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Healthcare Spending and New Persistent Opioid Use After Surgery

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Abstract

We analyzed data from a national dataset of de-identified commercial insurance claims (Clinformatics® Data Mart (OptumInsight, Eden Prairie, MN) to describe changes in healthcare spending associated with new persistent opioid use after surgery. After accounting for other postoperative complications, new persistent opioid use was independently associated with significantly higher total healthcare spending during the 180 days after surgery (by \$2,500 for uncomplicated inpatient procedures and \$1,000 for uncomplicated outpatient procedures). This increase was primarily due to higher utilization of ambulatory care and readmissions. Patients with new persistent opioid use also continued to have significantly higher monthly healthcare spending even 180 days after surgery. This is in contrast to other common postoperative complications in which patients return to baseline healthcare spending by 180 days after surgery. Targeted value-based care initiatives may be required to incentivize early identification and coordinated pathways of care for patients with new persistent opioid use after surgery.

Keywords

opioids; pain; surgery; cost; value

INTRODUCTION

The United States uses more opioids than any other country in the world.¹ Mortality attributable to opioid overdoses continues to increase, now reaching 115 fatalities each day.² Procedural care represents a common episode of opioid prescribing to manage acute pain. In the United States, over 45 million procedures are performed each year, and surgeons provide 10% of all opioid prescriptions.³ However, excess prescribing is common, with 72% of opioid prescriptions going unused after common surgical procedures.⁴ Moreover, 6–10% of previously opioid-naïve patients transition to new persistent opioid use after elective surgery.^{5–8}

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To date, the trajectory of care for patients who develop new persistent opioid following surgical care is not well understood. Surgical patients with new persistent opioid use may be at particular risk for high utilization but poorly coordinated care. In prior work, we have observed that patients who develop new persistent opioid use following surgery often have a prolonged transition of care with uncoordinated opioid prescribing from multiple physicians and specialties.^{9,10} In addition, patients with established chronic opioid use have higher healthcare spending and utilization across multiple domains of care compared with opioid naïve patients, including surgical care.¹¹ Moreover, patients with ongoing opioid use are more likely to develop postoperative complications, further driving excess utilization and cost.¹²

Understanding how new persistent opioid use impacts the value of surgical care is critical in order to design efficient and patient-centered care pathways. To identify potential targets for optimizing care pathways for these vulnerable patients, we performed a study with the following objectives: 1) describe changes in total healthcare spending associated with new persistent opioid use after surgery; 2) describe changes in total healthcare spending attributed to different types of care for patients who develop new persistent opioid use; and 3) describe changes in monthly healthcare spending over time for patients who develop new persistent opioid use. We hypothesized new persistent opioid use would be associated with higher total healthcare spending with sustained increases in monthly healthcare spending 180 days after surgery.

METHODS

Data Source and Study Cohort

Using a national dataset of de-identified commercial insurance claims (Clinformatics® Data Mart (OptumInsight, Eden Prairie, MN), we identified opioid-naïve adults age 18 to 64 years old who underwent both major and minor elective surgical procedures between January 2008 – March 2015 and filled an opioid prescription attributable to surgery. Similar to previous work,⁷ major surgery was defined as bariatric surgery, colectomy, incisional hernia repair, reflux surgery, and hysterectomy. Minor surgery was defined as varicose vein removal, laparoscopic appendectomy, hemorrhoidectomy, laparoscopic cholecystectomy, transurethral prostate surgeries, thyroidectomy, parathyroidectomy, and carpal tunnel release. We included only patients with continuous enrollment 1 year prior to surgery through 6 months in the postoperative period. We excluded patients with length of stay greater than 30 days (n=2,378) or a postoperative procedural code for additional anesthesia (i.e. reoperation) within 6 months of their index operation (n=56,343). We also excluded patients who utilized subacute rehabilitation (SAR) or skilled nursing facility (SNF) services postoperatively (n=220). Although SAR and SNF services are known to drive variation in healthcare spending for Medicare patients undergoing surgical procedures,¹³ utilization of these services is uncommon among privately-insured patients (less than 0.01% in this study cohort) who tend to be younger and healthier compared to Medicare patients.

For inpatient procedures, we excluded patients without facility claims for an index hospitalization (n=3,842). This step ensured accurate determination of admission and discharge dates for the index admission. For outpatient procedures, we excluded patients

with a postoperative hospitalization greater than 2 days (n=9,344). This exclusion was necessary because patients undergoing outpatient procedures are permitted to have postoperative hospitalizations classified as outpatient care as long as the hospitalization is less than or equal to 2 days.¹⁴

Primary Outcomes

This study had three primary outcomes: 1) total healthcare spending from the index surgical encounter to 180 days after discharge from the index surgical encounter; 2) the proportion of total healthcare spending attributable to different types of care (index admission, ambulatory care, readmission, emergency department, and all other care); 3) monthly healthcare spending beginning 180 days before the index surgical encounter and ending 180 days after discharge. Healthcare spending was quantified using price-standardized payments from payers, standardized to 2016 dollars and extracted from the medical claims dataset. Price standardization accounts for geographic differences in payments due to variation in local factors, such as labor costs, as well as differences contractual provider-payer reimbursement and regional pricing.¹⁵ This approach is similar to other administrative datasets.^{16,17} Specifically, a standardized payment was assigned to each service reflecting the national average payment for that service.

Total healthcare spending attributed to different types of care was characterized based on the index encounter and place of service codes as defined by the Centers for Medicare and Medicaid services:

1. Index encounter: Payments for all claims associated with the index encounter (including the index procedure and initial postoperative hospitalization).
2. Ambulatory care: Payments for all claims associated with an ambulatory or outpatient place of service.
3. Readmissions: Payments for all claims associated with an inpatient or hospital place of service (excluding the initial postoperative hospitalization).
4. Emergency department: Payments for all claims associated with an emergency department place of service.
5. Other care: Payments for all claims not specifically accounted for in the other categories.

Opioid Prescription Data and New Persistent Opioid Use

Data on opioid prescribing was obtained from pharmacy claims. Patients were considered opioid-naïve if they filled no opioid prescriptions between 12 months to 31 days prior to the surgical procedure. Patients were included in the study if they filled an opioid prescription attributable to surgery, which was defined as opioid prescription provided to a patient between 30 days before surgery and 2 weeks after discharge. For opioid prescriptions attributed to surgery, we evaluated two prescribing patterns: prescriptions filled by patients during the 30 days before surgery (preoperative opioid prescriptions) and quantity prescribed (in oral morphine equivalents) for the opioid prescription closest to the date of surgery (initial opioid prescribed). We defined new persistent postoperative use based on previously

published methods,^{5–8,18} and included opioid-naïve patients who filled an opioid prescription attributed to surgery, and continued to fill one or more additional opioid prescriptions between 91–180 days after surgery.

Postoperative Complications

Postoperative complications were identified using International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes (Supplemental Table 1). We specifically identified the following postoperative complications: pulmonary failure, pneumonia, myocardial infarction, deep venous thrombosis/pulmonary embolism, renal failure, surgical site infection, gastrointestinal bleeding, and hemorrhage. This method of identifying complications with administrative data has been previously described and validated.^{19,20} Specifically, complications were identified from primary and secondary ICD-9-CM diagnostic codes from the index hospitalization and any subsequent encounters within 30 days of discharge.^{21,22} To account for pre-existing conditions, claims with these diagnostic codes in the index hospitalization were not counted as postoperative complication if these diagnostic codes were present on admission.

Statistical Analysis

For total healthcare spending, multivariate regression models were used to calculate covariate-adjusted healthcare spending in the 180 days after surgery. For monthly healthcare spending, we used mixed linear models to calculate covariate-adjusted healthcare spending every 30 days beginning 180 days before surgery and ending 180 days after surgery. To account for differences in care pathways, separate models were constructed for inpatient and outpatient procedures. Adjustment covariates included age, sex, race/ethnicity, education, region, comorbidities, mental health disorders, pain disorders, preoperative opioid prescriptions, initial prescription size, and postoperative complications.

For comparison, we first divided patients into groups based on type of procedure (inpatient or outpatient procedure) and whether or not they had new persistent opioid use or other postoperative complications. These groups were selected to evaluate the association between new persistent opioid use and healthcare spending compared to other postoperative complications. For each group, we then calculated the mean covariate-adjusted total healthcare spending and compared these amounts between groups. For monthly healthcare spending, we also calculated the mean covariate-adjusted monthly healthcare spending for each group (excluding the index encounter), then compared groups using mixed linear models for repeated measures.

For all our models, we calculated variance inflation factors to evaluate for collinearity. Data were analyzed with Stata version 14.2 (StataCorp LLC, College Station, Texas). Two-sided *P* values < .05 were considered statistically significant.

RESULTS

Study Cohort

During the study period, 133,439 opioid-naïve patients underwent an eligible surgical procedure, filled an opioid prescription attributed to surgery, and were included in the analysis. Of these, 8,103 (6%) developed new persistent opioid use. Exhibit 1 compares characteristics of patients with and without new persistent opioid use. Patients who developed new persistent opioid use were less likely to have obtained a college degree (13% vs. 17%), had a significantly greater comorbidity score (1.1 vs. 0.8), were more likely to have a history of tobacco use (34% vs. 25%), and were more likely to have mood disorders and pain disorders. They were also more likely to receive preoperative opioid prescriptions (24% vs. 17%), received larger opioid prescriptions (210 vs. 200 oral morphine equivalents), were more likely to have other major postoperative complications (4% vs. 3%), and had longer index hospitalizations (1.5 vs. 1.2 days).

Total Healthcare Spending and New persistent opioid use

Exhibit 2 compares adjusted total healthcare spending for patients with and without new persistent opioid use. For patients who underwent inpatient procedures, new persistent opioid use was independently associated with significantly higher adjusted total healthcare spending. Healthcare spending was significantly higher for patients without other complications (+\$2,500, $P < 0.001$) and with other complications (+\$6,600, $P < 0.001$). For patients who underwent outpatient procedures, new persistent opioid use was also independently associated with significantly higher adjusted total healthcare spending. Healthcare spending was significantly higher for patients without other complications (+\$1,000, $P < 0.001$) and with other complications (+\$5,900, $P < 0.001$).

Total Healthcare Spending for Different Types of Care for New Persistent Opioid Use

Exhibit 3 compares the proportion of healthcare spending attributed to different types of care for patients with and without new persistent opioid use. For patients undergoing inpatient procedures without other complications, patients with new persistent opioid use had a reduced proportion of spending for the index encounter (71% vs. 81%) and an increased proportion of spending for ambulatory care (21% vs. 11%) and readmissions (6% vs. 1%) following surgery. For patients with other complications, patients with new persistent opioid use had a reduced proportion of spending for the index encounter (61% vs. 72%) and an increased proportion of spending for ambulatory care (20% vs. 16%) and readmissions (16% vs. 11%).

The same trend was observed for outpatient procedures. For patients without other complications, patients with new persistent opioid use had a reduced proportion of spending for the index encounter (71% vs. 86%) and an increased proportion of spending for ambulatory care (22% vs. 11%) and readmissions (5% vs. 2%). Similarly, for patients with other complications, patients with new persistent opioid use had a reduced proportion of spending for the index encounter (39% vs. 55%) and an increased proportion of spending for ambulatory care (29% vs. 19%) and readmissions (30% vs. 25%).

Changes in Monthly Healthcare Spending over Time for New Persistent Opioid Use

Exhibit 4 shows adjusted monthly healthcare spending for patients with and without new persistent opioid use. For inpatient procedures (Exhibit 4A), all patients had similar adjusted monthly healthcare spending before surgery. Patients without new persistent opioid use or other complications returned to baseline levels of adjusted monthly healthcare spending 180 days after surgery. In contrast, patients with new persistent opioid use only (without other complications) had a sustained increase in adjusted monthly healthcare spending 180 days after surgery (+\$200 per month, $P<0.001$). Patients with other complications only (without new persistent opioid use) returned to baseline levels of monthly healthcare spending by 180 days after surgery. Patients with both new persistent opioid use and other complications also had a sustained increase in adjusted monthly healthcare spending 180 days after surgery.

The same trends were observed for patients undergoing outpatient procedures (Exhibit 4B). Specifically, all patients had similar levels of adjusted monthly healthcare spending before surgery. Patients without new persistent opioid use or other complications returned to baseline levels of adjusted monthly healthcare spending 180 days after surgery. In contrast, patients with new persistent opioid use only (without other complications) had a sustained increase in adjusted monthly healthcare spending (+\$200 per month, $P<0.001$) 180 days after surgery. Patients with other complications only (without new persistent opioid use) returned to baseline levels of adjusted monthly healthcare spending by 180 days after surgery. Patients with both new persistent opioid use and other complications also had a sustained increase in adjusted monthly healthcare spending 180 days after surgery.

DISCUSSION

In this national study of adults undergoing surgery, we observed that new persistent opioid use was independently associated with significantly higher healthcare spending during the 180 days after surgery. This increase in healthcare spending was primarily from greater utilization of ambulatory care and readmissions. In addition, patients with new persistent opioid use continued to have significantly higher monthly healthcare spending, even 180 days after surgery. This is in contrast to patients who develop other common postoperative complications, in which healthcare spending returns to baseline by 180 days after surgery.

This study is aligned with prior work examining the risks of opioid use among surgical patients. Similar to previous studies of new persistent opioid use,^{5–8} we found that the risk of new persistent opioid for surgical patients was 6%. Our findings further build on this work and demonstrate the potential long-term consequences of new persistent opioid use on healthcare spending and utilization. Specifically, we observed that the increase in monthly healthcare spending associated with new persistent opioid was similar to other postoperative complications, such as surgical site infections and pneumonia, and is sustained for months following procedural care. These observed increase in healthcare spending are similar to other studies describing the association between healthcare spending and non-opioid postoperative complications²³ or chronic opioid use in non-surgical patients.¹¹ In addition, although previous work has shown that new persistent opioid use is associated with uncoordinated opioid prescribing from multiple physician and specialties,^{9,10} it was unknown which healthcare services were being used. The current findings reveal that new

persistent opioid use is associated with significantly higher spending on ambulatory care and readmissions, with fewer increases related to the index surgical procedure.

The study has several notable limitations. First, it is a retrospective study of insurance claims data from privately-insured patients, which limits its generalizability. To mitigate this, we adjusted for insurance type and income in our analysis. In addition, because we used insurance claims data, we are unable to determine the reasons for opioid prescriptions. Nevertheless, previous work demonstrates that the risk of new persistent opioid is 0.6% for non-surgical patients,⁷ so it is unlikely that patients in our study filled opioid prescriptions for reasons unrelated to surgery. Furthermore, we specifically accounted for postoperative complications in our analysis, which could drive both prolonged opioid use as well as healthcare costs and expenditures. In fact, even patients with new persistent opioid but no other postoperative complications had significantly higher healthcare spending and utilization. Another limitation is that we did not include indirect financial costs associated with lost productivity. Nonetheless, because opioid use is known to be associated with significantly higher disability,^{24–26} this would tend to bias our study findings towards the null hypothesis. Even without including disability and lost productivity, we found that new persistent opioid use was associated with significantly higher healthcare spending. The actual burden of new persistent opioid use is likely even higher than reported in this study. Finally, readmissions through the emergency department and related costs are likely included with readmission costs, and may underestimate the true costs to emergency care systems.

In conclusion, we found that new persistent opioid use is associated with significantly higher healthcare spending, primarily due to increased spending on ambulatory care and readmissions. This increase in healthcare spending persists even 180 days after surgery, and independent of postoperative complications. Because patients with new persistent opioid use have higher healthcare spending, these patients should be identified early and targeted for coordinated pathways of care. Moreover, given the burden of additional ambulatory care visits and readmissions, healthcare systems should consider strategies to expand capacity and tailor care toward specific patient needs, including opioid weaning pathways, opioid alternatives, and mental and social health services to speed cessation of opioid use. Surgeons must take ownership of these patients and coordinate long-term follow-up to improve the quality of care for this vulnerable population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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		No new persistent opioid use	New persistent opioid use	Difference
Outpatient procedures	With other complications	\$ 15,954	\$ 21,811	\$ 5,857
	Without other complications	\$ 10,432	\$ 11,383	\$ 952
Inpatient procedures	With other complications	\$ 27,005	\$ 33,578	\$ 6,573
	Without other complications	\$ 18,430	\$ 20,965.78	\$ 2,536

EXHIBIT 2 (Figure):

Adjusted total healthcare spending for new persistent opioid use.

Source/Notes: SOURCE Author's analysis of data from [Optum Clinformatics Data Mart, 2008 – 2015]. NOTES For patients who underwent inpatient procedures, new persistent opioid use was independently associated with significantly higher adjusted total healthcare spending. Healthcare spending was significantly higher for patients without other complications (+\$2,500, $P < 0.001$) and with other complications (+\$6,600, $P < 0.001$). For patients who underwent outpatient procedures, new persistent opioid use was also independently associated with significantly higher adjusted total healthcare spending. Healthcare spending was significantly higher for patients without other complications (+\$1,000, $P < 0.001$) and with other complications (+\$5,900, $P < 0.001$).

		Category	Index encounter	Ambulatory care	Readmissions	Emergency department and other
Outpatient procedures	With other complications	New persistent opioid use	39%	29%	30%	2%
		No new persistent opioid use	55%	19%	25%	2%
	Without other complications	New persistent opioid use	71%	22%	5%	2%
		No new persistent opioid use	86%	11%	2%	1%
Inpatient procedures	With other complications	New persistent opioid use	61%	20%	16%	2%
		No new persistent opioid use	72%	16%	11%	1%
	Without other complications	New persistent opioid use	71%	21%	6%	2%
		No new persistent opioid use	87%	11%	1%	1%

EXHIBIT 3 (Figure):

Total healthcare spending for different types of care for new persistent opioid use

Source/Notes: SOURCE Author's analysis of data from [Optum Clinformatics Data Mart, 2008 – 2015]. NOTES New persistent opioid use was associated with a significantly higher proportion of healthcare spending attributed to ambulatory care and readmissions, while the proportion of healthcare spending attributed to the index encounter was significantly lower. These findings were consistent for inpatient procedures, outpatient procedures, and patient with and without other complications.

Time from Surgery (days)	Inpatient Procedures			
	- New persistent opioid use - Other complications	+ New persistent opioid use - Other complications	- New persistent opioid use + Other complications	+ New persistent opioid use + Other complications
-165	315.5158757	309.897992	315.6392666	297.7240349
-135	324.8501583	314.0103669	327.7234131	293.8100657
-105	358.0273719	352.5125967	357.6175073	274.7650564
-75	406.8367593	406.3484326	404.831123	383.5315987
-45	487.0910176	478.41252	518.7184667	547.3081880
-15	692.3062775	745.6609453	772.2458825	765.0543
15	243.3023166	322.590113	1338.35586	1498.365847
45	253.9318154	353.5256349	398.3456119	556.6407173
75	274.8927441	384.4185758	334.300761	485.2071821
105	268.9201296	462.8323093	296.5819614	630.7745807
135	259.4380641	521.2428208	278.9931371	533.5223897
165	270.5679557	494.0036955	265.3091894	627.6127356

Time from Surgery (days)	Outpatient Procedures			
	- New persistent opioid use - Other complications	+ New persistent opioid use - Other complications	- New persistent opioid use + Other complications	+ New persistent opioid use + Other complications
-165	266.2372956	259.4105651	249.3481219	347.203478
-135	274.8642699	289.0981592	244.0972763	283.8361977
-105	297.5151096	290.7228779	255.3843735	341.8114354
-75	345.9453991	330.7824803	377.1943728	352.1383854
-45	461.921517	449.690591	416.779561	375.6309554
-15	841.2862747	854.2688658	973.0862742	1261.207207
15	286.9283699	308.5238555	1795.0906176	1395.0906176
45	255.218703	286.7039069	337.4998278	436.326344
75	250.6182838	281.804671	248.3527215	550.5230961
105	238.3143069	384.4400727	257.4764185	662.461892
135	236.4110436	394.3405989	216.5094877	516.7416295
165	243.7720312	409.339526	226.305862	468.3353777

EXHIBIT 4 (Figure):

Adjusted monthly healthcare spending for new persistent opioid use

Source/Notes: SOURCE Author's analysis of data from [Optum Clinformatics Data Mart, 2008 – 2015]. NOTES For inpatient procedures (Exhibit 4A), all patients had similar adjusted monthly healthcare spending before surgery. Patients without new persistent opioid use or other complications returned to baseline levels of adjusted monthly healthcare spending 180 days after surgery. In contrast, patients with new persistent opioid use only (without other complications) had a sustained increase in adjusted monthly healthcare spending 180 days after surgery (+\$200 per month, $P < 0.001$). Patients with other complications only (without new persistent opioid use) returned to baseline levels of monthly healthcare spending by 180 days after surgery. Patients with both new persistent opioid use and other complications also had a sustained increase in adjusted monthly healthcare spending 180 days after surgery. The same trends were observed for patients undergoing outpatient procedures (Exhibit 4B). Specifically, all patients had similar levels of adjusted monthly healthcare spending before surgery. Patients without new persistent opioid use or other complications returned to baseline levels of adjusted monthly healthcare spending 180 days after surgery. In contrast, patients with new persistent opioid use only (without other complications) had a sustained increase in adjusted monthly healthcare spending (+\$200 per month, $P < 0.001$) 180 days after surgery. Patients with other complications only (without new persistent opioid use) returned to baseline levels of adjusted monthly healthcare spending by 180 days after surgery. Patients with both new persistent opioid use and other complications also had a sustained increase in adjusted monthly healthcare spending 180 days after surgery.

EXHIBIT 1 (Table)

Comparison of patients with and without new persistent opioid use.

Characteristic	No New Persistent Opioid Use (n=125,336)	New Persistent Opioid Use (n=8,103)
Age, years, mean (SD)	44 (12)	45 (12)
Female sex, %	68%	71%
Race/ethnicity, %		
Caucasian	72%	73%
African-American	10%	12%
Hispanic	11%	10%
Asian	3%	2%
Unknown	4%	4%
Education, %		
Less than high school	> 1%	> 1%
High school diploma	28%	32%
Less than bachelor degree	54%	54%
College degree or more	17%	13%
Unknown	> 1%	1%
Charlson comorbidity index, mean (SD)	0.8 (1.4)	1.1 (1.9)
History of tobacco use, %	25%	34%
Mental health disorders, %		
Adjustment	4%	5%
Anxiety	14%	20%
Mood	16%	23%
Suicide or self-harm	> 1%	> 1%
Disruptive	2%	3%
Personality	> 1%	> 1%
Psychosis	> 1%	> 1%
Alcohol or substance abuse disorders	2%	4%
Other	3%	5%
Pain disorders, %		
Arthritis	45%	60%
Back	23%	38%
Neck	12%	19%
Other pain conditions	41%	52%
Procedure type, %		
Major surgery	24%	26%
Minor surgery	76%	74%
Setting of care, %		
Inpatient procedure	41%	43%

Characteristic	No New Persistent Opioid Use (n=125,336)	New Persistent Opioid Use (n=8,103)
Outpatient procedure	59%	57%
Preoperative opioid prescription ^a , %	17%	24%
Initial prescription size, oral morphine equivalents, median (IQR)	200 (113)	210 (150)
Major postoperative complications, %	3%	4%
Hospital length of stay (days), mean(SD)	1.2 (1.8)	1.5 (2.5)

^aOpioid prescription provided within 30 days before surgery

Source/Notes: SOURCE Author's analysis of data from [Optum Clinformatics Data Mart, 2008 – 2015]. NOTES Patients who developed new persistent opioid use were less likely to have obtained a college degree (13% vs. 17%), had significantly more comorbidities (1.1 vs. 0.8), were more likely to have a history of tobacco use (34% vs. 25%), and were more likely to have mood disorders and pain disorders. They were also more likely to receive preoperative opioid prescriptions (24% vs. 17%), received larger opioid prescriptions (210 vs. 200 oral morphine equivalents), were more likely to have other major postoperative complications (4% vs. 3%), and had longer index hospitalizations (1.5 vs. 1.2 days).