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Trajectories of new opioid use after hip fracture surgery: a population-based cohort study

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Abstract

Introduction: The global annual incidence of hip fractures is projected to double over the next 20 to 30 years. The rates and risk factors for new persistent opioid use after hip fracture surgery remain poorly quantified.

Objective: To describe trajectories, rates, and risk factors for new persistent opioid use after hip fracture surgery in Australia.

Methods: A retrospective population-based cohort study was conducted using linked administrative health data in Australia. Adults aged ≥30 years discharged from hospital after a first hip fracture surgery between July 2012 and June 2017, opioid-naïve on admission, and alive 12 months postdischarge were included. Group-based trajectory modelling was utilised to determine trajectories and rates of opioid use 12 months postdischarge. Multivariate multinomial logistic regression analysis was performed to identify risk factors for persistent opioid use.

Results: Among 10,309 opioid-naïve patients who had first hip fracture surgery, 5305 (51.5%) used opioids postdischarge. Opioid users were categorised as 58.9% (3127/5305) nonpersistent, 12.6% (670/5305) fluctuating, 12.1% (641/5305) late discontinuation, and 16.3% (867/5305) persistent. Key risk factors for persistent use were total oral morphine equivalent >600 mg in first 30 days postdischarge (relative risk [RR] 13.61, 95% confidence interval [CI] 9.34–19.83), transdermal opioid in the first 30 days postdischarge (RR 7.64, 95% CI 5.61–10.39), and hospital length of stay >60 days (RR 4.31, 95% CI 3.02–6.15).

Conclusion: Among opioid-naïve patients, 16.3% were persistent opioid users at 12 months posthospital discharge. Future research should focus on targeted interventions to address modifiable risk factors to reduce new persistent opioid use in older and vulnerable populations.

Keywords: Hip fracture, Persistent opioid use, Risk factors, Rates, Long-term opioid use

1. Introduction

The global annual incidence of hip fractures is projected to double over the next 20 to 30 years.[27] In Australia, the number of hip fractures increased by 20% from 2012 to 2018, with a 25% mortality rate at 12 months postinjury during this period.[18] Many countries have implemented management standards and systems to minimise postfracture complications.[29]

Perioperative pain management is a critical component of postfracture care.[3] Effective acute pain management improves patient outcomes, minimises transition to chronic pain, and increases patient satisfaction. Australian guidelines recommend multimodal analgesia over opioids to improve pain control and minimise adverse events,[3,17] especially since hip fractures often occur in older individuals with multimorbidity, polypharmacy, and heightened susceptibility to opioid-related harm. Rates of new persistent opioid use after hip fracture surgery range from 6.3% to 15%.[9,23,26,30] Persistent opioid use can reduce quality of life and lead to falls and fractures, osteoporosis, and depression.[5]

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Guidelines emphasise the need to balance effective analgesia with the risk of persistent use and other adverse events.[3,17]

Research from Europe and North America has identified various risk factors for persistent opioid use after hip fracture surgery.[9,23,26,30] Nonmodifiable and modifiable risk factors for persistent use include younger age, female sex, comorbidities such as anxiety, fracture fixation, preoperative medications, opioid type (like morphine and more than 1 opioid), and larger initial prescription quantity.[9,23,26,30] The rates and risk factors for new persistent opioid use after hip fracture surgery remain poorly quantified internationally and unknown in Australia. This study aims to describe trajectories, rates, risk factors, and temporal changes of new persistent opioid use after hip fracture surgery in Australia.

2. Methods

2.1. Study design

We conducted a retrospective population-based cohort study in Australia using linked administrative health data from July 1, 2012 to June 30, 2017 for people in the state of Victoria. In 2023, Victoria was reported to have a population of 6.81 million people, the second most populated state in Australia.[2] This study was approved by the Australian Institute of Health and Welfare Ethics Committee (EO2018-4-468) and Monash University Human Research Ethics Committee (14339).

Data were sourced from the Victorian Admitted Episodes Dataset (VAED), Pharmaceutical Benefits Scheme (PBS), and National Death Index (NDI). The VAED contains comprehensive records of public and private hospital admissions in Victoria, Australia, including patient demographics, diagnoses, procedures, admission sources, and discharge details from July 1, 2006 to June 30, 2018. The PBS dataset records dispensing of subsidised medications dispensed at community pharmacies, outpatient clinics, and at hospital discharge. Pharmaceutical Benefits Scheme data were utilised to determine medication use. Data were available for general and concessional patients (eg, low-income earners and pensioners).[20] The PBS dataset records the details of the dispensed medication (PBS item number for a given medication name, strength, quantity, and date dispensed), demographics (sex and age), concession or general status, and prescriber details. In 2014, PBS data captured an estimated 88% of prescription opioid dispensings.[11] The NDI includes data on registered deaths in Australia, available from July 1, 2012 to June 30, 2018.

2.2. Participants

Adults aged ≥30 years who were discharged from hospital after a first hip fracture surgery between July 1, 2012 and June 30, 2017 were included in the study. Patients with hip fractures within 5 years before the index hip fracture were excluded. To identify incident opioid users, we excluded patients dispensed opioids in the 12 months preceding hip fracture admission. In addition, individuals who died within 12 months of discharge from acute or subacute hospital or were hospitalised for >1 month of the 12-month follow-up period were also excluded, as PBS data do not include inpatient medication dispensing.

2.3. Trajectories and predictors of opioid use

Trajectories of opioid use was defined by 4 steps. First, patients not dispensed opioids within 12 months postdischarge from the index admission after first hip fracture surgery were classified as nonusers. Second, patients dispensed more than 1 opioid prescription in only the first month postdischarge were classified as opioid users. Third, patients dispensed 2 or more opioid prescriptions in the 12 months postdischarge were included in the group-based trajectory modelling (GBTM). Fourth, baseline opioid use was defined as patients only dispensed 1 opioid prescription in the first month postdischarge. Patients not dispensed opioids in the first month postdischarge but had 1 opioid dispensed in the 2nd to 12th month postdischarge were excluded because these patients were neither baseline nor nonusers. Group-based trajectory modelling was used to investigate persistence as opioids are dispensed in a range of quantities, doses, and formulations. This method allows for a data-driven approach to defining persistence in the absence of a universal definition.[13,15] GBTM does not require an explicit criterion[21] but instead defines persistent use by the patterns of opioid dispensing for the study cohort over the 12-month follow-up period.[6,14,15] The model identified 4 trajectories, as more trajectories did not provide stratification of clinical significance (eTable 1 in Supplement, http://links.lww.com/PR9/A313). The best-fitting model was chosen based on the following criteria: (1) average posterior probability of group membership >0.7, (2) odds of correct classification >5, (3) the highest order parameter of each trajectory was statistically significant, (4) the group proportions estimated by the model was similar to the actual proportions of individuals assigned to each group based on their maximum posterior probability, (5) the Bayesian information criteria, (6) parsimony principle, and (7) clinical judgement (eTable 2 in Supplement, http://links.lww.com/PR9/A313). A detailed description of the methods used for GBTM were previously published.[19]

Preadmission comorbidities and new diagnoses in hospital were identified from ICD-10-AM diagnoses within 5 years before hospital discharge (eTable 3 in Supplement, http://links.lww.com/PR9/A313). Based on published literature, a priori comorbidities of interest included anxiety, psychiatric illness, alcohol or tobacco dependence, and pain.[9,16,23] Quan's Charlson Comorbidity Index (CCI) was calculated using ICD-10-AM diagnosis codes.[25] The validated Hospital Frailty Risk Score (HFRS) was used to assess frailty and calculated from ICD-10-AM diagnosis codes within 2 years of the index admission.[10] HFRS was categorised to 4 frailty risk categories: no risk (HFRS 0), low risk (HFRS >0 and <5), intermediate risk (HFRS 5–15), and high risk (HFRS > 15). Socioeconomic status was indicated by the PBS copayment category for discharge medications, either concessional or nonconcessional. Patients' residential region from the recent entry was classified into metropolitan (north-western Melbourne, eastern Melbourne, and south-eastern Melbourne) or nonmetropolitan (other areas). Additional risk factors analysed included length of hospital stay, year of hospital discharge, and discharge to an aged care facility. To account for transfers between hospitals, rehospitalisation within 1 day was considered a single admission.

Opioid medications dispensed in the first 30 days postdischarge were identified by PBS item numbers and categorised by Anatomical Therapeutic Chemical (ATC) codes (eTable 4 in Supplement, http://links.lww.com/PR9/A313). Opioid potency was categorised as weaker or stronger, with concurrent dispensing of both classified as stronger. Duration of action and route of opioid administration were categorised as short-acting oral, long-acting oral, or transdermal or other (eTable 5 in Supplement, http://links.lww.com/PR9/A313). Transdermal opioid included fentanyl and buprenorphine. For opioid dispensing in

the 30 days postdischarge, the total oral morphine equivalent (OME) was calculated using the formula: Total OME (mg) = pack strength × OME conversion factor for the opioid × number of tablets. The OME conversion factors were adapted from published values.[22,24] Total OME was categorised as 0 mg, 1 to 150 mg, 151–300 mg, 301–600 mg, and >600 mg. Other analgesics and medications used to treat the a priori comorbidities of interest were identified through ATC codes (eTable 6 in Supplement, http://links.lww.com/PR9/A313) within 90 days of index admission (preadmission medications) and within 30 days of discharge (discharge medications).

2.4. Statistical analysis

Baseline characteristics are presented as frequencies and percentages, means and standard deviations (SD), or medians with interquartile ranges (IQR). Multivariate multinomial logistic regression analysis was performed to identify risk factors for new persistent opioid use and to calculate the relative risks (RRs) with 95% confidence interval (95% CI). The multivariate analyses were adjusted for age, sex, concessional status, region of residence, length of hospital stay, discharge to aged care facility, year of hospital discharge, comorbidities, CCI, frailty score (HFRS), initial opioid dispensing (type, preparation, potency and total OME), and other medications preadmission (within 90 days before admission) and discharge (within 30 days of discharge). Statistical significance was defined as P value < 0.05. All statistical analyses were performed in SAS Version 9.4 (SAS Institute Inc., Cary, NC) and R Version 4.0.0 (R Core Team, Vienna, Austria).

3. Results

There were 10,309 patients who underwent first hip fracture surgeries in Victoria, were opioid-naïve, and met the study inclusion criteria (**Fig. 1**). Of the overall study cohort, 29.4% (n = 3034) were male, 72.3% (n = 7445) were aged 75 and above, with a similar proportion of patients discharged from hospital across the 5 years (**Table 1**). In addition, 30.4% (n = 3134) of patients were from nonmetropolitan region, 74.1% (n = 7637) were classified as concessional status, and 15.0% (n = 1545) had a CCI of 3 or more.

Among the 10,309 opioid-naïve patients, 5305 (51.5%) used opioids (**Table 1**) postdischarge. Opioid users compared to opioid non-users were more likely aged 30 to 74 years, located in nonmetropolitan region, have concessional status, higher CCI, and preadmission analgesics and psychotropic medications.

Of the 5305 new opioid users, 1167 (22.0%) were baseline use only and the remaining 4138 patients (78.0%) were included in GBTM to identify trajectories of persistent opioid use within 12 months of hospital discharge (**Fig. 2**). Four trajectories were identified and classified as early discontinuation (47.4%, n = 1960), fluctuating (16.2%, n = 670), late discontinuation (15.5%, n = 641), and persistent use (20.9%, n = 867). The total number of nonpersistent opioid users, ie, baseline use only and early discontinuation, was 3127. The absolute proportion of opioid users in each trajectory was 58.9% (3127/5305) nonpersistent, 12.6% (670/5305) fluctuating, 12.1% (641/5305) late discontinuation, and 16.3% (867/5305) persistent trajectories. Patient characteristics for the 4 trajectories of new opioid use are shown in the eTable 7 in Supplement, http://links.lww.com/PR9/A313. Details of discharge opioids and other medications prescribed within 30 days of discharge in opioid users are presented in the eTable 8 in Supplement, http://links.lww.com/PR9/A313.

Risk factors associated with fluctuating, late discontinuation, and persistent opioid use compared to nonpersistent opioid use are shown in **Table 2**. A total OME > 600 mg compared to 1 to 150 mg in first 30 days postdischarge was more likely to have late discontinuation (RR 21.79, 95% 14.09–33.68) or persistent (RR 13.91, 95% CI 9.54–20.28) opioid use. Transdermal opioid in the first 30 days postdischarge was associated with a five- and sevenfold risk of late discontinuation (RR 5.03, 95% CI 3.53–7.18) and persistent (RR 7.57, 95% CI 5.57–10.30) opioid use, respectively. Compared to hospital length of stay (LOS) ≤ 10 days, LOS > 60 days was significantly associated with persistent opioid use (RR 4.02, 95% CI 2.79–5.80). Other patient variables associated with persistent opioid use included nonmetropolitan region, concessional status, high frailty risk (HFRS > 15), year of hospital discharge, dementia, and Alzheimer disease. Medications associated with persistent opioid use were nonsteroidal anti-inflammatory drugs (NSAIDS) at discharge, as well as preadmission use of paracetamol, NSAIDS, antidepressants for pain, antidepressants, antipsychotics, and benzodiazepines. Age group 65 to 74 years was associated with less risk for persistent opioid use compared to age group 30 to 64 years.

4. Discussion

To our knowledge, this is the first study to assess trajectories of persistent opioid use in opioid-naïve patients after first hip fracture surgery. Among 10,309 opioid-naïve patients, 16.3% of the 5305 opioid users who survived 12 months were persistent opioid users at 12 months postdischarge. The proportion of persistent opioid users increased in subsequent years. A considerably higher proportion of patients who undergo hip fracture surgery become persistent opioid users at 12 months compared to the general Australian population without cancer (2.6%).[15] Key risk factors for persistent opioid use were high OME, transdermal opioid, and longer LOS. Several other patient characteristics, comorbidities, and medication-related factors were identified in new persistent opioid users.

The rate of new persistent opioid use in our study was higher than that reported in 2 US population–based studies but comparable to findings from 2 Danish studies. Torchia and colleagues[30] reported a 6.4% rate of opioid use at 12 months among 91,749 opioid-naïve community dwelling US Medicare beneficiaries aged >65 years who underwent hip fracture surgery between 2007 and 2010. Similarly, Okike and colleagues[23] found a 6.3% rate of prolonged opioid use among 47,309 opioid-naïve patients aged ≥60 who survived 6 months postsurgery between 2009 and 2020. In contrast, Danish studies of older opioid-naïve patients reported persistent opioid use in 15% and 16.5% of patients at 9 months (n = 3188)[26] and 12 months (n = 5497),[9] respectively, compared to 16.3% (n = 867) at 12 months in our study of opioid-naïve patients ≥30 years. Despite these variations, our findings highlight a significant risk of new persistent opioid use after hip fracture surgery, underscoring the need for effective pain management strategies.

Variability in defining opioid-naïve and persistent opioid use may explain the differing rates of persistent opioid use reported across studies. Numerous methods and definitions exist to assess persistent opioid use, leading to significant discrepancies in identifying long-term users based on the criteria employed.[13,20,28] In our study, we used GBTM, which analysed opioid dispensing patterns over a 12-month period without requiring a specific criterion for persistent use. Other definitions for persistent opioid use include filling an opioid prescription anytime in the fourth quarter after surgery,[26] filled prescriptions in

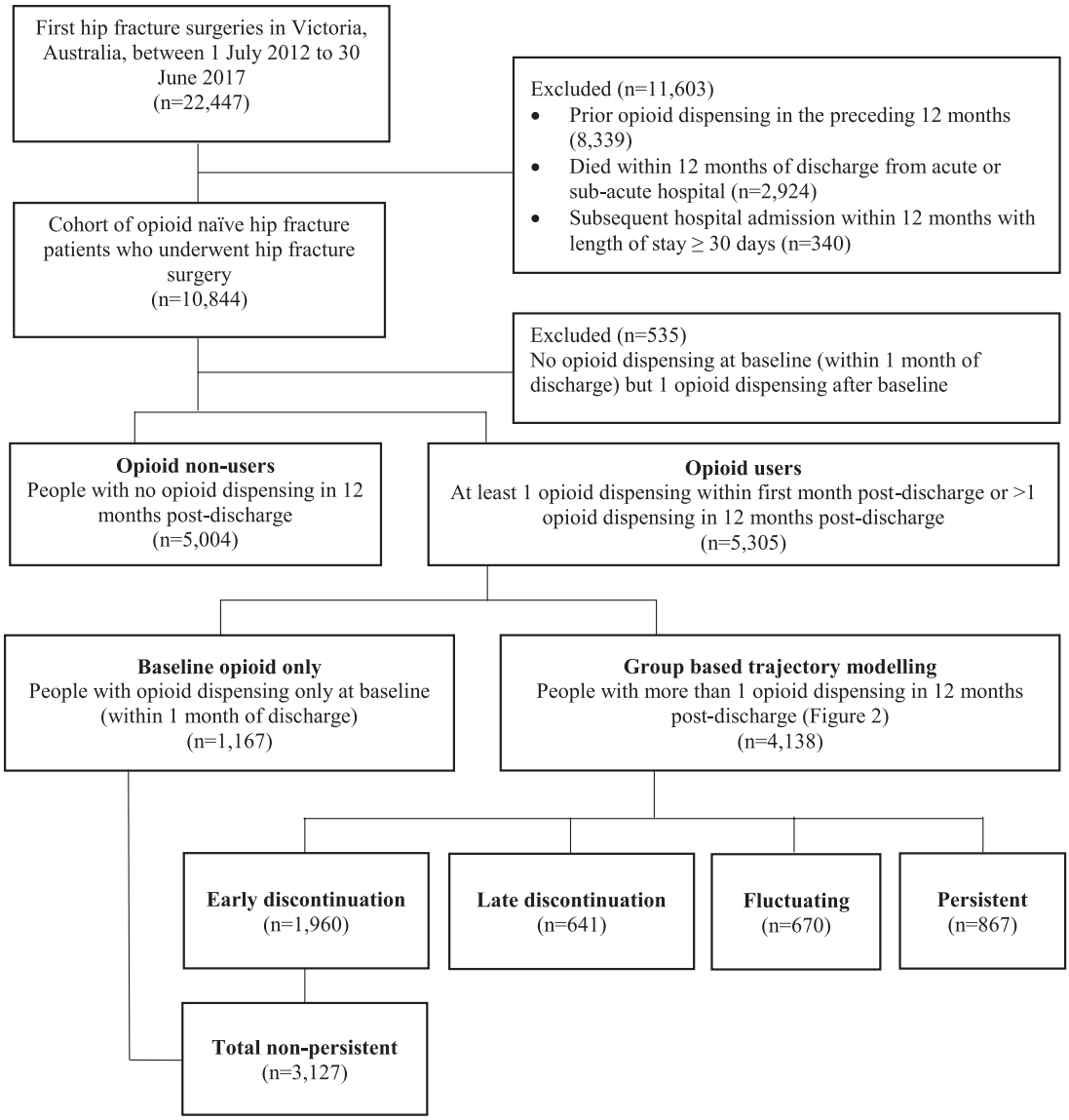

Figure 1. Flowchart of study cohort.

2 of the last 3 quarters after surgery,[9] proportion of patients filled opioid prescription in the 12th month after hip fracture,[30] 1 or more opioid prescriptions dispensed in all 3 time periods up to 6 months after surgery.[23] Similarly, definitions of opioid-naïve vary widely, from no opioids dispensed 4 months[30] or 6 months[9,26] and >4500 OME in the 9 months[23] before the hip fracture compared to 12 months prior in our study. Opportunity exists to develop universal definitions for new persistent opioid use to support consistency and comparability between studies.

Differences in study periods and changes in opioid prescribing practices in response to awareness of opioid-related harm may also account for the variable rates of persistent opioid use between countries. From the Danish study, the proportion initiating long-term opioid use decreased after 2010.[26] This was attributed to changes over time in prescribed opioid types and Danish national recommendations to prescribe morphine as first line.[26] A US study found that a decrease in the amount of opioid initially prescribed was accompanied by a statistically significant reduction in the risk of persistent opioid use, from 8.0% in 2009 to 3.9% in 2019.[23] This was likely due to an awareness of the opioid epidemic in the 2010s and US laws passed in several states to restrict opioid prescribing.[23] Our study demonstrated an increase in the proportion and risk of persistent opioid use between 2012 and 2017. This mirrors the 5% increase in national opioid dispensing rates per 100,000 people between 2023 to 2014 and 2016 to 2017.[4] Our study provides valuable insight into trends of persistent opioid use preimplementation of national and state initiatives introduced from 2018, after this study concluded, including regulatory changes to reduce the amounts of opioids supplied per prescription, changes to PBS restrictions for different opioid preparations, introduction of real-time prescription monitoring systems in Victoria (voluntary in 2019 and mandatory from 2020), and analgesic stewardship programs to curtail opioid prescribing and harm.[4]

Specific preadmission and discharge medications including type and dose have been reported as risk factors for new persistent opioid use after hip fracture surgery. Preadmission medications including nonopioid analgesics (paracetamol, NSAIDs, pregabalin, and antidepressants) and psychotropic medications (antipsychotics, antidepressants, and benzodiazepines) associated with persistent opioid use in our study were not dissimilar to those described in a Danish study.[5] Although

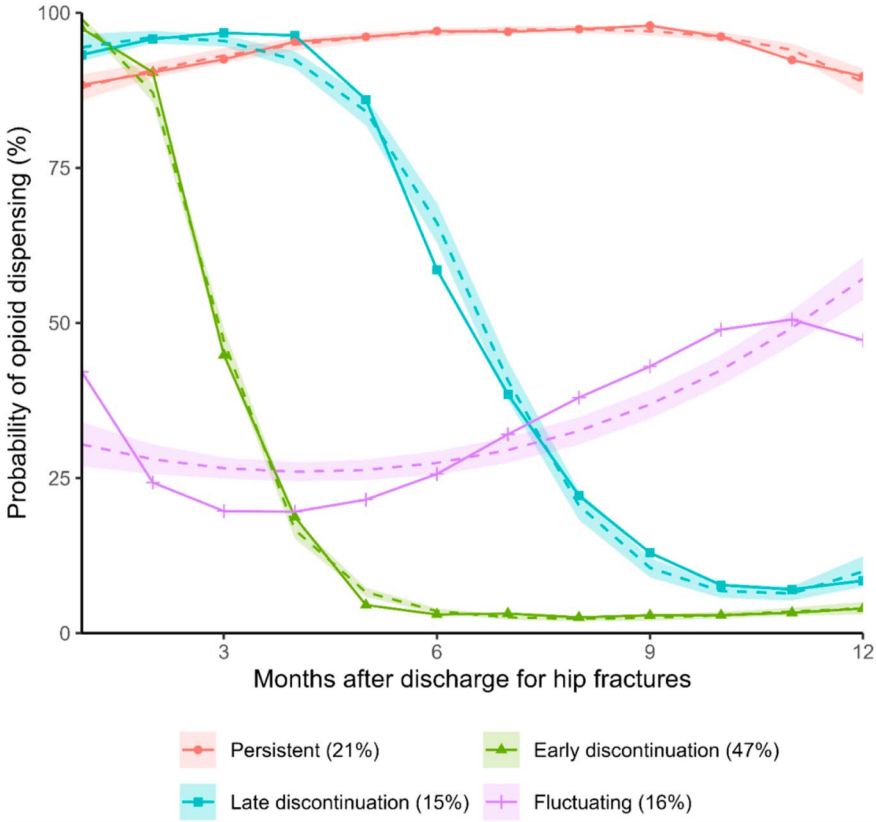

Figure 2. Trajectories of opioid use in people dispensed opioids >1 prescription. Among 4138 people, 4 trajectories of opioid use in the 12 months after hip fracture surgery were identified: persistent (21%), late discontinuation (15%), early discontinuation (47%), and fluctuating (16%). Persons in the early discontinuation trajectory were considered nonpersistent opioid users as the trajectory suggest minimal opioid dispensing in the 12-month follow-up.

gabapentin and pregabalin are available in Australian, gabapentin was not included in our study as it is not widely reimbursed for neuropathic pain in Australia.[1] Our study also identified discharge with NSAIDs a risk factor. These medication-related risk factors are likely linked to known risks for chronic pain and long-term opioid use described in other patient groups.[6,14–16] This highlights the need for judicious opioid prescribing posthospital discharge in patients on preadmission analgesics and psychotropic medications.

Numerous patient characteristics and comorbidities are correlated with new persistent opioid use after hip fracture surgery. Previous studies identified younger age (<85 years) and female sex as risks for persistent use in older patients.[9,23] In contrast, we found that ages 65 to 74 were protective against persistent opioid use, likely due to differences in patient characteristics such as inclusion of younger patients in our study and opioid prescribing practices. Our study also showed that concessional status, indicating lower socioeconomic status, was associated with increased risk of new persistent opioid use, whilst income classification did not impact risk in a US study.[23] In our study, patients with dementia and Alzheimer disease and high frailty risk were more likely to have persistent opioid use, possibly due to inappropriate pain assessment and management. Interestingly, other research suggested that dementia may be protective against persistent use.[23] Additional risks identified in our study included LOS > 21 days, residing in nonmetropolitan region and discharged to aged care facility. These risks have been identified in studies of other patient groups.[6,14–16] Longer LOS may reflect more complex cases requiring extended care and potential for continuation or limited tapering of opioid therapy. Limited access to health professionals and specialist pain management services in nonmetropolitan regions are potential reasons for continued opioid use. Challenges providing effective pain management in aged care facilities include pain assessment in elderly patients with cognitive impairment, patient and clinician beliefs, and attitudes to pain, frailty, and comorbidities, which often limits choice of pharmacotherapy. These factors may contribute to the high rates of opioid use in older Australians residing in aged care facilities.[8] Opportunity exists to implement initiatives to optimise pain management to address the higher risk of new persistent opioid use in the older and vulnerable patients after hip fracture surgery.

Our study has several limitations. First, since it only includes data from Victoria, the findings may not be generalisable to other regions with different opioid prescribing practices. Second, the 5-year look-back period to identify comorbidities might have included conditions no longer acutely active. Third, studies relying on administrative data may be prone to incomplete recording of medical diagnoses or incorrect admission and discharge dates. However, this is minimised with regular Australian Government data integrity audits[31] and previous validation of ICD-10-AM coding in Victorian hospitals.[12] In addition, our PBS dispensing data lacked information on the indication for opioid prescriptions and did not capture those dispensed outside the PBS system, with PBS claims underestimating various opioid use, ranging from 5.3% to 21.0%.[7,12] Further limitations of our study included the observational design that precluded causal inference, lack of information on why patients continued to be dispensed opioids over the duration of the follow-up (eg, possible new diagnoses or indications), and

Table 1

Baseline patient characteristics of opioid non-users and opioid users cohorts and overall.

	Opioid non-users (n = 5004)	Opioid users (n = 5305)	Overall (n = 10,309)	*P*
Male	1475 (29.5%)	1559 (29.4%)	3034 (29.4%)	0.91
Age				
30–64	480 (9.6%)	840 (15.8%)	1320 (12.8%)	<0.0001
65–74	712 (14.2%)	832 (15.7%)	1544 (15.0%)	0.03
75–84	1606 (32.1%)	1669 (31.5%)	3275 (31.8%)	0.51
≥85	2206 (44.1%)	1964 (37.0%)	4170 (40.5%)	<0.0001
Year of hospital discharge				
2012–2013	1002 (20.0%)	916 (17.3%)	1918 (18.6%)	0.0004
2013–2014	962 (19.2%)	1057 (19.9%)	2019 (19.6%)	0.37
2014–2015	1041 (20.8%)	1130 (21.3%)	2171 (21.1%)	0.53
2015–2016	971 (19.4%)	1074 (20.2%)	2045 (19.8%)	0.31
2016–2017	1028 (20.5%)	1128 (21.3%)	2156 (20.9%)	0.32
Length of hospital stay				
0–10 d	1040 (20.8%)	1819 (34.3%)	2859 (27.2%)	<0.0001
11–20 d	1171 (23.4%)	995 (18.8%)	2166 (21.0%)	<0.0001
21–30 d	1177 (23.5%)	954 (18.0%)	2131 (20.7%)	<0.0001
31–60 d	1252 (25.0%)	1186 (22.4%)	2438 (23.6%)	0.002
>60 d	36.4 (7.3%)	351 (6.6%)	715 (6.9%)	0.16
Nonmetropolitan region*	1444 (28.9%)	1690 (31.9%)	3134 (30.4%)	0.001
Concessional status	3257 (65.1%)	4380 (82.6%)	7637 (74.1%)	<0.0001
Hospital frailty risk score (HFRS)†				
0	3281 (65.6%)	3112 (58.7%)	6393 (62.0%)	<0.0001
>0 and <5	1065 (21.3%)	1275 (24.0%)	2340 (22.7%)	0.001
5–15	615 (12.3%)	853 (16.1%)	1468 (14.2%)	<0.0001
>15	43 (0.9%)	65 (1.2%)	108 (1.0%)	0.14
Charlson Comorbidity Index‡				
0	3423 (68.4%)	3197 (60.3%)	6620 (64.2%)	<0.0001
1–2	904 (18.1%)	1240 (23.4%)	2144 (20.8%)	<0.0001
≥3	677 (13.5%)	868 (16.4%)	1545 (15.0%)	<0.0001
Comorbidities				
Tobacco dependence	1548 (30.9%)	1856 (35.0%)	3404 (33.0%)	<0.0001
Alcohol dependence	149 (3.0%)	220 (4.1%)	369 (3.6%)	0.002
Anxiety	129 (2.6%)	206 (3.9%)	335 (3.2%)	0.0002
Pain	604 (12.1%)	729 (13.7%)	1333 (12.9%)	0.01
Psychiatric illness	181 (3.6%)	270 (5.1%)	451 (4.4%)	0.0002
Cardiovascular and cerebrovascular disease	1682 (33.6%)	1811 (34.1%)	3493 (33.9%)	0.59
Dementia and Alzheimer disease	379 (7.6%)	582 (11.0%)	961 (9.3%)	<0.0001
Respiratory disease	276 (5.5%)	364 (6.9%)	640 (6.2%)	0.003
Gastrointestinal disease	1613 (32.2%)	1961 (37.0%)	3574 (34.7%)	<0.0001
Chronic kidney disease	520 (10.4%)	562 (10.6%)	1082 (10.5%)	0.74
Diabetes mellitus	786 (15.7%)	950 (17.9%)	1736 (16.8%)	0.003
Preadmission medications§				
Paracetamol	589 (11.8%)	1188 (22.4%)	1777 (17.2%)	<0.0001
NSAIDs	194 (3.9%)	353 (6.7%)	547 (5.3%)	<0.0001
Pregabalin	60 (1.2%)	92 (1.7%)	152 (1.5%)	0.03
Antidepressants	561 (11.2%)	1092 (20.6%)	1653 (16.0%)	<0.0001
Antidepressants for pain‖	192 (3.8%)	344 (6.5%)	536 (5.2%)	<0.0001
Antipsychotics	189 (3.8%)	464 (8.7%)	653 (6.3%)	<0.0001
Benzodiazepines	376 (7.5%)	772 (14.6%)	1148 (11.1%)	<0.0001

Data are n (%).

* Based on Department of Health Human Services Region classification.

† Weighted score calculated using diagnoses within 2 years of index admission.

‡ Based on diagnoses within 5 years before hospital discharge.

§ Based on dispensing within 90 days of index admission.

‖ Included amitriptyline, nortriptyline, venlafaxine, and duloxetine.

COPD, chronic obstructive pulmonary disease; NS, not statistically significant; NSAIDs, nonsteroidal anti-inflammatory drugs.

lack of information on whether dispensed opioids were consumed by patients. We did not have data to investigate whether administration of intraoperative/inpatient opioids or anaesthetic techniques were associated with opioid trajectories. Due to the small sample size for some opioids such as fentanyl and methadone, we were not able to compute trajectories for individual opioids. Finally, since our data were collected from July 2012 to June 2017, there may have been changes in practice since then. More recent national data show a decline in opioid dispensing between 2016 to 2017 and 2020 to 2021, likely due to initiatives aimed at improving appropriate opioid use.[4] Nevertheless, this study offers valuable insights into opioid use patterns and risks of persistent opioid use after hip fracture surgery, informing ongoing and future efforts to reduce long-term opioid use.

Among opioid-naïve patients who survived 12 months after first hip fracture surgery, 16.3% were persistent opioid users at 12 months posthospital discharge. Higher OME, transdermal opioid preparations, and longer hospital LOS were most significantly associated with new persistent opioid use. An

Table 2

Predictors of new fluctuating, late discontinuation, and persistent opioid use compared to nonpersistent opioid users.

	Fluctuating aRR [95% CI]*	Late discontinuation aRR [95% CI]*	Persistent aRR [95% CI]*
Sex			
Female	Reference	Reference	Reference
Male	1.04 [0.81–1.34]	0.84 [0.68–1.06]	1.13 [0.91–1.39]
Age			
30–64	Reference	Reference	Reference
65–74	0.75 [0.47–1.19]	0.82 [0.57–1.18]	**0.51 [0.34–0.77]**
75–84	0.92 [0.59–1.41]	0.90 [0.63–1.30]	0.96 [0.67–1.39]
≥85	1.26 [0.81–1.94]	1.30 [0.90–1.89]	1.39 [0.96–2.01]
Year of hospital discharge			
2012–2013	Reference	Reference	Reference
2013–2014	**1.55 [1.11–2.17]**	1.07 [0.77–1.47]	**1.39 [1.03–1.87]**
2014–2015	**1.79 [1.28–2.51]**	0.94 [0.68–1.28]	1.22 [0.91–1.64]
2015–2016	**1.56 [1.10–2.22]**	1.06 [0.77–1.46]	**1.51 [1.12–2.03]**
2016–17	**1.99 [1.39–2.83]**	1.21 [0.87–1.68]	**1.56 [1.14–2.13]**
Length of hospital stay (d)			
<11	Reference	Reference	Reference
11–20	**1.41 [1.01–1.98]**	0.86 [0.64–1.14]	1.25 [0.93–1.67]
21–30	**1.59 [1.13–2.23]**	0.81 [0.59–1.10]	**1.34 [1.00–1.80]**
31–60	**1.60 [1.14–2.25]**	**1.35 [1.01–1.80]**	**2.59 [1.99–3.38]**
>60	**2.36 [1.49–3.74]**	1.07 [0.67–1.71]	**4.02 [2.79–5.80]**
Region of residence†			
Metropolitan	Reference	Reference	Reference
Nonmetropolitan	1.13 [0.91–1.42]	0.96 [0.78–1.18]	**1.30 [1.08–1.57]**
Concessional status			
Nonconcessional	Reference	Reference	Reference
Concessional	1.33 [0.94–1.90]	1.08 [0.81–1.46]	**1.61 [1.17–2.20]**
Discharged to aged care facility	0.87 [0.64–1.18]	**1.45 [1.11–1.88]**	**2.02 [1.63–2.51]**
Hospital frailty risk score (HFRS)‡			
0	Reference	Reference	Reference
>0 and <5	1.00 [0.76–1.30]	0.85 [0.66–1.10]	0.93 [0.74–1.17]
5–15	1.02 [0.73–1.43]	1.16 [0.85–1.59]	1.10 [0.84–1.45]
>15	1.34 [0.51–3.53]	2.06 [0.89–4.74]	**2.26 [1.10–4.68]**
Charlson Comorbidity index (CCI)§			
0	Reference	Reference	Reference
1–2	1.10 [0.74–1.35]	1.02 [0.77–1.35]	0.98 [0.76–1.26]
≥3	0.91 [0.61–1.35]	0.71 [0.48–1.04]	0.86 [0.62–1.21]
Comorbidities			
Tobacco dependence	1.17 [0.92–1.48]	**1.48 [1.19–1.84]**	1.03 [0.84–1.26]
Alcohol dependence	1.07 [0.61–1.88]	1.17 [0.74–1.83]	0.82 [0.51–1.31]
Anxiety	0.84 [0.48–1.47]	0.59 [0.33–1.07]	1.38 [0.92–2.07]
Pain	0.92 [0.68–1.24]	0.99 [0.74–1.31]	0.92 [0.71–1.19]
Psychiatric illness	0.87 [0.52–1.45]	1.06 [0.67–1.67]	1.19 [0.81–1.74]
Cardiovascular and cerebrovascular disease	1.11 [0.86–1.45]	0.98 [0.76–1.26]	1.20 [0.96–1.50]
Dementia and Alzheimer disease	0.96 [0.65–1.41]	0.97 [0.68–1.38]	**1.52 [1.16–2.01]**
Respiratory disease	1.09 [0.73–1.64]	0.94 [0.63–1.39]	1.09 [0.78–1.53]
Gastrointestinal disease	1.04 [0.82–1.30]	1.10 [0.89–1.36]	0.89 [0.73–1.08]
Chronic kidney disease	1.13 [0.79–1.61]	1.36 [0.97–1.91]	1.06 [0.78–1.43]
Diabetes mellitus	0.89 [0.66–1.20]	1.18 [0.89–1.56]	0.99 [0.77–1.28]
Preadmission medications‖			
Paracetamol	**1.61 [1.24–2.09]**	1.09 [0.85–1.40]	**1.49 [1.20–1.84]**
NSAIDs	**1.52 [1.02–2.27]**	0.95 [0.64–1.43]	**1.46 [1.03–2.06]**
Pregabalin	0.71 [0.32–1.59]	0.94 [0.45–1.96]	0.86 [0.43–1.70]
Antidepressants	**1.36 [1.04–1.76]**	1.16 [0.91–1.48]	**1.35 [1.09–1.67]**
Preadmission medications‖			
Antidepressants for pain¶	**1.88 [1.13–3.14]**	1.36 [0.81–2.30]	**2.15 [1.39–3.34]**
Antipsychotics	1.06 [0.69–1.63]	0.89 [0.61–1.31]	**1.51 [1.12–2.05]**
Benzodiazepines	1.10 [0.81–1.48]	1.13 [0.86–1.49]	**1.38 [1.09–1.76]**
Discharge opioids#			
Opioid potency			
Weaker opioids	Reference	Reference	Reference
Nil opioids	**4.18 [2.97–5.88]**	**5.10 [3.41–7.63]**	**3.26 [2.44–4.43]**
Stronger opioids	0.85 [0.48–1.48]	1.50 [0.75–2.98]	0.81 [0.49–1.34]
Oral morphine equivalents			
1–150 mg	Reference	Reference	Reference
0 mg	**4.18 [2.97–5.88]**	**5.10 [3.41–7.63]**	**3.28 [2.44–4.43]**

(*continued on next page*)

Table 2 (*continued*)

Predictors of new fluctuating, late discontinuation, and persistent opioid use compared to nonpersistent opioid users.

	Fluctuating aRR [95% CI]*	Late discontinuation aRR [95% CI]*	Persistent aRR [95% CI]*
151–300 mg	0.78 [0.51–1.18]	**2.20 [1.45–3.34]**	**1.94 [1.39–2.69]**
301–600 mg	0.97 [0.61–1.54]	**4.36 [2.87–6.63]**	**2.71 [1.90–3.86]**
>600 mg	0.83 [0.45–1.52]	**21.79 [14.09–33.68]**	**13.91 [9.54–20.28]**
Opioid preparation			
Oral short-acting	0.74 [0.49–1.11]	**2.04 [1.58–2.62]**	**1.30 [1.03–1.64]**
Oral long-acting	**0.58 [0.35–0.98]**	1.17 [0.82–1.67]	1.02 [0.73–1.44]
Transdermal	0.91 [0.51–1.62]	**5.03 [3.53–7.18]**	**7.57 [5.57–10.30]**
Discharge nonopioid analgesics#			
Paracetamol	0.87 [0.69–1.09]	1.22 [0.99–1.50]	1.16 [0.96–1.41]
NSAIDs	0.91 [0.52–1.58]	**1.58 [1.07–2.32]**	**1.57 [1.04–2.38]**
Pregabalin	1.19 [0.62–2.26]	1.04 [0.65–1.68]	0.96 [0.60–1.53]
Antidepressants for pain¶	0.72 [0.39–1.36]	0.89 [0.50–1.57]	0.71 [0.43–1.19]

Bold text highlights significant values.

* Adjusted for sex, age, year of hospital discharge, region of residence, concessional status, discharge to aged care facility, length of hospital stay, HFRS, CCI, comorbidities, and medication variables.

† Based on Department of Health Human Services Region classification.

‡ Weighted score calculated using diagnoses within 2 years of index admission.

§ Based on diagnoses within 5 years before hospital discharge.

‖ Based on dispensing within 90 days of index admission.

¶ Included amitriptyline, nortriptyline, venlafaxine, and duloxetine.

Based on dispensing within 30 days after hospital discharge.

aRR, adjusted relative risk; CI, confidence interval; COPD, chronic obstructive pulmonary disease; NSAIDs, nonsteroidal anti-inflammatory drugs.

understanding of risk factors can assist clinicians and health care services implement monitoring and interventions to minimise unintended harm from long-term opioid use after hip fracture surgery. Future research should focus on targeted interventions to address modifiable risk factors to reduce new persistent opioid use in older and vulnerable populations.

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