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Postsurgical Opioid Prescriptions and Risk of Long-term Use:

An Observational Cohort Study Across the United States

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Abstract

Objective—The aim of this study was to evaluate differences in risk of long-term opioid therapy after surgery among an opioid-naive population using varying cutoffs based on days supplied (DS), total morphine milligram equivalents (MME) dispensed, and quantity of pills (QTY) dispensed.

Background—In response to the US opioid crisis, opioid prescription (Rx) limits have been implemented on a state-by-state basis beginning in 2016. However, there is limited evidence informing appropriate prescribing limits, and the effect of these policies on long-term opioid therapy.

Methods—Using the MarketScan claims databases, we identified all opioid-naive patients undergoing outpatient surgery between July 1, 2006 and June 30, 2015. We identified the initial postsurgical opioid prescribed, examining the DS, total MME, and QTY dispensed. We used Poisson to estimate adjusted risk differences and risk ratios of long-term opioid use comparing those receiving larger versus smaller volume of opioids.

Results—We identified 5,148,485 opioid-naive surgical patients. Overall, 55.5% received an opioid for postoperative pain, with median days supply =5 and median total MME = 240. The proportion of patients receiving prescriptions above 7 DS increased from 11% in 2006 to 19% in 2015. Among those receiving postoperative opioids, 8% had long-term opioid use, and risk of long-term use was 1.16 times [95% confidence interval (CI), 1.10–1.25] higher among those receiving >7 days compared with those receiving ≤7 days. Those receiving >400 total MME (15% of patients) were at 1.17 times (95% CI, 1.10–1.25) the risk of long-term use compared with those receiving ≤400 MME.

Conclusions—Between 2005 and 2015, the amounts of opioids prescribed for postoperative pain increased dramatically, and receipt of larger volume of opioids was associated with increased risk of long-term opioid therapy.

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Keywords

long-term opioid use; opioids; pain management; postsurgical pain; surgery

Despite the known risks associated with opioid analgesics, these medications play an important role in healthcare and evidence supports the efficacy of short-term opioid use to manage acute pain, such as that after surgery.[1] In the postoperative setting, undertreatment of pain has been associated with surgical complications, increased healthcare costs, reductions in quality of life, increased risk of developing chronic pain, and overall increased morbidity and mortality.[2–4] Although opioid analgesics have been found to be effective in managing postsurgical pain, the safety and effectiveness of long-term opioid therapy are contentious, and long-term use of opioids after surgery has been cited as one of the most common surgical complications.[5]

A recent Annals of Surgery Special Series focusing on the opioid crisis published several new findings and perspectives related to the opioid epidemic in the context of surgical care. Larash found that among patients beginning opioid therapy, the proportion initiating opioids for surgical pain increased from 2010 to 2016, and the amount dispensed per patient has increased over time.[6] Meanwhile, many have found that wide variations in the amount of opioids prescribed at discharge with little consensus on the appropriate days supply, quantity, and dosage for postsurgical pain.[7–9] Notably, Sekhri recently reported a wide variation on total dosage dispensed after elective surgery, and found no difference in refill probability based on initial dosage prescribed, suggesting opportunity to improve judicious prescribing.[9] In line with these views, Feinberg conducted a systematic review and found that among examining dispensed opioids for varying procedures, the proportion of consumed opioids was <50% for most procedures.[10] Lastly, Jiang reported that in one institution, >9% of surgical patients had long-term opioid use after surgery.[11] This increase and heterogeneity in postsurgical prescribing, potential ramifications of excess opioid supply, and prevalence of long-term opioid use after surgery led to a common call for more evidence-based research to inform prescribing guidelines for postsurgical pain.[6,7,10]

In February 2018, Centers for Medicare & Medicaid Services (CMS) released a statement proposing day supply and dosage limits for opioids in attempts to address prescription opioid overuse. For acute pain, cut points of 7 days and 50 MME/d were given as examples; however, no definitive limits were set.[12] Since 2016, opioid prescription (Rx) limits have been implemented on a state-by-state basis, with varying policies setting limits based on day supply, quantity (number of units) dispensed, total dosage dispensed, or some combination. Although there exists variance between state policies, the most common policy has been to limit initial prescriptions to 7 days for acute (including postoperative) pain.[13] Little data exists to support the effectiveness of these policies, and evidence informing optimal thresholds of prescribing to achieve adequate pain management while minimizing the risk of overuse is needed.

Our objective was to examine the 7-day supply cut point for initial postsurgical prescriptions, to describe the proportion of patients receiving prescriptions exceeding this cut point, the characteristics associated with receiving a prescription exceeding 7 days, and

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to examine whether a longer days supply was associated with an increase in long-term opioid use. We also aim to examine other cut points based on differing values of days supplied (DS), quantity dispensed, and total dosage dispensed in morphine milligram equivalents.

METHODS

Data Source

We used IBM Watson MarketScan Commercial Claims and Encounters and Medicare Supplemental Databases from 2006 to 2015. The MarketScan Research Databases have been widely used in health services research and contains fully paid and adjudicated healthcare claims across the continuum of care (physician office visits, inpatient and outpatient services, and outpatient prescription medications including those from mail-order and specialty pharmacies). The database consists of deidentified data from over 350 carriers, covering over 255 million individuals across the United States.[14] These insurance claims data include records for all healthcare received that is submitted through a beneficiary's insurance benefit, thus we are able to observe services and medications received across pharmacies and institutions.

We identified patients undergoing surgery using Current Procedural Terminology (CPT) codes billed in the outpatient services file between July 1, 2006 and June 30, 2015. Surgery was defined as a CPT for general anesthesia (00100–01999) occurring on the same day as a CPT code for invasive surgery as defined by the Healthcare Cost and Utilization Project (HCUP).[15] All eligible patients were required to have ≥180 days of prior continuous enrollment to allow for complete capture of baseline medical history and to screen for opioid exposure before initiation. Any patients with an opioid prescription in the 180 days prior until 7 days before surgery, or evidence of opioid poisoning, abuse, or addiction (based on ICD-9 diagnosis codes or receipt of naloxone) during baseline were excluded from the cohort to align with clinical practice concerns of initiating opioid use in naive patients and subsequent development of opioid-related problems. We also excluded patients with surgery in the prior 180 days to minimize the inclusion of patients with postsurgical pain or complications from prior surgeries. Patients were required to have a minimum of 180 days of continuous follow-up with no evidence of additional surgical procedure, to measure the outcome of long-term opioid therapy.

Exposure

The initial opioid prescription for postoperative pain was defined as the first opioid prescription filled within 7 days before or 7 days after surgery (Fig. 1). Any patients filling a single prescription in this window were assumed to be receiving this prescription for expected postoperative pain.

The MarketScan claims data include the National Drug Code (NDC) for each dispensed medication allowing for exact identification of active ingredient and dosage, as well as information on the number of pills dispensed and total length in days of each prescription. We calculated the total morphine milligram equivalents (MME) dispensed using dosage as

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indicated by the NDC and published morphine conversion factors (Appendix Table 1).[16] We characterized (1) total DS, (2) total quantity of pills dispensed (QTY), and (3) total dosage in MME.

Outcome

Long-term therapy was defined as any opioid prescription filled between 90- and 180-day postsurgical discharge.[5]

Statistical Analyses

We characterize prescribing patterns, describing the median DS, QTY, and MME across patient sex, medication, and surgical site.[17] We present the proportion of patients receiving opioid prescriptions above the 7-day supply cut point in the entire study population and stratified by patient sex and surgical site. We additionally examine alternative cut points based on varying values of DS, QTY, and MME. We used the Cochran Armitage test for linear trend to assess changes in prescribing over the study period.

We used Poisson regression adjusting for demographics (age, sex, region), surgery characteristics (surgical site, year of surgery), pain-related diagnoses, recent emergency room or inpatient hospitalization, medication use, and baseline comorbidities (Table 1) to estimate adjusted risk differences and risk ratios of long-term opioid use comparing those receiving larger versus smaller volume of opioids.

RESULTS

We identified 5,148,485 opioid-naive surgical patients (Supplemental Figure 1, http://links.lww.com/SLA/B748). The mean age was 45 years, and 55% were female. The most common surgical sites were head (28% of patients) and knee (11% of patients) (Supplemental Table 1, http://links.lww.com/SLA/B748). Overall, 55% (2,957,115) received an opioid for postoperative pain. Among the 2,957,115 patients initiating opioids for postsurgical pain, hydrocodone was the most commonly prescribed opioid, with 59% of patients filling a prescription for hydrocodone, followed by oxycodone, accounting for 31% of patients (Table 1). In 2015 following the rescheduling of hydrocodone, the overall proportion of patients filling a prescription for hydrocodone fell to 44%; however, it remained the most commonly prescribed opioid (Supplemental Table 2, http://links.lww.com/SLA/B748). Among opioid initiators, 8% (9% females, 7% males) filled a prescription between 90 and 180 days' postsurgery. Patients initiating on levorphanol (40%) and methadone (33%) had the highest proportion of patients who went on to have long-term opioid therapy, whereas those initiating on codeine had the lowest (7%). When stratified by surgical site, those undergoing spine surgery and radiologic procedures (13%) had the highest proportion with long-term opioid therapy, whereas those receiving care for burn (6%) and obstetric surgery (5%) had the lowest (Table 1).

Days Supplied

Prescribing Patterns—Among all patients receiving an opioid prescription for postoperative pain, the median DS was 5, with no difference between sexes. Buprenorphine

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(median = 23) and transdermal fentanyl (median = 15) had the highest median DS, whereas codeine had the lowest median at 4 DS (Table 1). Overall, 14% of patients received an opioid prescription >7 days. Buprenorphine (88%), methadone (74%), and fentanyl (74%) had the highest proportion of patients receiving a prescription for >7 days, whereas codeine (8%) had the smallest proportion of patients receiving a prescription for >7 days (Supplemental Table 3, http://links.lww.com/SLA/B748). Overall, the proportion of patients receiving a prescription >7 days' supply increased monotonically, nearly doubling between 2006 (11%) and 2015 (19%) ($P < 0.0001$) (Table 2). When stratifying by sex we found that a higher proportion of males (14.6%) received a prescription >7 days supply compared with females (12.9%). As illustrated in Figure 2, the proportion increased monotonically in both sexes over time (10.3% in 2006 to 18.3% in 2015; males: 11.8% in 2006 to 20.3% in 2015).

Spine surgery had the highest proportion of patients receiving an initial prescription >7 DS [$P = 0.43$ (0.43–0.44)], followed by pelvic surgery [$P = 0.32$ (0.29–0.34)]. Obstetric [$P = 0.08$ (0.07–0.08)], and lower abdominal [$P = 0.07$ (0.07– 0.08)] surgeries had the lowest proportion of patients receiving an initial prescription >7 DS (Supplemental Table 3, http://links.lww.com/SLA/B748). Figure 2 illustrates prescribing trends stratified among the 8 most common surgical sites. The proportion receiving a prescription exceeding 7 days increased among all surgical sites, with the largest percentage increase between 2006 and 2015 observed among upper abdominal surgery (5.7%–11.8%), and the smallest percentage increase among head surgery (10.7%–13.6%) (Supplemental Table 4, http://links.lww.com/SLA/B748).

Risk of Long-term Therapy—For every 100 patients receiving a DS >7, 9.2 went on to have long-term use, compared with 7.8 for those receiving 7 days or fewer [aRD = 1.09 (1.00–1.18), NNT = 92] (Table 3). Patients receiving a prescription >7 days were 1.17 (1.10–1.25) times as likely to have long-term use (Supplemental Table 5a, http://links.lww.com/SLA/B748).

Figure 3 illustrates the proportion of patients receiving a prescription above varying days supply cut points, and the relative risk of long-term use comparing patients above that cut point to those below. The largest relative increases in risk were seen using cut points of 1 and 26 days. Among all patients receiving an opioid for postoperative pain, 99% received a prescription >1 day, and these patients were 34% [95% confidence interval (CI), 1.01–1.79] more likely to have long-term use compared with those receiving a DS of 1. Using the 26 DS cut point, 0.5% of patients received a prescription >26 days, and these patients were 47% more likely to have long-term use (95% CI, 1.23–1.76) (Supplemental Table 5a, http://links.lww.com/SLA/B748).

Quantity Dispensed

Prescribing Patterns—Among all patients receiving an opioid prescription for postoperative pain, the median quantity dispensed was 30 pills. The median quantity dispensed ranged from 10 (fentanyl) to 60 (methadone, morphine, and oxymorphone) (Table 1). The 50 QTY cut point identified a similar proportion of patients as the 7 DS, with 13% of

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patients receiving greater a prescription >50 QTY. Prescribing patterns were similar to those seen in the days supply analysis (Supplemental Table 3, http://links.lww.com/SLA/B748).

Risk of Long-term Therapy—For every 100 patients receiving a QTY >50, 8.9 went on to have long-term use, compared with 7.9 for those receiving 50 or less [aRD = 0.91 (0.82–1.00), NNT = 110] (Table 3). Patients receiving a prescription with quantity dispensed >50 were at 1.13 (1.06–1.21) times increased risk of long-term use (Fig. 3, Supplemental Table 5b, http://links.lww.com/SLA/B748). The largest increase in risk was seen using a 100 QTY cut point, which identified 2% of the population who were at 19% increased risk of long-term use (95% CI, 1.03–1.38).

Dosage Dispensed

Prescribing Patterns—Among all patients receiving an opioid prescription for postoperative pain, the median dosage in morphine milligram equivalents dispensed was 240 MME. Codeine had the lowest median dosage dispensed (90 MME), whereas methadone (1,410 MME) and oxymorphone (840 MME) had the highest (Table 1). Using a 400 MME cut point identified 17% of patients who received a prescription above this threshold. Overall, the proportion of patients receiving a prescription >400 MME more than doubled throughout the study period, rising from 11% in 2006 to 22% in 2015 ($P < 0.0001$) (Table 2).

Prescribing patterns were similar to those seen in the days supply analysis (Supplemental Table 3, http://links.lww.com/SLA/B748).

Risk of Long-term Therapy—For every 100 patients receiving a prescription >400 MME, 9.0 had long-term therapy, compared with 7.8 among those with <400 MME [aRD = 1.16 (1.07–1.25), NNT = 87] (Table 3). Patients receiving >400 MME were at 1.17 (1.10–1.25) times increased risk of long-term opioid therapy. The highest increase in risk was seen using the 2,000 MME cut point, which identified 1 (1.3% of patients) who were at 1.25 (1.00–1.56) times increased risk of long-term opioid therapy (Fig. 3; Supplemental Table 5c, http://links.lww.com/SLA/B748).

DISCUSSION

Overall, we found that 55% of opioid-naive patients undergoing invasive surgery requiring general anesthesia received perioperative opioids, of which 8% went on to have long-term opioid therapy. This is consistent with prior studies finding that 6% to 13% of patients had evidence of opioid use 90 to 180 days after surgery.[5,18] In comparison, among patients who did not receive opioids for postoperative pain, 4% had long-term opioid therapy (data not shown). These findings suggest that overall, the impact of postoperative opioids on long-term use may be smaller than previously reported; however, those receiving high dosages or large days supply may be at increased risk.

We chose to focus on a 7-day supply cut point, mirroring the most common cut point used in recent policies implemented on a state-by-state basis. Although many states have prescribing limits, few have passed limits specific to postoperative pain. As of April 2019, the only

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states with specific limits for postoperative pain are Arizona (limit of 14 d) and North Carolina (limit of 7 d for initial prescriptions).[13,19] Balancing clinical relevance with population impact is important to consider in creating regulations on prescribing. Although patients receiving 1 or more days supply were at increased risk of long-term use compared with patients receiving only 1 day, it is likely not feasible or clinically sound to limit all postoperative prescriptions to 1 day. Similarly, although the 0.5% of patients receiving >26 days were at much higher risk of long-term use compared with those receiving 26 days or less, this cut point is likely much higher than clinically optimal and would make little impact as our data show that such long prescriptions are rare for opioid-naive patients undergoing surgery in our population. In addition to limits based on days supply, we also examined limits based on quantity dispensed and total morphine milligram equivalents dispensed. To directly compare with the 7-day cut point, we examined cut points that identified a similar proportion of initiators and examined associated risk ratios (50 quantity dispensed, 400 MME). We found that quantity dispensed was less predictive of long-term use. Contrary to hypothesized, we found that patients receiving very large quantities (over 300 units) were at decreased risk of long-term use. This may be due to errors in the claims data. Among patients receiving 300 units or more, the median number of pills per day (quantity dispensed divided by days supply) was 75 which is likely clinically implausible, suggesting errors in the data. Although cut points based on MME seemed to define patients at higher risk of long-term use, this measure may be more difficult to implement in clinical practice compared with measures based on DS and is also susceptible to errors in recorded quantity dispensed. Prescribing limits based on MMEs require a universally accepted conversion table and require that providers take an additional step to convert all prescriptions dosages, complicating the clinical decision-making process.

We included buprenorphine, fentanyl, levorphanol, methadone, and oxymorphone because we were interested in seeing how often these are prescribed, but these are typically prescribed for chronic pain. Because our focus was to examine opioids prescribed for acute postoperative pain, we repeated the analysis limiting the population to patients who initiated on codeine, hydrocodone, meperidine, oxycodone, and tramadol. We removed patients who initiated on buprenorphine, fentanyl, hydromorphone, levorphanol, methadone, morphine, oxymorphone, and tapentadol as these are more often prescribed for chronic pain. Overall these medications were prescribed very rarely, and this removed <2% of the study population. The percent of initiators who went on to have long-term opioid therapy dropped from 8.03% to 8.01%; all other results were also stable (data not shown).

We found that the proportion of patients receiving initial postoperative opioids exceeding 7 days increased from 2006 to 2015, and that this trend was consistent within both sexes and when stratified by surgical site. We can speculate on several factors that may have influenced postsurgical prescribing practice but are limited by what can be inferred from the claims database used in this study. Postsurgical pain that is not adequately managed leads to increased risk of complications, morbidity, long-term pain, and cost of care, as well as decreased quality of life.[2,3,20] Surgeons balance adequate pain management needs while complying with institutional and societal demands, further restricted by which modalities are affordable for the patient.[21] The evolving restrictions on refills for opioids and other Schedule II medications and electronic prescribing requirements (eg, by state laws) have the

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potential to shape initial postoperative prescribing over time. There are rational reasons to prescribed longer initial doses, such as reducing copay and travel burden on patients who have recently had surgery, as well as institutional pressure to use clinic time for more highly remunerated visit types, but how these have varied over time cannot be discerned from our data. A potential factor may be the Center for Medicare and Medicaid Services (CMS) value-based performance surveys where patient satisfaction was tied to hospital payment, which included pain management from 2006 to 2018.[22–25] However, per capita outpatient opioid dispensing in the United States peaked in 2012,[26] but subsequently the average days supply per prescription increased between 2006 and 2015.[27] Although opioids as a class of molecules may have similar analgesic properties, there seem to be fundamental differences in how they are prescribed across practice settings, and subtle shifts over time in pain management practice, limiting our ability to extend macrolevel observations to surgical practice.

These results should be interpreted in context, bearing in mind limitations of the present study. We defined long-term opioid therapy as evidence of a filled opioid prescription occurring 90 to 180 days after surgery, replicating prior work this area.[5,18] However, it is possible that the opioid medications during follow-up could be prescribed for pain unrelated to the index surgery. The current definition of long-term opioid use does not require evidence of continuous exposure to opioids after surgery. To contextualize our findings, we report that 4% of patients who do not receive opioids in the perioperative window fill an opioid prescription in the 90 to 180 days after surgery, meeting the long-term use definition. This suggests that a meaningful proportion of patients who are identified as long-term users after surgery may in fact be receiving opioids for pain unrelated to perioperative opioid receipt. These analyses were conducted using longitudinal, prospectively collected insurance claims data. We were able to examine baseline health comorbidities, surgical site, and patient demographics, but these data do not include information on surgical pain severity. However, this analysis was limited to outpatient surgeries, and complicated procedures requiring inpatient admission were not included. Any opioid prescriptions paid for out of pocket without insurance benefits were not observed; however, we limited the population to those who have evidence of prescription drug benefits. Although we can observe the amount of opioids dispensed for all prescriptions procured through the insurance benefit, we do not know how much was consumed by the patient. We used MME conversions which are used widely by clinicians; however, individual patients likely have differing variable biologic responses to varying opioids. These data include commercially insured individuals and may not be generalizable to the general United States population. However, this is one of the largest insurance databases in the United States and includes over 260 contributing employers from across the country.[28]

In contrast to prior work published in this area, we focused on a broad surgical population. We found that surgical site was differentially predictive of receipt of postoperative prescriptions exceeding 7 days, as is clinically expected due to varying levels of pain associated with different surgical procedures. Although current policies enacted are applied across all surgeries, these results suggest that it may be more clinically relevant to have procedure-specific limits to ensure safe, but adequate pain management after surgery.

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Further detailed analyses can help elucidate the optimal amounts of opioids for postsurgical pain for specific procedures.

As efforts continue to combat the opioid crisis, legislators have placed limits on postsurgical opioid prescriptions. However, careful thought balancing clinical expertise and judgment, patient safety and reduction of iatrogenic opioid addiction, and adequate pain management are necessary moving forward.[29] As various legislations are implemented across the country, the heterogeneity in policies may present an opportunity for researchers and policymakers to learn from varying impacts across states and medical systems in the United States. With increasing concern about excess opioid supply and risks of addiction, diversion, and overdose associated with these medications, efforts to decrease the amounts of opioids prescribed must be balanced with ensuring that patients receive adequate pain management after surgical care. Enhanced recovery after surgery (ERAS) protocols, aiming to shorten length of stays and improve patient outcomes after surgeries, have been found to be successful in various settings.[30–33] Likewise, incorporating methods of multimodal analgesia,[34–36] having realistic discussions about expectations surrounding pain and recovery,[37] and leveraging multidisciplinary teams involving pain specialists, physical medicine, occupational therapy, addiction and mental health services can help with pain management.[36]

The current results describe initial opioid prescribing for postoperative pain in a large opioid-naive commercially insured adult population. We found that between 2006 and 2015, the amounts of opioids prescribed increased dramatically, and that receipt of larger amounts of opioids was associated with increased risk of long-term opioid therapy. We found that MME cut points were associated with the largest increases in risk of long-term therapy, followed by DS, and lastly quantity dispensed. Given potential difficulties with MME conversion factors, days supply cut points may provide reasonable guidance. These analyses help add to the evidence base informing clinicians of the point at which increasing opioid prescriptions for postoperative pain may impact iatrogenic long-term opioid use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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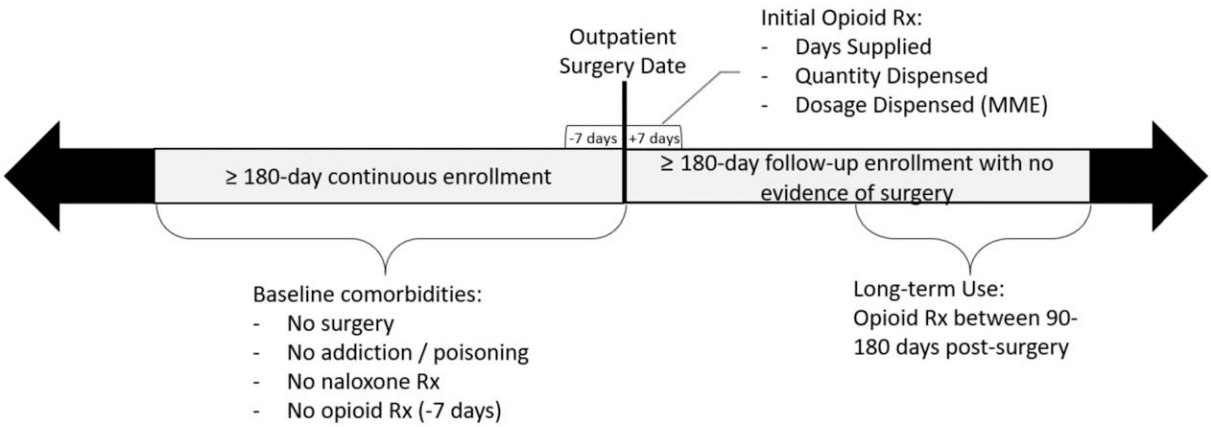

FIGURE 1.
Study schematic illustrating cohort enrollment criteria and follow-up.

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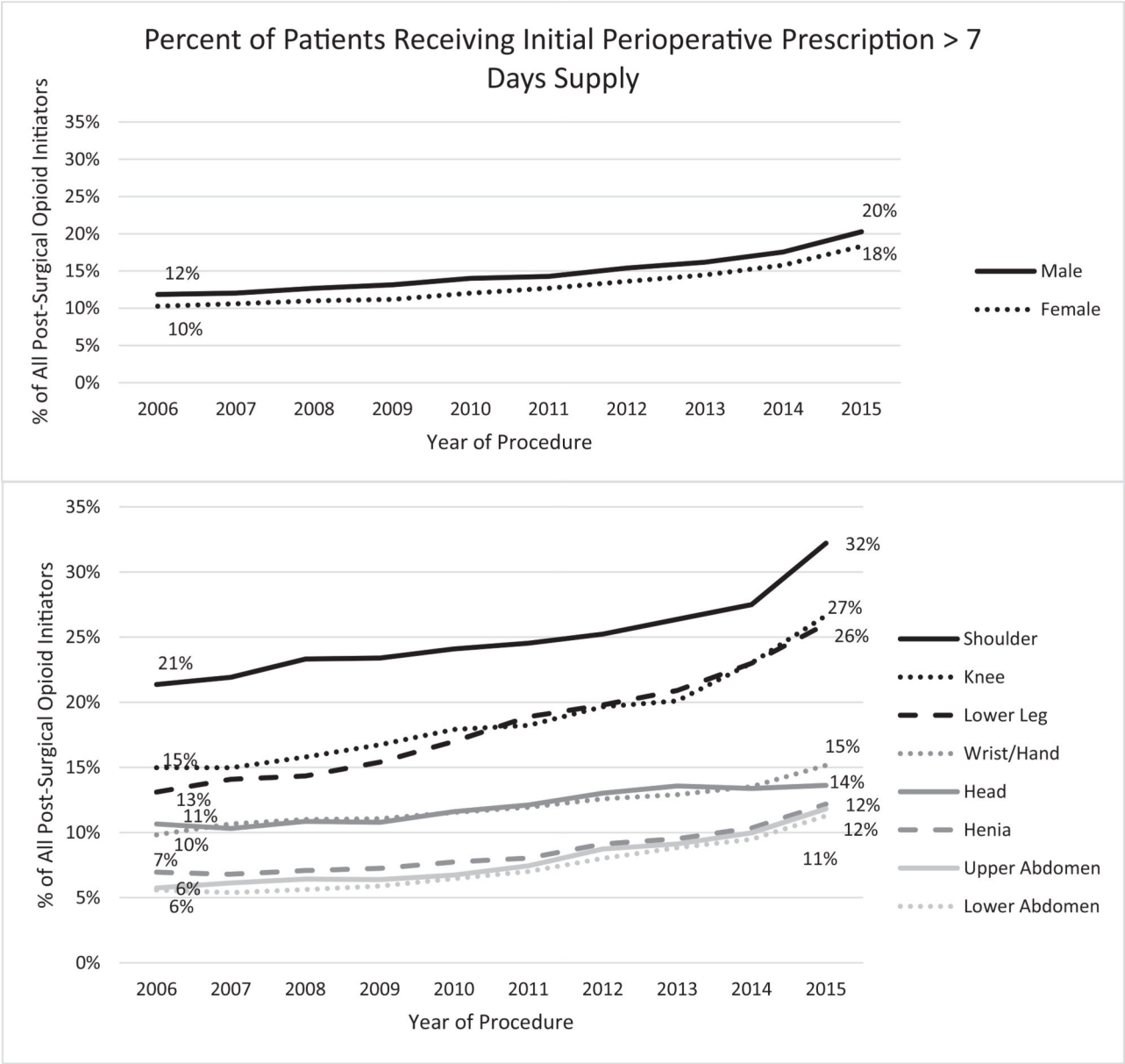

FIGURE 2.

Percent of patients receiving an initial perioperative prescription exceeding 7 days supply, stratified by sex and the 8 most common surgical sites.

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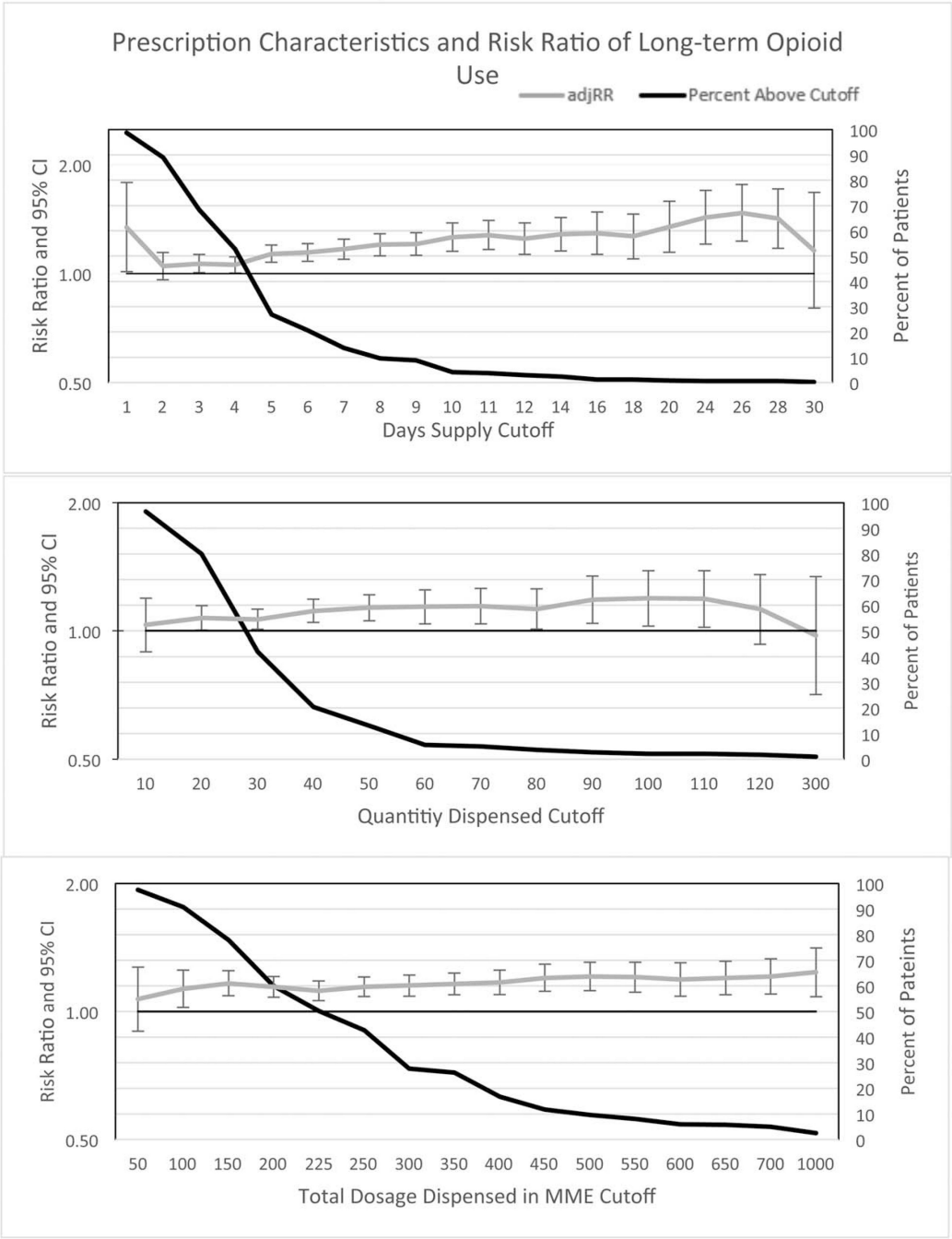

FIGURE 3.

Percent of patients receiving opioid prescriptions above various cut points and risk ratios of long-term use comparing those receiving opioid prescriptions above versus below various thresholds.

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TABLE 1.

Initial Postoperative Opioid Prescription Characteristics by Sex, Medication, and Surgical Site.

	Proportion of All Postsurgical Opioid Initiators, %	Days Supplied	Quantity Dispensed	Total MME	Proportion With Long-term Therapy, %
		Median (IQR)	Median (IQR)	Median (IQR)	
Overall	N=2,857,115	5 (3–6)	30 (28–40)	240 (180–360)	8.00
Sex					
Female	55.34%	5 (3–6)	30 (25–40)	225 (180–300)	8.75
Male	44.65%	5 (3–6)	30 (30–40)	240 (180–360)	7.13
Medication					
Buprenorphine	<0.1	28 (28–33)	23 (4–64)	194 (88–750)	17.70
Codeine	5.20	4 (3–5)	30 (20–30)	90 (60–120)	6.70
Fentanyl	<0.1	15 (7–22)	10 (5–44)	405 (259–675)	18.70
Hydrocodone	58.90	5 (3–6)	30 (25–40)	225 (180–300)	8.30
Hydromorphone	1.00	5 (3–7)	40 (30–55)	400 (300–600)	9.30
Levorphanol	<0.1	10 (7–12)	40 (32–80)	501 (481–912)	40.00
Meperidine	1.10	5 (3–6)	30 (24–40)	150 (120–200)	9.60
Methadone	<0.1	13 (7–30)	60 (30–94)	1,410 (600–2,820)	32.60
Morphine	0.10	10 (5–15)	60 (30–80)	600 (405–900)	9.70
Oxycodone	30.90	5 (3–6)	40 (30–50)	300 (225–425)	7.50
Oxymorphone	<0.1	10 (5–20)	60 (30–90)	840 (450–1,500)	21.30
Tapentadol	0.30	5 (4–7)	30 (30–50)	750 (500–1,040)	8.10
Tramadol	2.50	5 (4–8)	30 (25–45)	300 (200–420)	9.50
Surgical site					
Burn	<0.1	5 (3–6)	27 (20–35)	180 (120–240)	5.63
Genitalia	5.50	4 (3–5)	30 (20–30)	187.5 (150–270)	8.14
Head	10.00	4 (3–5)	30 (20–40)	180 (120–300)	7.23
Hernia	7.80	4 (3–5)	30 (30–40)	225 (180–300)	6.28
Intrathoracic	0.30	4 (3–6)	30 (20–30)	180 (108–240)	12.70
Knee	15.20	5 (4–7)	40 (30–50)	300 (225–400)	7.80
Lower abdomen	12.10	4 (3–5)	30 (20–30)	187.5 (150–270)	7.35
Lower leg	10.70	5 (4–7)	30 (30–44)	270 (180–375)	8.39

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	Proportion of All Postsurgical Opioid Initiators, %	Days Supplied	Quantity Dispensed	Total MME	Proportion With Long-term Therapy, %
		Median (IQR)	Median (IQR)	Median (IQR)	
Neck	2.10	4 (3–5)	30 (20–35)	180 (120–270)	7.66
Obstetric	0.10	4 (3–5)	30 (25–35)	225 (150–262.5)	5.45
Other	<0.1	5 (4–7)	40 (30–60)	315 (225–480)	8.99
Pelvis	0.10	5 (4–8)	50 (33–60)	375 (262.5–562.5)	10.56
Radiologic	<0.1	5 (3–7)	30 (20–45)	225 (144–360)	13.04
Shoulder	7.60	5 (4–7)	40 (30–60)	360 (240–500)	9.94
Spine	1.40	7 (5–10)	50 (40–60)	450 (300–600)	13.09
Thorax	6.40	4 (3–5)	30 (20–40)	180 (135–270)	8.45
Upper abdomen	8.30	4 (3–5)	30 (24–40)	225 (180–270)	8.18
Upper arm	1.70	5 (4–7)	40 (30–50)	300 (187.5–450)	7.90
Upper leg	0.80	5 (4–8)	40 (30–60)	300 (220–450)	9.37
Wrist/hand	9.80	5 (3–5)	30 (25–40)	225 (150–300)	8.18

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TABLE 2.

Proportion of Opioid Initiators Receiving an Initial Prescription >*7* days Supply, 50 Quantity Dispensed, or 400 MME, by Year.

		% of Initiators Receiving Prescriptions Exceeding Cutoffs		
Year or Surgery	**Total Opioid Initiators (N)**	**>7 d Supply, %**	**> 50 Quantity Dispensed, %**	**>400 Morphine Milligram Equivalents, %**
2006	106,407	11.0	7.9	10.7
2007	216,658	11.3	8.8	11.9
2008	275,945	11.8	9.5	12.7
2009	324,707	12.1	10.5	13.9
2010	343,948	12.9	11.7	15.5
2011	414,265	13.4	12.4	16.2
2012	398,217	14.4	14.0	17.8
2013	370,357	15.2	18.4	21.9
2014	299,142	16.6	17.5	20.6
2015	107,469	19.2	20.2	23.2

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TABLE 3.

Risk Differences for Long-term Use at Selected Cut Points of Initial Postsurgical Opioid Prescriptions

Selected Cut Points		RD (95% CI)	NNT
Day Supply	5	0.8 (0.73–0.87)	125
	7	1.09 (1–1.18)	92
	10	2.11 (1.94–2.29)	48
	30	7.11 (5.9–8.32)	15
Quantity	30	0.46 (0.39–0.52)	218
	50	0.91 (0.82–1)	110
	60	0.84 (0.7–0.97)	120
	90	0.43 (0.25–0.61)	233
MME	225	0.74 (0.67–0.8)	136
	400	1.16 (1.07–1.25)	87
	500	1.38 (1.27–1.49)	73
	650	1.29 (1.16–1.43)	78