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Trends of opioid use following anterior cervical discectomy and fusion: A 10-year longitudinal study of the Veterans Health Administration



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ABSTRACT

Background: The United States Veteran Health Administration (VHA) cares for a substantial group of patients who are at higher risk of substance abuse in comparison to the general population. The purpose of this study was to (1) examine opioid consumption in the veteran population both pre- and postoperatively to anterior cervical discectomy and fusion (ACDF) and (2) understand the risk factors that are associated with sustained postoperative opioid use.

Methods: A retrospective database study was conducted using the Veterans Affairs Informatics and Computing Infrastructure database. Patients who underwent ACDF between 2010 and 2020 were identified and stratified into 3 groups based on their preoperative opioid usage prior to the procedure: opioid naïve, low preoperative opioid use (1–3 preoperative claims), and high preoperative opioid use (≥ 4 preoperative claims). Cumulative pre- and postoperative opioid usage for each patient was calculated in Morphine Milligram Equivalents (MME).

Results: A total of 7,894 patients were identified with 3,929 (49.7%) opioid naïve, 1,813 (23.0%) low preoperative opioid use, and 2,152 (27.3%) high opioid usage. The proportion of patients in the opioid-naïve cohort, low preoperative usage cohort, and high preoperative opioid usage cohort, that remained on opioids 1 year postoperatively was 13.1%, 31.3%, and 77.8%, respectively. At 1 year postoperatively, the median opioid MME significantly decreased pre- to postoperatively (25.0 vs. 0, $p < .006$). High preoperative opioid consumption was found to be the greatest risk factor for continued chronic opioid use (OR 17.1, $p < .001$).

Conclusions: Following ACDF procedures, opioid consumption significantly decreased; however, at 1 year, over one-third of patients remained on opioid therapy. A disproportionate number of patients who remained on chronic opioid therapy had high preoperative opioid consumption. Notably, increased scrutiny and policy changes regarding opioids, which began around 2017, resulted in a significant reduction in preoperative opioid use by 2020 compared to a decade earlier.

Background

Consisting of 20.3 million people, the United States (U.S.) veteran population is at high risk for substance use problems compared to the general population. Nearly 11% of veterans receiving first time care at the Veterans Health Administration (VHA) meet diagnostic criteria for substance use disorder [1–3]. This population has been observed to have more comorbidities than the general population including depression, post-traumatic stress disorder (PTSD) and anxiety. Opioid management in these patients is higher risk and more challenging as mental health

diagnoses further increase the likelihood of developing a subsequent substance use problem after receiving an opioid [3,4].

U.S. veterans have also been shown to demonstrate significantly increased prevalence of severe, debilitating chronic neck and low back pain than the civilian population [3]. Patients undergoing spine surgery are heavy utilizers of opioid medications and often have comorbid pathology that make long term pain control challenging [5]. Spine surgery has been associated with substantial postoperative opioid requirements and consumption; however, opioid medications can be beneficial when used appropriately [6–8]. Increased opioid consumption

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Table 1

Patient demographics and comorbidities of the opioid naïve, low preoperative opioid usage, and high preoperative opioid usage cohorts.

| | Opioid naïve (n = 3,929, 49.7%) | Low preoperative opioid usage (n = 1,812, 23.0%) | High preoperative opioid usage (n = 2,153, 27.3%) | p-value |
|-----------------------------|---------------------------------|--|---|---------|
| Age (Years) | 65.7 ± 10.7 | 65.3 ± 10.9 | 65.9 ± 9.3 | .147 |
| Male sex | 3654 (93.0%) | 1664 (91.8%) | 1975 (91.7%) | >.999 |
| Median length of stay (IQR) | 1.0 day (1.0–3.0) | 1.0 day (1.0–3.0) | 1.0 day (1.0–3.0) | .955 |
| Race | | | | |
| Caucasian | 2,884 (73.4%) | 1,333 (73.0%) | 1,631 (75.8%) | >.999 |
| African American | 731 (18.6%) | 368 (20.3%) | 375 (17.4%) | >.999 |
| Asian | 12 (0.3%) | 8 (0.4%) | 6 (0.3%) | >.999 |
| Native American | 38 (1.0%) | 9 (0.5%) | 9 (0.4%) | >.999 |
| Other | 34 (0.9%) | 12 (0.7%) | 17 (0.8%) | >.999 |
| Comorbidities | | | | |
| Depression | 407 (10.4%) | 206 (11.4%) | 263 (12.2%) | >.999 |
| Diabetes mellitus | 596 (15.2%) | 287 (15.8%) | 318 (14.8%) | >.999 |
| Hypertension | 1582 (40.3%) | 743 (41.0%) | 937 (43.5%) | >.999 |
| Obesity | 249 (6.3%) | 102 (5.6%) | 172 (8.0%) | .347 |
| PTSD | 358 (9.1%) | 209 (11.5%) | 218 (10.1%) | .766 |
| Tobacco use | 557 (14.2%) | 274 (15.1%) | 395 (18.3%) | .004 |

Bolded p-values indicate statistically significant results.

IQR, interquartile range; PTSD, post-traumatic stress disorder.

and chronic preoperative opioid therapy have previously been shown to increase risk for complications, increased hospital length of stay, increased healthcare expenditure, and suboptimal outcomes [9]. Anterior cervical discectomy and fusion (ACDF) is a common surgical procedure for degenerative and traumatic conditions of the cervical spine and is expected to increase by 13% in annual volume by 2040 demonstrating a further need to understand the clinical impact of opioid consumption before and after surgery [10].

Long term outcomes after ACDF have demonstrated significant improvements in self-reported pain scores and outcome measures; [11] however, postoperative opioid utilization remains an area of interest in the published literature. The purpose of the current study was to examine perioperative opioid consumption in the VHA population undergoing ACDF procedures and identify risk factors associated with chronic opioid consumption postoperatively.

Methods

Upon receiving approval from the Veteran Affairs (VA) Central Institutional Review Board (IRB) and the local Veterans Health Care System IRB, patient records were queried from the VA Informatics and Computing Infrastructure (VINCI) database. This national database contains deidentified patient data from both inpatient and outpatient settings of the VHA. Data were queried from the period beginning January 1, 2010, to December 31, 2020 using Current Procedural Technology (CPT) and International Classification of Diseases, Ninth and Tenth revision (ICD-9/ICD-10) codes. A retrospective cohort study was conducted to evaluate trends in opioid consumption among patients undergoing ACDF. Patients were initially identified based on the presence of CPT codes 22551 or 63075 for ACDF. Patients who were readmitted within 455 days of initial admission were then excluded to minimize bias for postoperative opioid use due to another medical condition which necessitated readmission. Patients who were deceased within 455 days of initial admission and patients with incomplete data for any variable of interest were also excluded. We chose a 455-day period to capture opioid use trends 1 year after the standard 90-day postoperative care period. This timeframe provided a comprehensive view of opioid use patterns over a full year following surgery, based on the assumption that most patients should have transitioned off opioids by 90 days.

Baseline demographic data was obtained for all patient cohorts including age, sex, race, and year of surgery. Clinical characteristics obtained included postoperative length of stay (LOS), as well as the prevalence of diabetes mellitus, tobacco use, obesity, and other comorbidities as listed in Table 1. The database was queried for both surgical (implant

complication, dural tear, wound complications) and medical (cardiovascular, neurological, pulmonary, infectious, and urogenital) complications based off ICD-10 codes. Patients were stratified into 3 groups based on preoperative opioid usage within 365 days prior to operative date: opioid-naïve (0 preoperative claims), low preoperative use (1-3 preoperative claims), and high preoperative usage (≥4 preoperative claims).

A claim is each instance that a given patient filled a prescription including type of opioid, strength, and quantity. Research indicates that patients with ≥4 claims are at higher risk for prolonged use and related complications, making this a practical and clinically relevant threshold [12,13]. For groups (II) and (III), the proportion of patients with at least 1 postoperative opioid claim was calculated for 4 distinct postoperative time periods: (I) 0 to 30 days; (II) 31 to 90 days; (III) 91 to 180 days; and (IV) 181 to 365 days. Postoperative analysis was taken to day 455 to evaluate for 365 days beyond the acute postoperative period of 90 days. Generic drug codes for the most commonly prescribed transdermal and oral opioid medications were used to quantify the number of patients who filled at least 1 opioid claim during each postoperative time interval. The list of specific drugs queried is included in Appendix A. Cumulative opioid usage for each patient was calculated as Morphine Milligram Equivalents (MME) as outlined by the Centers for Disease Control and Prevention (CDC) [14]. When calculating cumulative postoperative MME, the initial 90 days postoperatively was not analyzed since it was expected that there would be an elevation in opioid consumption due to acute postoperative pain.

Statistical analysis

All analyses were conducted using R statistical software (R Foundation for Statistical Computing, Vienna, Austria) with a significance level of less than 0.05. The Cochran-Armitage test was used to perform trend analysis of opioid usage following ACDF. For each stratified group, the distribution of cumulative MME was assessed using the Shapiro-Wilk normality test which confirmed non-normality for every variable except age. The paired Wilcoxon signed rank test was then subsequently used to compare cumulative preoperative MME (between days –365 and 0) to cumulative postoperative MME (between days 91 and 455). Fisher exact tests were used to determine associations between covariates and opioid usage after postoperative day 90 (as defined by at least 1 filed claim between postoperative days 91 and 455) and Odds Ratios are reported. Mann Whitney U tests were used to compare cumulative MME from the years 2010-2015 to cumulative MME from the years 2016-2020. Chi-squared tests were used to compare 30-day complication rates between

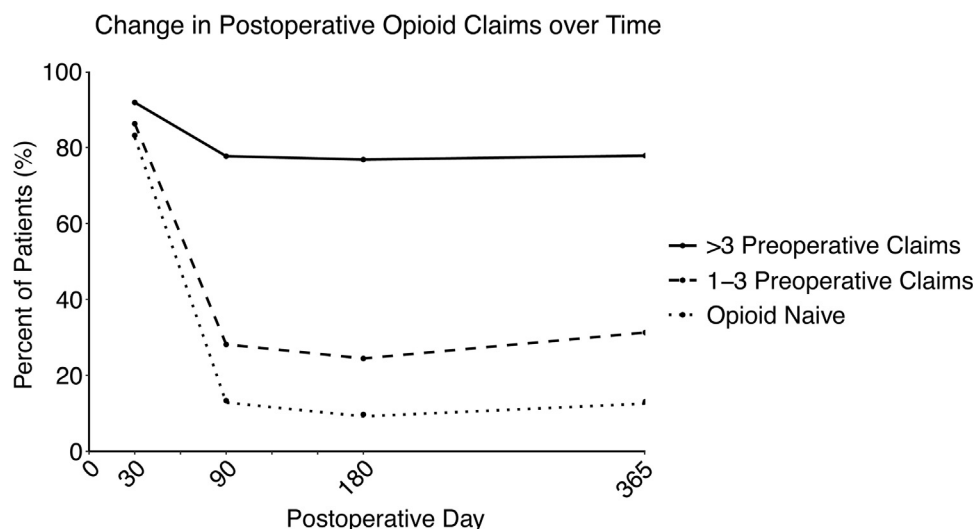


Fig. 1. The proportion of patients in each cohort who filed at least 1 opioid claim at postoperative days 30, 90, 180, and 365.

the opioid naïve, low preoperative opioid usage, and high preoperative opioid usage groups.

Results

Study populations, demographics, and comorbidities

A total of 7,894 veterans who underwent ACDF between 2010 and 2020 met inclusion criteria. Of the 7,894 patients identified, 3,929 (49.7%) were opioid naïve preoperatively, 1,812 (23.0%) had low preoperative opioid usage, and 2,153 (27.3%) had high preoperative opioid usage. The 3 cohorts were statistically similar across all demographics and comorbidities except for tobacco use. About 18% of the high preoperative opioid usage group used tobacco compared to 15% and 14% of low and naïve groups, respectively ($p=.004$, Table 1).

Postoperative opioid usage

Thirty-five percent of all patients remained on opioids 1 year postoperatively, and opioid claim rates significantly differed among cohorts ($p<.001$, Fig. 1). The proportion of patients in the preoperative opioid-naïve group with at least 1 opioid claim dropped from 83% at postoperative day 30 to 13% at day 90 and 13% at day 365. The proportion of patients with at least 1 opioid claim in the low preoperative usage cohort dropped from 86% at postoperative day 30, to 28% at day 90, to 31% at day 365. Finally, the proportion of patients with at least 1 opioid claim in the high preoperative usage cohort dropped from 92% at day 30 to 78% at day 90 and 78% at day 365.

Preoperative versus postoperative median opioid MME

After 90 days the median cumulative MME significantly decreased postoperatively among all patients (25 vs. 0, $p<.006$). When stratified by cohort, the opioid-naïve (0 vs. 0, $p<.001$), low (450 vs. 0, $p<.001$), and high (6,300 vs. 5,070, $p<.001$) preoperative opioid usage cohorts demonstrated significantly decreased median MME postoperatively (Table 2).

Risk factors associated with continued postoperative opioid use (>90 days)

High preoperative opioid usage was the covariate most associated with continued postoperative opioid usage (OR 17.1, Table 3). Being opioid-naïve was associated with discontinued opioid usage (OR, 0.1, $p<.001$). Increased age and Hispanic ethnicity (OR, 1.2) were also associated with continued opioid usage. Other comorbidities significantly

associated with continued opioid usage were anemia (OR 1.9) depression (OR 1.2), hypertension (OR 1.2), liver disease (OR 1.5), psychoses (OR 1.9), and tobacco use (OR 1.3) (Table 3). Surgical complications significantly associated with continued postoperative opioid use included any implant complication (OR 1.9), any surgical complication (OR 1.2), wound dehiscence (OR 2.4), and wound infection (OR 1.9).

Postoperative complications within 30 days of ACDF

The overall complication rate for the 10-year period was 12.6%. All postoperative complication rates were statistically comparable across all 3 cohorts (Table 4).

Trends in preoperative and postoperative opioid prescriptions

From the years 2010 to 2017, the percentage of patients with preoperative opioid claims was consistently greater than 50.0% while the percentage of patients with opioid claims after postoperative day 90 was greater than 40.0%. There was a steady decline in both preoperative and postoperative opioid claims with lowest reported pre- and postoperative usage of 31.6% and 21.7%, respectively, in the final year of this study, 2020 (Fig. 2). Median cumulative preoperative MME significantly decreased from 2010 to 2015 compared to 2016-2020 (150 vs. 0, $p<.001$). (Table 5).

Discussion

This study examined perioperative opioid use in the VHA patient population to analyze trends in opioid consumption and identify risk factors for prolonged use after ACDF procedures. The steady declines in opioid consumption observed in this study, both in usage and MME, are mirrored in the literature [15–19]. For instance, Hadlandsmay et al. studied opioid prescription trends within the VHA from 2010 to 2016 and reported a peak in opioid prescribing in 2012, with a subsequent decline by 2016, reflecting a reduction in both the quantity and duration of prescriptions [20]. This trend aligns with national efforts and regulations to address the opioid crisis, which have led to a decrease in opioid prescriptions across both VHA and civilian populations [21,22]. The observed reduction in preoperative and postoperative opioid use in recent years suggests that these regulatory and educational efforts are having a significant impact. Specifically, the decrease mirrors national data on opioid prescribing trends, such as those reported by the CDC and the NIDA, which indicate that increased awareness and new prescribing guidelines have effectively contributed to the decline in opioid use [23,24].

Table 2

Preoperative versus postoperative MME for the opioid naïve, low preoperative opioid (1-3 preoperative claims), and high preoperative opioid (>3 preoperative claims) cohorts.

| Cohort | Preoperative median MME (IQR) | Postoperative median MME (IQR) | p-value |
|--------------------------------|-------------------------------|--------------------------------|-----------------|
| All | 25 (0–1,800) | 0 (0–1,650) | .006 |
| Opioid-Naïve | 0 (0–0) | 0 (0–0) | <.001 |
| Low preoperative opioid usage | 450 (199–900) | 0 (0–636) | <.001 |
| High preoperative opioid usage | 6,300 (2,850–13,160) | 5,070 (930–13,350) | <.001 |

Bolded p-values indicate statistically significant results.

MME, morphine milligram equivalent; IQR, interquartile range.

Table 3

Risk factors associated with continued or discontinued postoperative opioid use at 90 days.

| Demographics | Discontinued (n = 4625) | Continued (n = 3269) | OR (95% CI) | p-value |
|------------------------------|-------------------------|----------------------|-------------------------|-----------------|
| Age | 65.4 ± 10.9 | 66.1 ± 9.6 | - | .001 |
| Length of stay (Days) | 6.1 ± 10.9 | 6.1 ± 9.6 | - | .962 |
| Male gender | 4,272 (92.4%) | 3,021 (92.4%) | 1.0 (0.9-1.2) | 1.0 |
| Hispanic ethnicity | 225 (4.9%) | 195 (6.0%) | 1.2 (1.0-1.5) | .033 |
| Not Hispanic ethnicity | 4,221 (91.3%) | 2,942 (90.0%) | 0.9 (0.7-1.0) | .059 |
| Comorbidities | | | | |
| Alcohol use disorder | 171 (3.7%) | 113 (3.5%) | 0.9 (0.7-1.2) | .582 |
| Anemia | 50 (1.1%) | 67 (2.0%) | 1.9 (1.3-2.8) | <.001 |
| Congestive heart failure | 81 (1.8%) | 63 (1.9%) | 1.1 (0.8-1.6) | .609 |
| Depression | 474 (10.2%) | 402 (12.3%) | 1.2 (1.1-1.4) | .005 |
| Diabetes mellitus | 689 (14.9%) | 512 (15.7%) | 1.1 (0.9-1.2) | .356 |
| Drug abuse | 102 (2.2%) | 84 (2.6%) | 1.2 (0.9-1.6) | .293 |
| Hypertension | 1,836 (39.7%) | 1,426 (43.6%) | 1.2 (1.1-1.3) | <.001 |
| Liver disease | 114 (2.5%) | 118 (3.6%) | 1.5 (1.1-1.9) | .004 |
| Obesity | 293 (6.3%) | 230 (7.0%) | 1.1 (0.9-1.3) | .232 |
| Opioid naïve | 3,215 (69.5%) | 714 (21.8%) | 0.1 (0.1-0.1) | <.001 |
| Low preoperative opioid use | 1,089 (23.5%) | 723 (22.1%) | 0.9 (0.8-1.0) | .142 |
| High preoperative Opioid Use | 321 (6.9%) | 1,832 (56.0%) | 17.1 (14.9-19.6) | <.001 |
| Psychoses | 95 (2.1%) | 122 (3.7%) | 1.9 (1.4-2.5) | <.001 |
| Tobacco use | 645 (13.9%) | 581 (17.8%) | 1.3 (1.2-1.5) | <.001 |
| Surgical complications | | | | |
| Any instrumentation | 2,310 (49.9%) | 1,671 (51.1%) | 1.0 (1.0-1.2) | .315 |
| Any implant complication | 29 (0.6%) | 38 (1.2%) | 1.9 (1.1-3.1) | .013 |
| Any surgical complication | 555 (12.0%) | 442 (13.5%) | 1.2 (1.0-1.3) | .046 |
| Dural tear | 56 (1.2%) | 39 (1.2%) | 1.0 (0.6-1.5) | 1.0 |
| Wound dehiscence | 9 (0.2%) | 15 (0.5%) | 2.4 (1.0-6.1) | .039 |
| Wound infection | 21 (0.5%) | 28 (0.9%) | 1.9 (1.0-3.5) | .029 |
| Wound hematoma/Hemorrhage | 52 (1.1%) | 41 (1.3%) | 1.1 (0.7-1.7) | .598 |

Bolded p-values indicate statistically significant results.

Table 4

Postoperative complications with 30 days of ACDF stratified by preoperative opioid usage.

| Complications | Opioid naïve (n = 3,927) | Low preoperative opioid use (n = 1,813) | High preoperative opioid use (n = 2,152) | p-value |
|---------------------------|--------------------------|---|--|---------|
| Any complication | 490 (12.5%) | 228 (12.6%) | 279 (13.0%) | >.999 |
| Cardiovascular | 39 (1.0%) | 17 (0.9%) | 11 (0.5%) | >.999 |
| Dural tear | 38 (1.0%) | 29 (1.6%) | 28 (1.3%) | >.999 |
| Neurological | 35 (0.9%) | 10 (0.6%) | 23 (1.1%) | >.999 |
| Pneumonia | 42 (1.1%) | 20 (1.1%) | 19 (0.9%) | >.999 |
| Pulmonary | 230 (5.9%) | 93 (5.1%) | 100 (4.6%) | >.999 |
| Sepsis | 36 (0.9) | 15 (0.8) | 14 (0.7) | >.999 |
| Urinary tract infection | 74 (1.9%) | 34 (1.9%) | 29 (1.3%) | >.999 |
| Wound infection | 22 (0.6%) | 5 (0.3%) | 22 (1.0%) | .140 |
| Wound dehiscence | 7 (0.2%) | 5 (0.3%) | 12 (0.6%) | .501 |
| Wound hematoma/Hemorrhage | 42 (1.1%) | 25 (1.4%) | 26 (1.2%) | >.999 |

Table 5

Median preoperative MME for each cohort between 2010 and 2015 and 2016–2020.

| Cohort | Years 2010-2015 (IQR) | Years 2016-2020 (IQR) | p-value |
|-------------------------|-----------------------|-----------------------|-----------------|
| All | 150 (0–2,800) | 0 (0-900) | <.001 |
| Opioid naïve | 0 (0–0) | 0 (0-0) | N/A |
| 1–3 preoperative claims | 535 (245–1,000) | 305 (150-630) | <.001 |
| >3 preoperative claims | 6,627 (3,075–13,755) | 5,727 (2,426–11,370) | <.001 |

Bolded p-values indicate statistically significant results.

MME, morphine milligram equivalent; IQR, interquartile range.

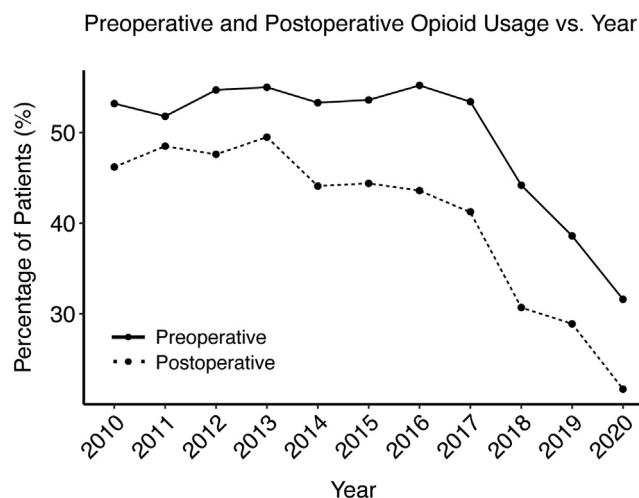


Fig. 2. Percentage of patients with preoperative opioid usage (solid line) and sustained opioid usage after postoperative day 90 (dashed line) from 2010 to 2020.

Half of all veterans undergoing ACDF had preoperative opioid prescriptions, and 27% of all patients had high preoperative opioid behavior. When looking at cervical surgery, the preoperative opioid utilization reported here trends higher but is within the range of comparable studies in the civilian population (32%–52.4%) [25–28]. The postoperative opioid consumption in this population decreased across all cohorts. Twenty-two and 69% of patients remained opioid free after 12 months of high and low preoperative usage patients, respectively. Wang et al. studied a prospective cohort of civilian patients undergoing elective cervical surgery to evaluate the effects of preoperative opioid use on patient reported outcomes and long-term consumption. While patients in both groups demonstrated great improvements in satisfaction and pain control, those with preoperative opioid use showed smaller improvements compared to the opioid naïve. Number of surgical levels treated and surgical approach (anterior vs. posterior) did not show any difference on postoperative opioid use. The association between preoperative opioid consumption as an independent risk factor for continued use has been demonstrated in numerous studies on opioid consumption after orthopedic and spine procedures [19,27,29–31]. The low utilization of postoperative narcotics in naïve and low usage patients compared to the persistent consumption in the high utilizing veterans demonstrate that persistent pain may be less the result of the surgical intervention but rather an effect of the complex emotional, psychological, and biological interplay between opioid medications and chronic pain symptoms.

In addition to continued opioid use among veterans on preoperative opioid therapy, the opioid naïve patients who remain on chronic opioid therapy after ACDF warrant discussion. Thirteen percent of patients without preoperative narcotic consumption continued to consume after 1 year. Similar trends of persistent opioid use in the opioid-naïve veterans are seen after lumbar spine surgery [32]. Several comorbid conditions identified in this study including tobacco consumption, mental disorder (anxiety, depression, mood disorder), concomitant substance use, medical comorbidity (anemia, hypertension, liver disease) have all been shown to increase the risk of long-term use within the published literature [25,32,33]. Slightly lower than reported in this study, the rates of naïve conversion to chronic use in the civilian population have been reported between 3% and 9% [34]. In 2022, Lovecchio et al. published a prospective analysis of civilian patients undergoing ACDF or cervical disk arthroplasty between 2018 and 2019 demonstrating early postoperative narcotic discontinuation. While chronic opioid users were excluded from analysis, 75% of patients with low or no preoperative opioid use discontinued narcotic usage by postoperative day 12.

Limitations

This study is not without limitations. Claims data do not contain any information on the amount of opioids that patients consume after filling the prescription. Additionally, the database does not include information on opioids obtained through a non-VA healthcare provider. While we excluded patients who were readmitted to minimize bias for postoperative opioid use due to another medical condition, we were unable to account for pain medication from other hospital visits and admissions that may have occurred outside the confines of the database. Other analgesics were not queried in this study and over the counter analgesics (e.g. nonsteroidal anti-inflammatory drugs) are difficult to track. Thus, concomitant usage of other analgesics and their influence on opioid consumption postoperatively is not considered in this study. Additionally, the possibility of coding errors is inherent with any retrospective analysis of administrative claims data. It is possible that uncharted prescriptions and postoperative complications were not captured. However, such errors are exceedingly rare and consisted of only 0.7% of Medicare and Medicaid payments in 2021 [31]. A further confounder in the data is the possible inclusion of combined surgical procedures in addition to the ACDF, which is unable to be filtered out based on the database.

Conclusions

Following ACDF procedures, opioid consumption significantly decreased within the veteran population. At 1 year, 69% of the cohort ceased opioid therapy. A disproportionate number of patients who remained on chronic opioid therapy had high preoperative opioid consumption. Notably, the increased scrutiny and policy changes regarding opioids around 2017 led to a significant reduction in preoperative opioid use by 2020 compared to a decade earlier. Various other factors, such as surgical complications, tobacco use, and psychological or medical comorbidity, increased the individual risk of continued opioid use. Implementing additional strategies to curb preoperative opioid consumption could potentially mitigate chronic opioid usage within the VHA patient population.

Declaration of competing interest

One or more of the authors declare financial or professional relationships on ICMJE-NASSJ disclosure forms.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.xnsj.2025.100595](https://doi.org/10.1016/j.xnsj.2025.100595).

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