Published in final edited form as:

Lancet. 2019 April 13; 393(10180): 1547–1557. doi:10.1016/S0140-6736(19)30428-3.

Inappropriate opioid prescription after surgery

Mark D Neuman, **Brian T Bateman**, and **Hannah Wunsch**

Department of Anesthesiology and Critical Care, Perelman School of Medicine and Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia, PA, USA (M D Neuman MD); Department of Anesthesia, Perioperative, and Pain Medicine, and Division of Pharmacoepidemiology and Pharmacoeconomics, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA (B T Bateman MD); Department of Critical Care Medicine, Sunnybrook Health Sciences Centre, Toronto, ON, Canada (Prof H Wunsch MD); Sunnybrook Research Institute, Toronto, ON, Canada (Prof H Wunsch); and Department of Anesthesia and Interdepartmental Division of Critical Care Medicine, University of Toronto, Toronto, ON, Canada (Prof H Wunsch)

Abstract

Worldwide, the use of prescription opioid analgesics more than doubled between 2001 and 2013, with several countries, including the USA, Canada, and Australia, experiencing epidemics of opioid misuse and abuse over this period. In this context, excessive prescribing of opioids for pain treatment after surgery has been recognised as an important concern for public health and a potential contributor to patterns of opioid misuse and related harm. In the second paper in this Series we review the evolution of prescription opioid use for pain treatment after surgery in the USA, Canada, and other countries. We summarise evidence on the extent of opioid overprescribing after surgery and its potential association with subsequent opioid misuse, diversion, and the development of opioid use disorder. We discuss evidence on patient, physician, and system-level predictors of excessive prescribing after surgery, and summarise recent work on clinical and policy efforts to reduce such prescribing while ensuring adequate pain control.

Introduction

Worldwide, the use of prescription opioid analgesics more than doubled between 2001 and 2013.[1] In some countries, including the USA,[2] Canada,[3] Australia,[4] and the UK[5,6] the growth of prescription opioid dispensing over time has been linked to increases in harm related to opioid misuse and abuse.

The common prescribing of opioids for pain treatment after surgery has prompted efforts to balance the desire to achieve adequate postoperative pain control and mitigate opioid related adverse events. Although decreasing the use of opioids for postoperative pain management has been a longstanding theme in the anaesthetic and surgical literature,[7] recent work has found that patients in some countries frequently receive opioids either unnecessarily or in

Correspondence to: Dr Brian T Bateman, Brigham and Women's Hospital, Boston, MA 02115, USA, bbateman@bwh.harvard.edu.

Contributors

All authors contributed to the drafting and revision of this paper.

excess of their requirements for surgical pain control.[8] Such work, combined with findings that prescription opioids could be commonly misused,[9] and that initiation of illicit opioid use is frequently preceded by prescription opioid misuse[10–12] has made efforts to reduce opioid prescribing after surgery a major priority for clinical care and health policy in multiple countries.

In this second paper in this Series, we review evidence on the evolution of prescription opioid use for pain treatment after surgery in the USA, Canada, and other countries, and focus in particular on prescribing practices after discharge. We summarise evidence on the extent and potential consequences of excessive postoperative opioid prescribing for individual patients and public health more broadly. Next, we review available evidence on system, physician, and patient-level predictors of excessive opioid use after surgery; finally, we summarise recent work on clinical and policy initiatives to reduce excessive opioid prescribing among patients who undergo surgery.

Historical context

The history of the US opioid epidemic has been described in detail before.[13,14] In summary, between the mid 1990s and early 2000s, physicians, researchers, professional societies, government organisations, and accrediting bodies took steps to show that inadequate pain treatment was a key gap in the quality of health care in the USA.[15,16] In 1995, the American Pain Society introduced the Pain As The Fifth Vital Sign campaign, which encouraged clinicians and health systems to expand pain treatments, including through broader use of opioid analgesics.[17] The US Veteran's Health Administration[18] subsequently adopted this campaign, and in 2001 the Joint Commission,[19] which accredits US hospitals, published pain management standards that were highly aligned with aspects of the campaign. Joint Commission materials at the time cited consideration of the campaign as an example of positive implementation, and encouraged routine use of quantitative pain measurements to guide pain treatment for patients in hospitals.[19,20] Simultaneously, pain treatment advocates cited methodologically weak but frequently referenced studies[21,22] to argue that opioids were not addictive if used as directed[15,23] and advocated against "unnecessary withholding ofopioid medications".[24] Such efforts were reinforced by policy efforts in the USA to link patients' ratings of pain intensity to hospital reimbursement through Medicare's Hospital Value Based Purchasing Programme.[25] Extensive marketing efforts by US pharmaceutical companies sought to downplay the risks of opioid treatment through aggressive marketing efforts, some of which have since become the focus of lawsuits in both Canada[26] and the USA.[27]

Global trends in opioid prescribing over time

According to data from the International Narcotics Control Board, global opioid analgesic use more than doubled between 2001 and 2013, from approximately 3 billion daily opioid doses per year to over 7·3 billion daily doses.[1] Notably, this growth in use was not uniformly distributed across the globe; while countries located in North America, western and central Europe, and Oceana experienced two-fold to three-fold increases in prescription opioid use over this period, countries in other regions experienced no substantial increases.

Nonetheless, as change occurs over time in factors hypothesised to underlie such international variation in opioid prescribing, such as differences in provider training; concerns regarding the risk of opioid dependence; local availability of opioid medications; and cultural attitudes towards pain management, growth in opioid prescribing in nations with historically low rates of use could create new challenges for public health to balance the potential benefits of such medications.[28] For example, Krawczyk and colleagues[29] examined pharmacy dispensing data from Brazil between 2009 and 2015, and found a greater than four-fold increase in opioid sales over this interval, along with an 11-fold relative increase in oxycodone sales. Similarly, in China, a Good Pain Management programme launched in 2011, with the goal of improving cancer pain treatment, has markedly increased the use of strong opioids in such contexts,[30] potentially improving the quality of palliative care; at the same time, placed alongside the US opioid epidemic, decreasing stigma surrounding opioid use and growth in opioid marketing efforts in China,[31] highlight the ongoing challenge of balancing access to effective pain treatment against risks of opioid overuse in diverse contexts across the globe.

Outpatient opioid prescribing after surgical procedures

Variability in prescribing

The predictors and pathophysiology of acute postoperative pain, the relationship between postoperative pain and phenomena such as acute opioid-induced hyperalgesia and persistent postsurgical pain, and the role of opioid and non-opioid strategies for pain management in the immediate (in-hospital) postoperative setting have been reviewed extensively elsewhere.[32–34] Here, we focus primarily on patterns of outpatient opioid prescribing after surgery (ie, among patients undergoing ambulatory surgery or after hospital discharge for inpatients who undergo surgery).

Few studies to date have compared opioid prescribing practices after surgery across countries; however, available evidence suggests marked international differences in patterns of opioid prescribing for individuals undergoing similar procedures. In 2009, Lindenhovius and colleagues[35] compared postoperative prescribing practices for patients who underwent surgery in one US hospital with patients in a hospital in the Netherlands. The authors found that 77% of patients undergoing hip fracture repair in the US hospital received opioids, whereas none did in the Netherlands hospital; 82% of US patients received opioids after undergoing ankle fracture repair versus 6% of Dutch patients. Similarly, a comparison of patients undergoing head and neck surgery at one US hospital versus a hospital in Hong Kong found that 87% of patients in the USA received opioid orders after surgery versus less than 1% of patients in Hong Kong.[36] Comparison studies highlight persistent differences between the USA and other countries in patterns of acute opioid prescribing; physician surveys assessing approaches to acute pain management in the USA compared with Japan,[37] France,[38] and the Dominican Republic[39] have shown that reliance on opioids for acute pain management is greater in the USA than in other settings. While few data are available to elucidate the reasons for such cross-national differences, it is likely that similar factors to those identified as influencing international patterns of opioid prescribing, such as differences in provider training, concerns regarding opioid dependence and diversion, and

cultural attitudes towards pain management, are also likely to explain differences in postoperative opioid prescribing for specific procedures.[40,41] Although little is known regarding international differences in actual pain experiences after surgery, available data suggest that country of treatment accounts for a negligible amount of variation in early (postoperative day 1) measures of satisfaction with pain treatment after accounting for patient-level and hospital-level effects.[42] In a survey regarding satisfaction with overall management of postoperative pain, satisfaction was highly related to impressions of improvement and appropriateness of care, as well as participation in pain treatment decisions.[42]

Unnecessary prescribing

Studies[8] suggest that opioid prescribing among US patients who undergo surgery can frequently be in excess of what is needed for pain control, with many receiving opioids that are not needed at all for adequate pain relief. Among 642 patients undergoing one of five outpatient surgeries at a US academic medical centre in 2015, Hill and colleagues[43] observed that 90·5% of patients received an opioid prescription at discharge, with substantial variation in the number of pills prescribed for a given procedure; for example, among patients undergoing open inguinal hernia repair, the number of pills prescribed ranged from 15 to 120. A review of six studies published between 2011 and 2017, showed further evidence of widespread overprescribing of opioids among US patients who undergo surgery; Bicket and colleagues[8] found that the proportion of patients reporting unused opioid tablets after surgery ranged from 67% to 92% across studies, with the overall proportion of unused tablets ranging from 42% to 71%.

Within the USA, studies on low-risk outpatients after surgery suggest that the amount of opioid dispensed for outpatient pain treatment after surgery has increased over time, even in the context of high baseline rates of opioid prescribing. In a national sample of US patients undergoing four low-risk surgical procedures (carpal tunnel repair, knee arthroscopy, laparoscopic cholecystectomy, and laparoscopic appendectomy), the percentage of patients who filled an opioid prescription after surgery increased from 2004 to 2012 for each procedure (figure). Although these data do not specifically show the causes of changes over time in postoperative prescribing, the average daily dose of opioid prescribed for postoperative pain increased by 13% across all procedures, with increases ranging from 8% for patients undergoing inguinal hernia repair to 18% for patients undergoing knee arthroscopy (figure).[44] More recent data have shown decreases in the amount of opioids dispensed per capita in the USA between 2010 and 2015,[45] which raises the possibility that earlier trends towards progressively higher rates of opioid utilisation after surgery might now be reversing.

Adverse outcomes related to overprescribing of opioids after surgery

Historically, research on the adverse effects of opioids in the perioperative period have focused on known shortterm side-effects such as respiratory depression, itching, nausea, and constipation.[46] However, increasing attention has been paid to the relationship between postoperative opioid prescribing—particularly in the outpatient or after hospital discharge

setting—and prescription opioid misuse and diversion, the development of opioid use disorder, and opioid overdose

Association of postoperative opioid prescribing with opioid misuse and opioid use disorder

Panel 1 presents key terms related to adverse opioid-related behaviours; available data suggest an association between postoperative opioid prescribing practices and such behaviours. Brat and colleagues[51] evaluated the association of postoperative opioid prescribing with indicators of new-onset opioid misuse and found that the total duration of the opioid prescription after surgery was strongly associated with an increased rate of misuse, with each refill associated with an increase in the rate of misuse. Although this study tried to exclude those with a history of opioid misuse, it is important to note that the observational design prevents firm conclusions regarding a causal link between the exposure and outcome, because predisposition to addiction or misuse may also play a causal, upstream role.

Postoperative opioid prescribing and risk of opioid diversion

Opioid diversion represents an important contributor to opioid misuse. For example, in a 2015 survey of US adults, approximately 65% of those with opioid misuse in the previous year reported obtaining opioids from a source other than a physician's prescription.[9] Excess pills stored in homes have been identified as an important source of diversion to relatives or friends, or other parties through sale or theft.[52,53] Overprescribing of opioids after surgery increases the likelihood that patients will have unused opioids after postoperative pain has resolved, with the potential to create opportunities for drug diversion. In a study[54] of patients who underwent urological surgery, 58% of the opioids dispensed immediately after surgery were consumed; 67% of patients had surplus medication from the initial prescription, and 91% of these individuals reported keeping this surplus medication at home. Similar data on excess pills have been reported after other low-risk surgery, such as dermatological surgery and hand surgery.[55,56]

Association of postoperative opioid prescribing with new prolonged opioid use

Since the development of opioid use disorder and related harms increase with greater degrees of opioid exposure and longer durations of opioid use,[57–61] understanding the association between postoperative opioid use and the initiation of prolonged opioid prescribing carries potentially important implications for public health.[50] However, such studies should be interpreted cautiously with regard to the insights they provide into such phenomena because many do not explicitly measure the incidence of opioid misuse or opioid use disorder via formal screening of enrolled participants or via presence of relevant diagnosis codes in administrative health databases. Moreover, no consensus currently exists as to what interval of prescribing should be used in defining new persistent, prolonged, or chronic opioid use. For the purposes of this Series, we will use the term prolonged opioid use as a generic term to describe any outcomes that identify extended use.

In one population-based study in Ontario assessing opioid-naive patients aged 66 years and older undergoing one of four low-risk procedures, Alam and colleagues[59] observed a marked

association between the administration of opioids after surgery and prolonged opioid use as assessed at 1 year. Overall, 7·7% of previously opioid-naive patients were identified as receiving an opioid prescription at 1 year after surgery, and those patients who received postoperative opioids were 44% more likely to have a prescription at 1 year than were those who did not fill an early prescription. Subsequent work, also done in Ontario suggested potentially lower rates of new prolonged opioid use after surgery depending on the surgical population examined.[63] Both of these studies used a cross-sectional assessment of opioid filling during these periods as proxies for prolonged opioid use, but neither study specifically assessed the opioid consumption over the interval examined; the absence of a control group that accounts for prevalent patterns of opioid prescribing in the general population limits inferences from either of these studies as to the causal relationship between postoperative prescribing and new prolonged opioid use.

Efforts to characterise variations in prolonged opioid use across different types of surgical procedures have produced conflicting results, which could relate to differences across studies in the definitions used for prolonged opioid use. Brummett and colleagues[64] used prescribing claims data to compare the likelihood of receiving an opioid prescription between 90 and 180 days after surgery within a cohort of 36 177 opioid-naive adults from the USA aged 18–64 years; the percentages of patients receiving an opioid prescription at 90–180 days were qualitatively similar for patients undergoing minor or major surgical procedures, ranging from 5·9% to 6·5%. Sun and colleagues[65] observed variability across surgical procedures in the probability of new prolonged opioid use, defined as filling ten or more prescriptions or more than 120 days' supply of an opioid within a year; among 641 941 opioid-naive patients undergoing any of the 11 selected surgical procedures prolonged opioid use in the first preoperative year ranged from 0·12% for caesarean delivery to 1·41% for total knee arthroplasty.[65] The low rate of new prolonged opioid use among women undergoing caesarean sections was also observed by other authors.[66] The absence of differentiation between minor and major surgical procedures with regard to prolonged opioid use, as well as the variability between procedures observed by Sun and colleagues is consistent with observations that the size of the surgery is not a strong determinant of either acute or chronic postsurgical pain.[33, 67–69]

Factors associated with prolonged opioid use

Beyond specific surgical procedure, other patient factors identified as associated with an increased risk of prolonged opioid use included younger age, lower household income, specific comorbidities (eg, diabetes), and specific mental illness such as depression, which is then correlated with the use of specific drugs (eg, benzodiazepines and selective serotonin reuptake inhibitors) in the preoperative period (panel 2).[63] Non-randomised evidence from prescription records in emergency department settings[73] and mixed patient populations,[74] including patients who had surgery, have suggested that larger initial opioid prescriptions and longer duration of an initial prescription could be associated with subsequent transition to prolonged opioid use.[59,70,74] However, another US study[75] of patients who had surgery found no association between the total morphine equivalents provided in the initial prescription and the likelihood of a second prescription (refill) after surgery for patients undergoing a range of major and minor procedures.

Because of the retrospective, observational design of available studies on determinants of new prolonged opioid use after surgery, the associations reported in these studies cannot be interpreted as causal in nature because of the potential for residual confounding, even after risk adjustment. For example, analyses based on health administrative data do not include data on differences in preoperative or postoperative pain symptoms between patients who did and did not fill opioid prescriptions after surgery.[62] This represents an important potential limitation to studies that have found associations between initial exposure and new prolonged use because greater experiences of pain immediately after surgery could be associated with a greater likelihood of developing chronic pain.[76] The prevalence of chronic postsurgical pain is not quantified in these studies.[68,69] Finally, the role of hyperalgesia associated with opioid use in creating a cycle of perceived need for opioids over time is also not addressed in these studies.[77]

Strategies to mitigate inappropriate opioid prescribing and related adverse effects

Individual patient interventions

Concerns regarding overprescribing have led to a range of efforts in the USA and elsewhere to reduce prescribing after surgery. In settings with high rates of opioid use for acute pain treatment, multiple studies suggest the potential to reduce the quantity of opioids dispensed without compromising effective pain control—an essential component to ensuring high-quality postoperative care. In a survey of patients who underwent caesarean delivery at six academic medical centres in the USA, Bateman and colleagues[78] observed no association between quantity of opioids dispensed and measures of patient satisfaction, the need for refills, or pain scores at 2 weeks; yet there was a direct correlation between the quantity dispensed and consumed and the rate of opioid related side-effects. Similarly, Lee and colleagues[79] found no association between hospitals' mean quantity of oral morphine equivalents dispensed after surgery and reported pain scores on standardised surveys of patient satisfaction.

Building on this work, one focus of interventions is a model of shared decision making that incorporates efforts to educate patients about appropriate expectations for pain control after surgery[20] and the risks and benefits of opioid pharmacotherapy. Prabhu and colleagues[80] developed and tested a shared decision-making tool for opioid prescribing after caesarean delivery. The tool provided information on the expected patterns of pain resolution and outpatient opioid consumption, risks and benefits of opioids and alternatives, and information about how to dispose of leftover medications. After the shared decision-making session, the patient selected the number of tablets they wanted to be prescribed, up to a limit of 40 tablets of oxycodone 5 mg. Testing this approach in 50 patients, the median number of tablets patients chose was half of the usual amount prescribed.[80] Despite this, 90% of patients reported being satisfied or very satisfied with their pain management, and only 8% of patients required refills of prescriptions.

Studies on the correlation of predischarge opioid prescribing with use after discharge also suggest the potential for alternative approaches to individualising opioid prescribing after

surgery. Chen and colleagues[81] identified that 36% of patients from a surgical cohort received no opioids in the 24 h before discharge; yet 46% of this group were prescribed opioids at the time of discharge. Similarly, a study[82] of an enhanced recovery programme after surgery for patients who underwent colorectal surgery was highly effective in decreasing intraoperative opioid use; however, the frequency of opioid prescribing at the time of discharge was not greatly affected by the programme, with opioids commonly being prescribed at discharge even to patients who had low levels of opioid use over the final portion of their hospital stay, showing the potential importance of focusing on prescribing practices at discharge. Hill and colleagues[83] observed similar patterns in a sample of patients undergoing a range of surgical procedures, estimating that by using an algorithm that couples the dose dispensed at hospital discharge to opioid consumption in the previous day, the total number of opioids pills prescribed could be decreased by 40% while still meeting the home opioid treatment requirements for 85% of patients. Further prospective testing of these interventions is required to assess their potential effects on prescribing and health in practice.

Alongside efforts to tailor opioid dispensing, an additional focus of interventions has been the use of opioidsparing or even opioid-free approaches to anesthesia and analgesia.[84] These include non-opioid systemic medications such as acetaminophen, gabapentin, or non-steroidal anti-inflammatory drugs, or regional anaesthetic techniques (eg, epidural catheters and peripheral nerve blocks).[85–87] These approaches are particularly recommended for the perioperative care of the subset of patients who might be on preoperative opioids, although data to support this approach are sparse.[88,89] Outside of the surgical context, emerging evidence has emphasised the potential for effective treatment of even severe pain without opioids. For example, a study[90] of patients presenting to emergency departments with moderate to severe acute extremity pain found no meaningful differences in pain reduction at 2 h among patients randomly allocated to receive ibuprofen and acetaminophen versus patients receiving one of three combinations of acetaminophen plus an opioid.

To date, studies on the effect of opioid-sparing approaches on prolonged opioid use have reported mixed results. In a large cohort of patients undergoing open abdominal surgical procedures, Ladha and colleagues[91] examined the effect of perioperative epidural placement on the time to opioid discontinuation after discharge. After controlling for a range of confounders, they observed no effect of epidural placement on prolonged opioid use. Similarly, in patients undergoing either total knee or shoulder arthroplasty, Sun and colleagues[92,93] did not find an association between the use of peripheral nerve blocks and prolonged opioid use. By contrast, in a randomised controlled trial by Hah and colleagues[94] in patients undergoing orthopaedic, thoracic, and general surgeries, perioperative gabapentin was associated with a modest increase in the rate of opioid cessation after surgery (hazard ratio 1·24, 95% CI 1·00–1·54). One potential explanation for the modest or negligible effect observed in these studies could be that discharge opioid prescribing behaviours for inpatients who undergo surgery inadequately incorporate information on pain or opioid requirements over the course of the hospital stay.[81] Future efforts to maximise the potential for multimodal analgesia approaches to affect postoperative opioid use might require pairing them with tailored approaches to opioid prescribing for individual patients at the time of discharge.[83]

Opioid overdose following hospital discharge after surgery is relatively rare, but the risk is substantially elevated above baseline levels.[95] The increase is greatest among patients on high doses of opioids preoperatively (≥50 morphine equivalents daily).[96] Opioid overdoses can be reversed through the administration of naloxone, which is an opioid antagonist. Many states in the USA passed laws in recent years to increase the accessibility of naloxone, including allowing dispensing of the medication without prescriptions,[97] and programmes to distribute naloxone appear to decrease rates of overdose in communities.[98] However, the utility of dispensing naloxone to postoperative patients has not been well defined and is an important topic for future research.

Hospital or health system interventions

Several studies show the steps taken at the individual health system level in the USA to directly address opioid overprescribing. For example, Hill and colleagues[83] formulated local guidelines for postoperative opioid prescribing for five common outpatient procedures (partial mastectomy, partial mastectomy with sentinel lymph node biopsy, laparoscopic cholecystectomy, laparoscopic inguinal hernia repair, and open inguinal hernia repair) and encouraged the use of acetaminophen and non-steroidal anti-inflammatory medications instead of opioids.[99] This intervention decreased the quantity of opioids prescribed by surgeons by 53%, with repeat opioid prescriptions required by only 0·4% of patients.

Other approaches leverage established principles of behavioural economics to use default prescribing options to nudge physicians towards more appropriate prescribing targets. Several studies in non-surgical settings have evaluated the use of setting default quantities for commonly prescribed opioids as a way of encouraging judicious prescribing.[100,101] In the context of perioperative prescribing, Chiu and colleagues[102] found marked decreases in both the number of opioid pills prescribed and total morphine equivalents prescribed after ten common surgical procedures in one large urban health system when the default number of pills on all electronic opioid prescriptions was lowered from 30 to 12. Notably, this change occurred without either a corresponding increase in the rate of opioid refills among patients who underwent surgery or a decrease in prescriptions for quantities smaller than the default level.[102]

Other interventions have targeted the disposal of leftover opioids.[103,104] Hasak and colleagues[104] found that providing patients who underwent surgery with a brochure describing how to properly dispose of opioids and locate take-back locations resulted in an increase in the frequency with which patients disposed of leftover medication. Because of the importance of leftover medication as a source of opioids that are misused, additional studies of behavioural interventions to encourage disposal are indicated.

Because of the known relationships between depression, anxiety, and catastrophising and chronic postsurgical pain and persistent opioid use,[65,71,105] there can be opportunities to provide psychiatric support that could affect postoperative opioid use.[106] One model of this is a multidisciplinary programme that incorporates psychological support as part of a broader platform of interventions to prevent chronic postsurgical pain.[107,108] Preliminary data from this approach show reductions in opioid use and pain interference and reductions in depressed mood.[109] Because of the prevalence of mood disorders in the general

population,[110] such interventions may be a key to improved outcomes; they might also be helpful for support of patients with preoperative opioid use, who can present specific challenges with regard to postoperative care.[108]

Improving practice guidelines

A key historical challenge to improving opioid prescribing for patients who undergo surgery on a large scale has been an absence of consensus regarding appropriate prescribing targets for individual patients or populations. Drawing primarily on evidence from the emergency medicine literature, the 2016 Centers for Disease Control and Prevention Guideline for the Prescribing of Opioids[111] stated that for most acute pain conditions, 3 days of opioid treatment or less should be adequate, and more than 7 days of treatment is rarely needed (although postsurgical prescribing was noted to be beyond the scope of these guidelines).

In the USA, multiple groups have since worked to develop prescribing recommendations that are procedure specific using data on medication refill claims and patient surveys. Using pharmacy claims for approximately 200 000 US patients, Scully and colleagues[112] recommended optimal prescribing durations for postoperative opioids of 4 to 9 days for general surgery procedures, 4–13 days for women's health procedures, and 6–15 days for musculoskeletal procedures on the basis of the observed median prescription length and the nadir of the modelled probability of obtaining a refill after the initial prescription. In a separate effort, investigators from the University of Michigan's Opioid Prescribing Engagement Network (OPEN) published recommended prescribing regimens for postoperative opioids; OPEN recommendations define an upper limit for postoperative opioid prescribing defined as the amount required to meet or exceed self-reported postoperative opioid use in 75% of patients based on surveys of postoperative pain and opioid consumption (table).[113,114] The creation of protocolised, procedure-specific upper limits for opioid prescriptions could help to depersonalise the processes around postoperative pain management,[115] preserving the patient-doctor therapeutic alliance when patients request inappropriately large quantities.

Policy interventions

Limiting the duration of initial opioid prescriptions for acute pain indications has been the focus of several policy initiatives. After the 2016 CDC guidelines, multiple US states implemented legislation limiting first-time opioid prescriptions to a 7 day supply.[116–118] A substantial challenge to this approach, which might compromise the effect of these policies, is that there is no clear definition of what constitutes a day's supply after most surgical procedures. Therefore, a 7 day supply could represent a very large amount of medication if the physician assumes that the patient takes a dose at regular intervals for all 7 days (eg, two tablets every 4 h for 7 days would result in a prescription for 84 pills).[83] Imposing prescription limits also has the potential to result in an inadequate supply for some patients, and systems need to be in place to insure timely access to additional opioids when needed. One possible support solution is the implementation of electronic prescribing of opioids that allows physicians to write for additional opioids remotely.[119]

Other policy initiatives aimed at reducing opioid-related harms have also gained traction. Prescription Drug Monitoring Programs (PDMPs) are databases that contain patient-level information on filled prescriptions for controlled substances. These are now available in nearly all US states, although requirements vary regarding their use.[116] They are useful for detecting patients who are seeking opioid prescriptions from multiple different physicians or who are co-prescribed medications that increase the risks associated with opioids, such as benzodiazepines. Some studies have reported an association between the implementation of PDMPs and a reduction in overall opioid prescribing, but data are mixed.[120–122] In patients who underwent surgery, the use of PDMPs might have particular utility in the early detection of patients transitioning to unintended prolonged use. Other policy initiatives have targeted reducing the supply of leftover medication in communities. These initiatives include introducing secure medication disposal boxes (drop-boxes) in medical facilities, law enforcement offices, or pharmacies,[123,124] and drug take-back events.[125] Aligned with such initiatives are public outreach efforts, such as the Rx Awareness campaign[126] by the US Centers for Disease Control and Prevention and the The Truth About Opioids campaign,[127] by the US Truth Initiative—both rely on a combination of digital and traditional media approaches to raise awareness about the risks associated with opioid analgesics and discourage inappropriate use.

Health-care payers have also begun to initiate programmes to address overprescribing of opioids.[128] The Centers for Medicaid and Medicare Service, which administers public insurance programmes in the USA, implemented numerous programmes that focused on this issue, including developing national quality improvement networks and sending letters to physicians who prescribe opioids at higher levels than do their peers. Their recently released roadmap to address the opioid epidemic highlights plans for further work to identify and curb overprescribing of opioids and to encourage the use of effective non-opioid pain treatments.[129]

There is also growing recognition of the need to improve medical student education on opioid prescribing. One study[130] has noted a relationship between medical school rank of schools where physicians received their degrees and opioid prescribing practices. The study showed that physicians trained at the lowest ranked US medical schools prescribed nearly three times as many opioids per year as did physicians trained at the top school, raising the possibility of education-based interventions to improve opioid prescribing. However, it is important to note that the finding was most pronounced for primary care physicians and less so for surgical specialists. Government agencies have recognised the importance of improving medical curricula on prescription opioid use. For example, in Massachusetts the Department of Public Health co-led a working group with representatives from the state's medical schools to define core competencies related to prescription drug misuse.[131]

Conclusion

Global increases in prescription opioid use over the past decade, along with an epidemic of opioid misuse and related harm, have led to a recognition of opioid overprescribing in the postoperative setting as a pronounced problem in some countries, with serious potential adverse consequences for public health. In settings where opioid overprescribing after

surgery appears to be common, such as the USA and Canada, efforts are ongoing to identify and implement effective interventions at the patient level, health system level, and policy level to discourage excess opioid prescribing and prevent related misuse and diversion. For countries in which access to opioids is limited but expanding, the experiences described in this Series show the importance of establishing and implementing evidence-based standards to encourage responsible opioid prescribing while also promoting effective pain management for patients after surgery.

Acknowledgments

All authors received support from the National Institute on Drug Abuse (R01 DA042299–01A1 to MDN, BTB, and HW, and R01 DA044293–01A1 to BTB). HW received support from the Canadian Institutes of Health Research (CIHR grant number 365432). The study sponsors had no role in study design; the collection, analysis, and interpretation of data; the writing of the report; or the decision to submit the series for publication.

We would like to thank Hance Clarke and Michael Ashburn who provided comments on an early draft of the manuscript. BTB confirms that he had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Declaration of interests

BTB is an investigator on grants to Brigham and Women's Hospital from the US Food and Drug Administration, Baxalta, GSK, Lilly, Pacira, and Pfizer for unrelated work; and a paid consultant to Aetion, Inc, and the Alosa Foundation. MDN and HW declare no competing interests.

References

1. Berterame S, Erthal J, Thomas J, et al. Use of and barriers to access to opioid analgesics: a worldwide, regional, and national study. Lancet 2016; 387: 1644–56. [PubMed: 26852264]
2. Okie S A flood of opioids, a rising tide of deaths. N Engl J Med 2010; 363: 1981–85. [PubMed: 21083382]
3. Fischer B, Argento E. Prescription opioid related misuse, harms, diversion and interventions in Canada: a review. Pain Physician 2012; 15 (suppl 3): 191–203.
4. Larance B, Degenhardt L, Peacock A, et al. Pharmaceutical opioid use and harm in Australia: the need for proactive and preventative responses. Drug Alcohol Rev 2018; 37 (suppl 1): s203–05. [PubMed: 29024092]
5. Winstock AR, Borschmann R, Bell J. The non-medical use of tramadol in the UK: findings from a large community sample. Int J Clin Pract 2014; 68: 1147–51. [PubMed: 24734958]
6. Winstock A, Bell J, Borschmann R. Friends, doctors, and tramadol: we might have a problem. BMJ 2013; 347: f5599. [PubMed: 24048307]
7. Kehlet H Postoperative pain relief—what is the issue? Br J Anaesth 1994; 72: 375–78. [PubMed: 8155433]
8. Bicket MC, Long JJ, Pronovost PJ, Alexander GC, Wu CL. Prescription opioid analgesics commonly unused after surgery: a systematic review. JAMA Surg 2017; 152: 1066–71. [PubMed: 28768328]
9. Han B, Compton W, Blanco C, Crane E, Lee J, Jones C. Prescription opioid use, misuse, and use disorders in US adults: 2015 national survey on drug use and health. Ann Intern Med 2017; 167: 293–301. [PubMed: 28761945]
10. Muhuri P, Gfroerer J, Davies C. Associations of nonmedical pain reliever use and initiation of heroin use in the United States. CBHSQ data review. 2013 https://www.samhsa.gov/data/sites/default/files/DR006/DR006/nonmedical-pain-reliever-use-2013.htm (accessed March 19, 2018).
11. Callinan CE, Neuman MD, Lacy KE, Gabison C, Ashburn MA. The Initiation of chronic opioids: a survey of chronic pain patients. J Pain 2017; 18: 360–65. [PubMed: 27919771]

12. Mars SG, Bourgois P, Karandinos G, Montero F, Ciccarone D. “Every ‘never’ I ever said came true”: transitions from opioid pills to heroin injecting. Int J Drug Policy 2014; 25: 257–66. [PubMed: 24238956]
13. Kolodny A, Courtwright DT, Hwang CS, et al. The prescription opioid and heroin crisis: a public health approach to an epidemic of addiction. Annu Rev Public Health 2015; 36: 559–74. [PubMed: 25581144]
14. Quinones S Dreamland: the true tale of America’s opiate epidemic. New York: Bloomsbury, 2016.
15. Max MB. Improving outcomes of analgesic treatment: is education enough? Ann Intern Med 1990; 113: 885–89. [PubMed: 2240903]
16. Quality improvement guidelines for the treatment of acute pain and cancer pain. American Pain Society Quality of Care Committee. JAMA 1995; 274: 187–80.
17. Campbell JN. 1995 APS Presidential Address. Pain Forum 1996; 5: 85–88.
18. Geriatrics and Extended Care Strategic Healthcare Group, National Pain Management Coordinating Committee. Pain as the 5th vital sign toolkit. 2000 https://www.va.gov/PAINMANAGEMENT/docs/Pain_As_the_5th_Vital_Sign_Toolkit.pdf (accessed March 20, 2018).
19. Baker DW. History of the Joint Commission’s Pain Standards: lessons for today’s prescription opioid epidemic. JAMA 2017; 317: 1117–18. [PubMed: 28241189]
20. Ballantyne JC, Sullivan MD. Intensity of chronic pain—the wrong metric? N Engl J Med 2015; 373: 2098–99. [PubMed: 26605926]
21. Porter J, Jick H. Addiction rare in patients treated with narcotics. N Engl J Med 1980; 302: 123.
22. Portenoy RK, Foley KM. Chronic use of opioid analgesics in non-malignant pain: report of 38 cases. Pain 1986; 25: 171–86. [PubMed: 2873550]
23. Portenoy RK. Opioid therapy for chronic nonmalignant pain: clinician’s perspective. J Law Med Ethics 1996; 24: 296–309. [PubMed: 9180514]
24. Haddox J, Joranson D, Angarola R, et al. The use of opioids for the treatment of chronic pain. Clin J Pain 1997; 13: 6–8. [PubMed: 9084947]
25. Thompson CA. HCAHPS survey to measure pain communication, not management. Am J Health Syst Pharm 2017; 74: 1924–26. [PubMed: 29167127]
26. Webster PC. Oxycodone class action lawsuit filed. CMAJ 2012; 184: e345–6. [PubMed: 22451692]
27. Carr D, Davis CS, Rutkow L. Reducing harm through litigation against opioid manufacturers? Lessons from the tobacco wars. Public Health Rep 2018; 1: 33354917751131.
28. Lancet The. Access to opioids: a balance of harms. Lancet Oncol 2017; 18: 1285. [PubMed: 28971809]
29. Krawczyk N, Greene MC, Zorzanelli R, Bastos FI. Rising trends of prescription opioid sales in contemporary Brazil, 2009–2015. Am J Public Health 2018; 108: 666–68. [PubMed: 29565665]
30. Yu SY, Wang JJ, Huang YG, et al. Managing Pain in patients with cancer: the Chinese good pain management experience. J *Glob Oncol* 2016; 3: 583–95. [PubMed: 29094098]
31. Times Financial. Opioid boom in China as patients lose addiction fears. 2017 https://www.ft.com/content/4e482c4c-897e-11e7-bf50-e1c239b45787 (accessed March 19, 2019).
32. Wu CL, Raja SN. Treatment of acute postoperative pain. Lancet 2011; 377: 2215–25. [PubMed: 21704871]
33. Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W. Pain intensity on the first day after surgery: a prospective cohort study comparing 179 surgical procedures. Anesthesiology 2013; 118: 934–44. [PubMed: 23392233]
34. Sommer M, de Rijke JM, van Kleef M, et al. Predictors of acute postoperative pain after elective surgery. Clin J Pain 2010; 26: 87–94. [PubMed: 20090433]
35. Lindenhovius AL, Helmerhorst GT, Schnellen AC, Vrahas M, Ring D, Kloen P. Differences in prescription of narcotic pain medication after operative treatment of hip and ankle fractures in the United States and The Netherlands. J Trauma 2009; 67: 160–64. [PubMed: 19590328]
36. Li RJ, Loyo Li M, Leon E, et al. Comparison of opioid utilization patterns after major head and neck procedures between Hong Kong and the United States. JAMA Otolaryngol Head Neck Surg 2018; 144: 1060–65. [PubMed: 30193293]

37. Onishi E, Kobayashi T, Dexter E, Marino M, Maeno T, Deyo RA. Comparison of opioid prescribing patterns in the United States and Japan: primary care physicians' attitudes and perceptions. J Am Board Fam Med 2017; 30: 248–54. [PubMed: 28379832]
38. Bounes V, Valle B, Concina F, Lauque D, Ducasse JL, Edlow JA. Treatment of acute renal colic in US and French EDS: simulated cases and real cases in acute pain management. Am J Emerg Med 2016; 34: 1955–58. [PubMed: 27431741]
39. Devine CA, Yu A, Kasdin RG, et al. Postoperative pain management among Dominican and American health-care providers: a qualitative analysis. J Bone Joint Surg Am 2016; 98: e50. [PubMed: 27307368]
40. Morden NE, Munson JC, Colla CH, et al. Prescription opioid use among disabled Medicare beneficiaries: intensity, trends, and regional variation. Med Care 2014; 52: 852–59. [PubMed: 25119955]
41. Gomes T, Juurlink D, Moineddin R, et al. Geographical variation in opioid prescribing and opioid-related mortality in Ontario. *Healthcare Q* 2011; 14: 22–24.
42. Schwenkglenks M, Gerbershagen HJ, Taylor RS, et al. Correlates of satisfaction with pain treatment in the acute postoperative period: results from the international PAIN OUT registry. Pain 2014; 155: 1401–11. [PubMed: 24785269]
43. Hill MV, McMahon ML, Stucke RS, Barth RJ Jr. Wide variation and excessive dosage of opioid prescriptions for common general surgical procedures. Ann Surg 2017; 265: 709–14. [PubMed: 27631771]
44. Wunsch H, Wijeysundera DN, Passarella MA, Neuman MD. Opioids prescribed after low-risk surgical procedures in the United States, 2004—2012. JAMA 2016; 315: 1654–57. [PubMed: 26978756]
45. Guy GP Jr, Zhang K, Bohm MK, et al. Vital signs: changes in opioid prescribing in the United States, 2006—2015. MMWR Morb Mortal Wkly Rep 2017; 66: 697–704. [PubMed: 28683056]
46. Pizzi LT, Toner R, Foley K, et al. Relationship between potential opioid-related adverse effects and hospital length of stay in patients receiving opioids after orthopedic surgery. Pharmacotherapy 2012; 32: 502–14. [PubMed: 22570188]
47. US National Institute on Drug Abuse. Misuse of prescription drugs. https://www.drugabuse.gov/publications/research-reports/misuse-prescription-drugs/summary (accessed April 17, 2018).
48. American Psychiatric Association. Opioid use disorder, diagnostic and statistical manual of mental disorders, 5th ed. Arlington: American Psychiatric Publishing, 2013.
49. Inciardi JA, Surratt HL, Lugo Y, Cicero TJ. The diversion of prescription opioid analgesics. Law Enforc Exec Forum 2007; 7: 127–41. [PubMed: 25267926]
50. Hooten WM CM, Sullivan MD, et al. A conceptual framework for understanding unintended prolonged opioid use. Mayo Clin Proc 2017; 92: 1822–30. [PubMed: 29108841]
51. Brat GA, Agniel D, Beam A, et al. Postsurgical prescriptions for opioid naive patients and association with overdose and misuse: retrospective cohort study. BMJ 2018; 360: j5790. [PubMed: 29343479]
52. Inciardi JA, Surratt HL, Kurtz SP, Cicero TJ. Mechanisms of prescription drug diversion among drug-involved club- and street-based populations. Pain Med 2007; 8: 171–83. [PubMed: 17305688]
53. Volkow ND, McLellan TA. Curtailing diversion and abuse of opioid analgesics without jeopardizing pain treatment. JAMA 2011; 305: 1346–47 [PubMed: 21467287]
54. Bates C, Laciak R, Southwick A, Bishoff J. Overprescription of postoperative narcotics: a look at postoperative pain medication delivery, consumption and disposal in urological practice. J Urol 2011; 185: 551–55. [PubMed: 21168869]
55. Harris K, Curtis J, Larsen B, et al. Opioid pain medication use after dermatologic surgery: a prospective observational study of 212 dermatologic surgery patients. JAMA Dermatol 2013; 149: 317–21. [PubMed: 23682368]
56. Rodgers J, Cunningham K, Fitzgerald K, Finnerty E. Opioid consumption following outpatient upper extremity surgery. J Hand Surg Am 2012; 37: 645–50. [PubMed: 22410178]

57. Paulozzi LJ, Zhang K, Jones CM, Mack KA. Risk of adverse health outcomes with increasing duration and regularity of opioid therapy. J Am Board Fam Med 2014; 27: 329–38. [PubMed: 24808111]
58. Deyo RA, Hallvik SE, Hildebran C, et al. Association between initial opioid prescribing patterns and subsequent long-term use among opioid-naive patients: a statewide retrospective cohort study. J Gen Intern Med 2017; 32: 21–27 [PubMed: 27484682]
59. Shah A, Hayes CJ, Martin BC. Factors influencing long-term opioid use among opioid naive patients: an examination of initial prescription characteristics and pain etiologies. J Pain 2017; 18: 1374–83. [PubMed: 28711636]
60. Dunn KM, Saunders KW, Rutter CM, et al. Opioid prescriptions for chronic pain and overdose: a cohort study. Ann Intern Med 2010; 152: 85–92. [PubMed: 20083827]
61. Gomes T, Mamdani MM, Dhalla IA, Paterson JM, Juurlink DN. Opioid dose and drug-related mortality in patients with nonmalignant pain. Arch Intern Med 2011; 171: 686–91. [PubMed: 21482846]
62. Alam A, Gomes T, Zheng H, Mamdani MM, Juurlink DN, Bell CM. Long-term analgesic use after low-risk surgery: a retrospective cohort study. Arch Intern Med 2012; 172: 425–30. [PubMed: 22412106]
63. Clarke H, Soneji N, Ko DT, Yun L, Wijeysundera DN. Rates and risk factors for prolonged opioid use after major surgery: population based cohort study. BMJ 2014; 348: g1251. [PubMed: 24519537]
64. Brummett CM, Waljee JF, Goesling J, Moser S, Lin P, Englesbe MJ, et al. New persistent opioid use after minor and major surgical procedures in US adults. JAMA Surg 2017; 152: e170504. [PubMed: 28403427]
65. Sun EC, Darnall BD, Baker LC, Mackey S. Incidence of and risk factors for chronic opioid use among opioid-naive patients in the postoperative period. JAMA Intern Med 2016; 176: 1286–93. [PubMed: 27400458]
66. Bateman BT, Franklin JM, Bykov K, et al. Persistent opioid use following cesarean delivery: patterns and predictors among opioid-naive women. Am J Obstet Gynecol 2016; 215: 353: e1–18. [PubMed: 26996986]
67. Gerbershagen HJ, Pogatzki-Zahn E, Aduckathil S, et al. Procedure-specific risk factor analysis for the development of severe postoperative pain. Anesthesiology 2014; 120: 1237–45. [PubMed: 24356102]
68. Macrae WA. Chronic post-surgical pain: 10 years on. Br J Anaesth 2008; 101: 77–86. [PubMed: 18434337]
69. Simanski CJ, Althaus A, Hoederath S, et al. Incidence of chronic postsurgical pain (CPSP) after general surgery. Pain Med 2014; 15: 1222–29. [PubMed: 24716774]
70. Mosher HJ, Hofmeyer BA, Hadlandsmyth K, Richardson KK, Lund BC. Predictors of long-term opioid use after opioid initiation at discharge from medical and surgical hospitalizations. J Hosp Med 2018; 13: 243–48. [PubMed: 29624187]
71. Schoenfeld AJ, Nwosu K, Jiang W, et al. Risk factors for prolonged opioid use following spine surgery, and the association with surgical intensity, among opioid-naive patients. J Bone Joint Surg Am 2017; 99: 1247–52. [PubMed: 28763410]
72. Rozet I, Nishio I, Robbertze R, Rotter D, Chansky H, Hernandez AV. Prolonged opioid use after knee arthroscopy in military veterans. Anesthesia and Analgesia 2014; 119: 454–59. [PubMed: 24977636]
73. Barnett ML, Olenski AR, Jena AB. Opioid-prescribing patterns of emergency physicians and risk of long-term use. N Engl J Med 2017; 376: 663–73. [PubMed: 28199807]
74. Shah A, Hayes CJ, Martin BC. Characteristics of initial prescription episodes and likelihood of long-term opioid use—United States, 2006–2015. MMWR Morb Mortal Wkly Rep 2017; 66: 265–69. [PubMed: 28301454]
75. Sekhri S, Arora NS, Cottrell H, et al. Probability of opioid prescription refilling after surgery: does initial prescription dose matter? Ann Surg 2017; 268: 271–76.
76. Perkins FM, Kehlet H. Chronic pain as an outcome of surgery. A review of predictive factors. Anesthesiology 2000; 93: 1123–33. [PubMed: 11020770]

77. Angst MS, Clark JD. Opioid-induced hyperalgesia: a qualitative systematic review. Anesthesiology 2006; 104: 570–87 [PubMed: 16508405]

78. Bateman BT, Cole NM, Maeda A, et al. Patterns of opioid prescription and use after cesarean delivery. Obstet Gynecol 2017; 130: 29–35. [PubMed: 28594763]

79. Lee JS, Hu HM, Brummett CM, et al. Postoperative opioid prescribing and the pain scores on hospital consumer assessment of healthcare providers and systems survey. JAMA 2017; 317: 2013–15. [PubMed: 28510669]

80. Prabhu M, McQuaid-Hanson E, Hopp S, et al. A shared decision-making intervention to guide opioid prescribing after cesarean delivery. Obstet Gynecol 2017; 130: 42–46. [PubMed: 28594762]

81. Chen EY, Marcantonio A, Tornetta P. Correlation between 24-hour predischarge opioid use and amount of opioids prescribed at hospital discharge. JAMA Surg 2018; 153: e174859. [PubMed: 29238810]

82. Brandal D, Keller MS, Lee C, et al. Impact of enhanced recovery after surgery and opioid-free anesthesia on opioid prescriptions at discharge from the hospital: a historical-prospective study. Anesth Analg 2017; 125: 1784–92. [PubMed: 29049123]

83. Hill MV, Stucke RS, Billmeier SE, Kelly JL, Barth RJ. Guideline for discharge opioid prescriptions after inpatient general surgical procedures. J Am Coll Surg 2017; 226: 996–1003. [PubMed: 29198638]

84. Lavand'homme P, Estebe JP. Opioid-free anesthesia: a different regard to anesthesia practice. Curr Opin Anaesthesiol 2018; 31: 556–61. [PubMed: 29994942]

85. American Society of Anesthesiologists Task Force. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. Anesthesiology 2012; 116: 248–73. [PubMed: 22227789]

86. Chou R, Gordon DB, de Leon-Casasola OA, et al. Management of postoperative pain: a clinical practice guideline from the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. J Pain 2016; 17: 131–57. [PubMed: 26827847]

87. Ladha KS, Patorno E, Huybrechts KF, Liu J, Rathmell JP, Bateman BT. Variations in the use of perioperative multimodal analgesic therapy. Anesthesiology 2016; 124: 837–45. [PubMed: 26835644]

88. Huxtable CA, Roberts LJ, Somogyi AA, MacIntyre PE. Acute pain management in opioid-tolerant patients: a growing challenge. Anaesth Intensive Care 2011; 39: 804–23. [PubMed: 21970125]

89. Ward EN, Quaye AN, Wilens TE. Opioid use disorders: perioperative management of a special population. Anesth Analg 2018; 127: 539–7 [PubMed: 29847389]

90. Chang AK, Bijur PE, Esses D, Barnaby DP, Baer J. Effect of a single dose of oral opioid and nonopioid analgesics on acute extremity pain in the emergency department: a randomized clinical trial. JAMA 2017; 318: 1661–67. [PubMed: 29114833]

91. Ladha KS, Patorno E, Liu J, Bateman BT. Impact of perioperative epidural placement on postdischarge opioid use in patients undergoing abdominal surgery. Anesthesiology 2016; 124: 396–403. [PubMed: 26575145]

92. Sun EC, Bateman BT, Memtsoudis SG, Neuman MD, Mariano ER, Baker LC. Lack of association between the use of nerve blockade and the risk of postoperative chronic opioid use among patients undergoing total knee arthroplasty: evidence from the Marketscan Database. Anesth Analg 2017; 125: 999–1007. [PubMed: 28430692]

93. Mueller KG, Memtsoudis SG, Mariano ER, Baker LC, Mackey S, Sun EC. Lack of association between the use of nerve blockade and the risk of persistent opioid use among patients undergoing shoulder arthroplasty: evidence from the Marketscan Database. Anesth Analg 2017; 125: 1014–20. [PubMed: 28742777]

94. Hah J, Mackey SC, Schmidt P, et al. Effect of perioperative gabapentin on postoperative pain resolution and opioid cessation in a mixed surgical cohort: a randomized clinical trial. JAMA Surg 2018; 153: 303–11. [PubMed: 29238824]

95. Mudumbai SC, Lewis ET, Oliva EM, et al. Overdose risk associated with opioid use upon hospital discharge in veterans health administration surgical patients. Pain Med 2018; published online Aug 21. DOI:10.1093/pm/pny150.

96. Ladha KS, Gagne JJ, Patorno E, et al. Opioid overdose after surgical discharge. JAMA 2018; 320: 502–04. [PubMed: 30087999]

97. Davis CS, Carr D. Legal changes to increase access to naloxone for opioid overdose reversal in the United States. Drug Alcohol Depend 2015; 157: 112–20. [PubMed: 26507172]

98. Walley AY, Xuan Z, Hackman HH, et al. Opioid overdose rates and implementation of overdose education and nasal naloxone distribution in Massachusetts: interrupted time series analysis. BMJ 2013; 346: f174. [PubMed: 23372174]

99. Hill MV, Stucke RS, McMahon ML, Beeman JL, Barth RJ. An educational intervention decreases opioid prescribing after general surgical operations. Ann Surg 2018; 267: 468–72. [PubMed: 28267689]

100. Zivin K, White JO, Chao S, et al. Implementing electronic health record default settings to reduce opioid overprescribing: a pilot study. Pain Med 2018; 20: 103–12.

101. Delgado MK, Shofer FS, Patel MS, et al. Association between electronic medical record implementation of default opioid prescription quantities and prescribing behavior in two emergency departments. J Gen Intern Med 2018; 33: 409–11. [PubMed: 29340937]

102. Chiu AS, Jean RA, Hoag JR, Freedman-Weiss M, Healy JM, Pei KY. Association of lowering default pill counts in electronic medical record systems with postoperative opioid prescribing. JAMA Surg 2018; 153: 1012–19. [PubMed: 30027289]

103. Maughan BC, Hersh EV, Shofer FS, et al. Unused opioid analgesics and drug disposal following outpatient dental surgery: a randomized controlled trial. Drug Alcohol Depend 2016; 168: 328–34. [PubMed: 27663358]

104. Hasak JM, Roth Bettlach CL, Santosa KB, Larson EL, Stroud J, Mackinnon SE. Empowering post-surgical patients to improve opioid disposal: a before and after quality improvement study. J Am Coll Surg 2018; 226: 235–40. [PubMed: 29331347]

105. Theunissen M, Peters ML, Bruce J, Gramke HF, Marcus MA. Preoperative anxiety and catastrophizing: a systematic review and meta-analysis of the association with chronic postsurgical pain. Clin J Pain 2012; 28: 819–41. [PubMed: 22760489]

106. Howe CQ, Sullivan MD. The missing ‘P’ in pain management: how the current opioid epidemic highlights the need for psychiatric services in chronic pain care. Gen Hosp Psychiatry 2014; 36: 99–104. [PubMed: 24211157]

107. Hanna MN, Speed TJ, Shechter R, et al. An innovative perioperative pain program for chronic opioid users: an academic medical center’s response to the opioid crisis. Am J Med Qual 2019; 1: 1062860618777298.

108. Katz J, Weinrib A, Fashler SR, et al. The Toronto General Hospital Transitional Pain Service: development and implementation of a multidisciplinary program to prevent chronic postsurgical pain. J Pain Res 2015; 8: 695–702. [PubMed: 26508886]

109. Abid Azam M, Weinrib AZ, Montbriand J, et al. Acceptance and commitment therapy to manage pain and opioid use after major surgery: preliminary outcomes from the Toronto General Hospital Transitional Pain Service. Can J Pain 2017; 1: 37–49.

110. Steel Z, Marnane C, Iranpour C, et al. The global prevalence of common mental disorders: a systematic review and meta-analysis 1980–2013. Int J Epidemiol 2014; 43: 476–93. [PubMed: 24648481]

111. Dowell D, Haegerich TM, Chou R. CDC guideline for prescribing opioids for chronic pain — United States, 2016. JAMA 2016; 315: 1624–45. [PubMed: 26977696]

112. Scully RE, Schoenfeld AJ, Jiang W, et al. Defining optimal length of opioid pain medication prescription after common surgical procedures. JAMA Surg 2018; 153: 37–43. [PubMed: 28973092]

113. Howard R, Waljee J, Brummett C, Englesbe M, Lee J. Reduction in opioid prescribing through evidence-based prescribing guidelines. JAMA Surg 2017; 53: 285–87

114. Michigan Opioid Prescribing Engagement Network. Opioid prescribing recommendations for surgery. 2018 https://opioidprescribing.info/ (accessed March 19, 2018).

115. Helmerhorst GT, Teunis T, Janssen SJ, Ring D. An epidemic of the use, misuse and overdose of opioids and deaths due to overdose, in the United States and Canada: is Europe next? Bone Joint J 2017; 99-B: 856–64. [PubMed: 28663389]
116. Liepert AE, Ackerman TL. 2016 state legislative year in review and a look ahead. Bull Am Coll Surg 2016; 101: 35–39.
117. Bateman BT, Choudhry NK. Limiting the duration of opioid prescriptions: balancing excessive prescribing and the effective treatment of pain. JAMA Intern Med 2016; 176: 583–84. [PubMed: 27043188]
118. Baker-White A A look at state legislation limiting opioid prescriptions. 2017 http://www.astho.org/StatePublicHealth/A-Look-at-State-Legislation-Limiting-Opioid-Prescriptions/2-23-17/ (accessed March 21, 2018).
119. Gawande AA. It's time to adopt electronic prescriptions for opioids. Ann Surg2017; 265: 693–94. [PubMed: 28067675]
120. Bao Y, Pan Y, Taylor A, et al. Prescription drug monitoring programs are associated with sustained reductions in opioid prescribing by physicians. Health Aff (Millwood) 2016; 35: 1045–51. [PubMed: 27269021]
121. Haffajee RL, Jena AB, Weiner SG. Mandatory use of prescription drug monitoring programs. JAMA 2015; 313: 891–92. [PubMed: 25622279]
122. Lin HC, Wang Z, Boyd C, Simoni-Wastila L, Buu A. Associations between statewide prescription drug monitoring program (PDMP) requirement and physician patterns of prescribing opioid analgesics for patients with non-cancer chronic pain. Addict Behav 2017; 76: 348–54. [PubMed: 28898808]
123. Gray J, Hagemeier N, Brooks B, Alamian A. Prescription disposal practices: a 2-year ecological study of drug drop box donations in appalachia. Am J Public Health 2015; 105: e89–94. [PubMed: 26180956]
124. Egan KL, Wolfson M, Dudley WN, et al. Diffusion of medication drop-boxes in North Carolina from 2007 to 2016. Addict Behav 2018; 86: 44–50. [PubMed: 29631797]
125. Gray JA, Hagemeier NE. Prescription drug abuse and DEA-sanctioned drug take-back events: characteristics and outcomes in rural Appalachia. Arch Intern Med 2012; 172: 1186–87. [PubMed: 22733245]
126. US Centers for Disease Control and Prevention National Center. Rx Awareness. 2017 https://www.cdc.gov/RxAwareness/ (accessed Oct 25, 2018).
127. Initiative Truth. The truth about opioids. 2018 https://opioids.thetruth.com/o/home (accessed Oct 25, 2018).
128. Katz NP, Birnbaum H, Brennan MJ, et al. Prescription opioid abuse: challenges and opportunities for payers. Am J Manag Care 2013; 19: 295–302. [PubMed: 23725361]
129. US Centers for Medicare and Medicaid Services. CMS roadmap to address the opioid epidemic. 2018 https://www.cms.gov/About-CMS/Agency-Information/Emergency/Downloads/Opioid-epidemic-roadmap.pdf (accessed Oct 25, 2018).
130. Schnell M, Currie J. Addressing the opioid epidemic: is there a role for physician education NBER working papers. 2017 https://www.nber.org/papers/w23645 (accessed March 19, 2019).
131. Antman KH, Berman HA, Flotte TR, Flier J, Dimitri DM, Bharel M. Developing core competencies for the prevention and management of prescription drug misuse: a medical education collaboration in Massachusetts. Acad Med 2016; 91: 1348–51. [PubMed: 27532868]

Panel 1:

Key terms describing opioid-related outcomes

Prescription opioid misuse

Use of a prescription opioid medication in a manner or dose other than directed by a physician. Prescription opioid misuse done with the intent to feel euphoria is sometimes referred to as prescription opioid abuse.[47]

Opioid use disorder

A medical condition characterised by a problematic pattern of prescription or illicit opioid use that causes clinically significant impairment or distress.[48]

Opioid diversion

Transfer, by any means, of a legitimately prescribed opioid medication to a party other than the individual to whom it was originally prescribed.[49]

New or unintended prolonged opioid use

Receipt of opioids via prescription or diversion over an extended period of time among individuals not previously using opioids, with or without a formal diagnosis of opioid misuse or opioid use disorder; various time windows have been used in the literature for defining new or unintended prolonged opioid use.[50]

Panel 2:

Selected risk factors associated with prolonged opioid use after surgery*

System risk factors

- Type of surgery[63,65]
- High dosage of prescriptions[70]
- Longer duration of initial prescription[70]

Patient risk factors

- Age[65] (aged 50 years or older)
- Sex[65] (male)
- Household income[63] (lower)
- Specific comorbidities[63–65,71] (diabetes; heart failure; pulmonary disease)
- Mood disorders[65,71] (depression)
- Preoperative opioid use[72]
- Early postoperative opioid use[62]
- Specific preoperative medications[63,65,66] (benzodiazepines; antidepressants; ACE inhibitors)
- Preoperative history of drug abuse[64–66]
- Preoperative tobacco use[64,66]
- Preoperative pain disorders[64,66]

*Variable definitions for prolonged opioid use—see specific references.

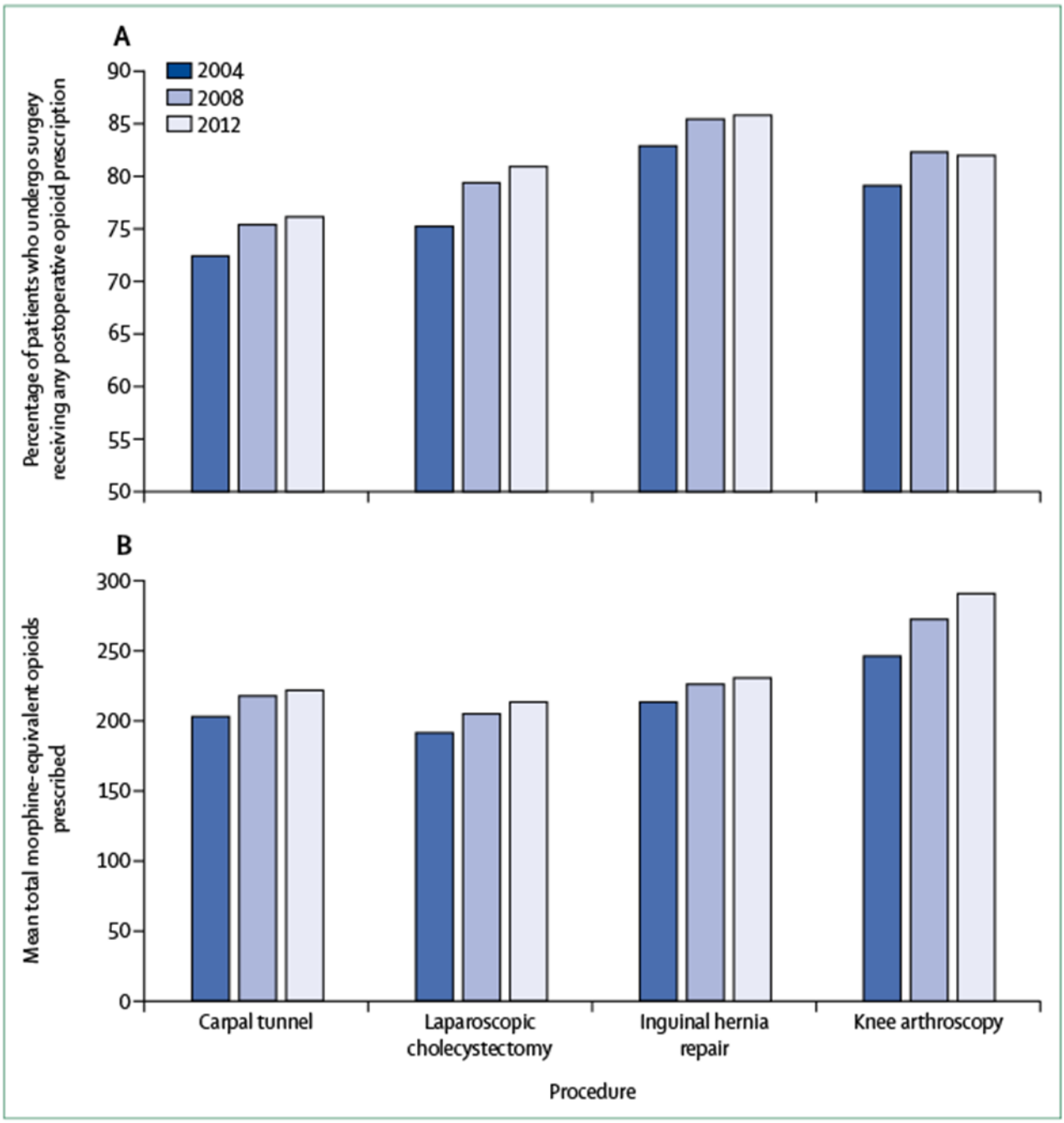

Figure: Increasing prescribing of opioids after surgery in the USA

Changes in patterns of postoperative opioid prescribing between 2002 and 2012 for four common low-risk procedures among 155 297 US adults who had private insurance and did not use opioids 6 months before surgery. (A) The percentage of all patients filling any opioid prescription within the first 7 days after surgery by year and procedure type. (B) The average amount of opioid pain medication received in morphine equivalents among those filling a prescription by year and procedure type.[44]

Table:

Michigan Opioid Prescribing Engagement Network postoperative opioid prescribing recommendations for surgery among patients without previous opioid use (selected)[108]

	Maximum recommended tablet count (oxycodone 5 mg or hydromorphone 2 mg)
Laparoscopic cholecystectomy	10
Laparoscopic appendicectomy	10
Inguinal or femoral hernia repair (open or laparoscopic)	10
Open incisional hernia repair	10
Laparoscopic colectomy	15
Open colectomy	15
Ileostomy or colostomy creation, re-siting, or closure	15
Open small bowel resection or enterolysis	20
Thyroidectomy	5
Vaginal hysterectomy	15
Laparoscopic or robotic hysterectomy	15
Abdominal hysterectomy	15
Breast biopsy or lumpectomy alone	5
Lumpectomy with sentinel lymph node biopsy	5
Sentinel lymph node biopsy alone	5
Simple mastectomy with and without sentinel lymph node biopsy	20
Modified radical mastectomy or axillary lymph node dissection	30
Wide local excision with and without sentinel lymph node biopsy	20