 19% of visits where individuals arrived by ambulance.

Acute pain management in individuals with opioid dependence can be challenging and limited research exists to inform evidence-based guidelines [7, 21]. General guidelines indicate that pharmacological approaches for the management of acute pain among those with opioid dependence should incorporate the use of opioids and non-opioids with the goals of effective analgesia, strategies that can assist to reduce the effects of opioid tolerance or opioid-induced hyperalgesia, and the prevention of opioid withdrawal reactions and complications [7, 21, 22]. In alignment with this, adults who met chronic opioid use criteria before the ED visit were more likely to receive opioids during and upon discharge from the ED.

Guidelines recommend use of NSAIDs for acute pain management in the outpatient setting for most patients [23]; when managing patients with acute pain for whom opioids are considered appropriate, the lowest effective dose (up to a maximum daily dose of 50 MME) of the least potent immediate-release opioid for short-term use is recommended by the Health Quality Council of Ontario and the Centres for Disease Control and Prevention (more than 7 days is rarely indicated) [22, 24]. Findings from this study indicate areas of concordance with these recommendations along with potential areas for improvement. While NSAIDs were the most commonly dispensed non-opioid analgesic during the first 7 days after being discharged home directly from the ED, more opioid (15.2%) prescriptions were dispensed than

Table 4 Outpatient analgesic medication dispensation during the first 7 days after the index trauma-related emergency department visit; presented among those discharged home directly from the emergency department

	Discharged home directly from the index ED visit		
	All subjects	Mode of arrival to the index ED visit	
	(*N* = 35,109)	Walk-in (*N* = 30,616)	Ambulance (*N* = 4493)
Received ≥ 1 dispensation, *n* (%)	7717 (22.0%)	6061 (19.8%)	1656 (36.9%)
Non-opioids			
Received ≥ 1 dispensation, *n* (%)	4028 (11.5%)	3096 (10.1%)	932 (20.7%)
Route of administration			
Oral	4008 (99.5%)	3082 (99.5%)	926 (99.4%)
Transmucosal	12 (0.3%)	11 (0.4%)	< 10 (N/A)
Parenteral	14 (0.3%)	< 10 (N/A)	< 10 (N/A)
Other (topical, dental, infiltration)	< 10 (N/A)	< 10 (N/A)	< 10 (N/A)
Drug class			
NSAIDs	3634 (90.2%)	2803 (90.5%)	831 (89.2%)
Gabapentinoids	561 (13.9%)	381 (12.3%)	180 (19.3%)
Local anesthetics	12 (0.3%)	< 10 (N/A)	< 10 (N/A)
Opioids			
Overall			
Received ≥ 1 dispensation, *n* (%)	5344 (15.2%)	4281 (14.0%)	1063 (23.7%)
Daily MME dose			
Median (IQR)	36 (20)	36 (20)	35 (23)
≥ 50 MME, *n* (%)	990 (18.5%)	776 (18.1%)	214 (20.1%)
Number of days of supply			
Median (IQR)	5 (7)	5 (6)	6 (7)
> 7 days, *n* (%)	1613 (30.2%)	1245 (29.1%)	368 (34.6%)
Met chronic opioid use criteria during the 1-year pre-index period, *n* (%)	984 (2.8%)	716 (2.3%)	268 (6.0%)
Received ≥ 1 dispensation	467 (47.5%)	333 (46.5%)	134 (50.0%)
≥ 50 MME daily dose	173 (37.0%)	129 (38.7%)	44 (32.8%)
> 7 days of supply	302 (64.7%)	233 (70.0%)	69 (51.5%)
Did not meet chronic opioid use criteria during the 1-year pre-index period, *n* (%)	34,125 (97.0%)	29,900 (97.7%)	4225 (94.0%)
Received ≥ 1 dispensation	4877 (14.3%)	3948 (13.2%)	929 (22.0%)
≥ 50 MME daily dose	817 (16.8%)	647 (16.4%)	170 (18.3%)
> 7 days of supply	1311 (26.9%)	1012 (25.6%)	299 (32.2%)
Did not meet chronic opioid use criteria during the 1-year post-index period, *n* (%)	33,808 (99.1%)	29,668 (99.2%)	4140 (98.0%)
Received ≥ 1 dispensation	4739 (14.0%)	3850 (13.0%)	889 (21.5%)

Table 4 continued

	Discharged home directly from the index ED visit		
	All subjects	Mode of arrival to the index ED visit	
	(*N* = 35,109)	Walk-in (*N* = 30,616)	Ambulance (*N* = 4493)
≥ 50 MME daily dose	780 (16.5%)	623 (16.2%)	157 (17.7%)
> 7 days of supply	1220 (25.7%)	946 (24.6%)	274 (30.8%)
Met chronic opioid use criteria during the 1-year post-index period, *n* (%)	317 (0.9%)	232 (0.8%)	85 (2.0%)
Received ≥ 1 dispensation	138 (43.5%)	98 (42.2%)	40 (47.1%)
≥ 50 MME daily dose	37 (26.8%)	24 (24.5%)	13 (32.5%)
> 7 days of supply	91 (65.9%)	66 (67.3%)	25 (62.5%)
Overall			
Formulation, *n* (%)			
Immediate release	5240 (98.1%)	4206 (98.2%)	1034 (97.3%)
Controlled release	191 (3.6%)	146 (3.4%)	45 (4.2%)
Route of administration, *n* (%)			
Oral	5291 (99.0%)	4237 (99.0%)	1054 (99.2%)
Transmucosal	43 (0.8%)	35 (0.8%)	< 10 (N/A)
Transdermal	24 (0.4%)	23 (0.5%)	< 10 (N/A)
Parenteral	< 10 (N/A)	< 10 (N/A)	< 10 (N/A)
Drug name, *n* (%)			
Codeine	3565 (66.7%)	2887 (67.4%)	678 (63.8%)
Tramadol	1159 (21.7%)	953 (22.3%)	206 (19.4%)
Oxycodone	621 (11.6%)	446 (10.4%)	175 (16.5%)
Hydromorphone	278 (5.2%)	200 (4.7%)	78 (7.3%)
Morphine	87 (1.6%)	67 (1.6%)	20 (1.9%)
Methadone	52 (1.0%)	43 (1.0%)	< 10 (N/A)
Buprenorphine	60 (1.1%)	52 (1.2%)	< 10 (N/A)
Fentanyl	< 10 (N/A)	< 10 (N/A)	0 (0%)
Other	< 10 (N/A)	< 10 (N/A)	< 10 (N/A)

ED emergency department, *IQR* interquartile range, *MME* morphine milligram equivalent, *N/A* not applicable

non-opioid (11.5%) analgesics; it is possible that a number of individuals received over-the-counter non-opioid analgesics, as these are not captured in administrative data. Among the opioids dispensed, prescribing practices were largely in alignment with recommendations, however potential gaps in optimal prescribing were noted. Adults who received a daily dose ≥ 50 MME and for more than 7 days was common; while causality cannot be established, 138 adult patients with trauma who received an opioid dispensation immediately after being discharged home directly from the ED newly met criteria for chronic opioid use in the

following year, among whom 26.8% received a daily dose ≥ 50 MME and 65.9% received > 7 days of supply. Also, codeine and tramadol were the most commonly dispensed opioid types, both of which have come under scrutiny. Although codeine use in the outpatient setting is widespread and has been found to be the most commonly prescribed opioid in many countries, including Canada, its analgesic effect is highly variable and associated with risk of adverse effects that can be severe [9, 25, 26]. Health Canada has recently classified tramadol as a Schedule I drug because of its potential for problematic use, risk for tolerance and dependence, and harmful adverse effects [27].

This study has several important strengths, including the large size and population-based design. However, this study is also subject to limitations that should be taken into consideration when interpreting results. Prehospital analgesic administration was not available for the 19% of trauma-related ED visits where patients arrived by ambulance. Severity of acute pain associated with trauma could not be determined as there were no measures of pain assessment within the administrative data. PIN only provides information on prescription medication dispensations, and therefore may not represent actual medication uptake by individuals. Whether individuals were counselled on the appropriate use of analgesics is also not included in administrative data. Use of over-the-counter or illicit analgesics and other non-pharmacotherapy pain management therapies are not captured within provincial administrative data and therefore were not reported.

CONCLUSIONS

Results of this study provide insight into current adult trauma-related analgesic practices within the ED and upon discharge that can be used to inform optimization of analgesic pharmacotherapy practices for the treatment of acute pain. Findings indicate that areas for improvement may include strategies to reduce time to initiation of analgesics in the ED, as well as consideration of recommendations for acute pain management upon discharge to provide ideal patient-centered, evidence-informed, and guideline concordant care. Further research into the continued development of non-opioid analgesics, as well as providing access to currently approved opioid alternatives, will offer healthcare providers additional options for improved treatment of acute pain.

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Compliance with Ethics Guidelines. Ethics approval for this study was received from the University of Alberta Institutional Review Board (Pro00096969). No participants were placed at risk as a result of the study, and informed consent was not required.

Data Availability. The datasets analyzed during the current study are not publicly available because the data custodians, Alberta Health Services and Alberta Health, do not allow users of the data to publish the data. Please contact the corresponding author for requests related to the data used in this study.

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