A Prospective Evaluation of Opioid Utilization After Upper-Extremity Surgical Procedures: Identifying Consumption Patterns and Determining Prescribing Guidelines.

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Investigation performed at the Rothman Institute at the Thomas Jefferson University, Philadelphia, Pennsylvania

**Background:** Although adequate management of postoperative pain with oral analgesics is an important aspect of surgical procedures, inadvertent overprescribing can lead to excess availability of opioids in the community for potential diversion. The purpose of our study was to prospectively evaluate opioid consumption following outpatient upper-extremity surgical procedures to determine opioid utilization patterns and to develop prescribing guidelines.

**Methods:** All patients undergoing outpatient upper-extremity surgical procedures over a consecutive 6-month period had the following prospective data collected: patient demographic characteristics, surgical details, anesthesia type, and opioid prescription and consumption patterns. Analysis of variance and post hoc comparisons were performed using t tests, with the p value for multiple pairwise tests adjusted by the Bonferroni correction.

**Results:** A total of 1,416 patients with a mean age of 56 years (range, 18 to 93 years) were included in the study. Surgeons prescribed a mean total of 24 pills, and patients reported consuming a mean total of 8.1 pills, resulting in a utilization rate of 34%. Patients undergoing soft-tissue procedures reported requiring fewer opioids (5.1 pills for 2.2 days) compared with fracture surgical procedures (13.0 pills for 4.5 days) or joint procedures (14.5 pills for 5.0 days) (p < 0.001). Patients who underwent wrist surgical procedures required a mean number of 7.5 pills for 3.1 days and those...
who underwent hand surgical procedures required a mean number of 7.7 pills for 2.9 days, compared with patients who underwent forearm or elbow surgical procedures (11.1 pills) and those who underwent upper arm or shoulder surgical procedures (22.0 pills) (p < 0.01). Procedure type, anatomic location, anesthesia type, age, and type of insurance were also all significantly associated with reported opioid consumption (p < 0.001).

Conclusions: In this large, prospective evaluation of postoperative opioid consumption, we found that patients are being prescribed approximately 3 times greater opioid medications than needed following upper-extremity surgical procedures. We have provided general prescribing guidelines, and we recommend that surgeons carefully examine their patients’ opioid utilization and consider customizing their opioid prescriptions on the basis of anatomic location and procedure type to prescribe the optimal amount of opioids while avoiding dissemination of excess opioids.

Although effective postoperative pain control is important, the U.S. Centers for Disease Control and Prevention (CDC) has reported that there is a growing epidemic of prescription painkiller abuse. In 2007 alone, there were 27,658 accidental deaths related to prescription opioid overdose. Furthermore, according to the American Society of Consultant Pharmacists, millions of pounds of "leftover" prescriptions go unused in patients’ medicine cabinets each year in the United States. Many factors contribute to this problem, including an increasingly aggressive culture of pain management, a lack of prescribing guidelines for physicians, inconsistent perioperative utilization of local anesthetics, and inadequate disposal instructions for patients.

Orthopaedic surgical procedures pose a unique challenge and opportunity in safe pain management. Specifically, orthopaedic surgical procedures often result in greater postoperative pain than other surgical procedures because of the manipulation of musculoskeletal tissue. Orthopaedic surgeons routinely prescribe opioids for postoperative pain management, yet little is known about the typical opioid requirements for various orthopaedic procedures. During a 2014 American Academy of Orthopaedic Surgeons (AAOS) symposium, it was recognized through an audience survey that most orthopaedic surgeons do not know how many pills to prescribe to their patients and/or how many pills their patients actually take. This may result in inconsistent and often excessive opioid-prescribing patterns. A greater understanding of opioid consumption patterns can result in more optimal and safer prescribing habits by physicians and can decrease the risk for overprescribing and potential diversion or abuse.

The purpose of our study was to prospectively evaluate opioid consumption following outpatient upper-extremity surgical procedures. The goal was to determine opioid utilization patterns to help to develop prescribing guidelines.

Materials and Methods
After obtaining institutional review board approval, 9 hand surgery fellowship-trained, board-certified orthopaedic surgeons practicing in a single private academic group prospectively collected postoperative opioid consumption data for 6 consecutive months (in April 2014 to October 2014). Data were collected via a standardized intake form. The surgeons were not blinded, were asked to continue their normal prescribing patterns, and were aware that the patients would be asked about their opioid consumption postoperatively. Nicotine use information was not collected. On the day of the surgical procedure, the surgeon recorded the following variables on the intake form: the patient’s age and sex, the procedure’s anatomic location (hand or wrist, forearm or elbow, and upper arm or shoulder), the procedure type (soft-tissue surgical procedure, joint surgical procedure, or fracture surgical procedure), the anesthesia type (local, sedation, general, and/or regional), the opioid type prescribed, and the quantity of the opioid prescribed.

Patients were included if they had an outpatient surgical procedure of the hand, wrist, elbow, forearm, or shoulder. Patients undergoing inpatient procedures were excluded. At the first postoperative visit, the following data were solicited directly from the patient by a member of the research team and were added to the standardized intake form: the quantity of the prescribed opioid used, the total days of opioid use, the reason for discontinuation (the opioids no longer being necessary or the side effects associated with the opioids), and the side effects (if any). Finally, patients were asked if opioid disposal instructions were given to them at any point in time. A research team member collected the intake form, and the data were subsequently entered into a central database.

The opioids prescribed and studied in this study included Percocet (oxycodone and acetaminophen) or an oxycodone 5-mg equivalent, Vicodin (acetaminophen and hydrocodone) or a hydrocodone 5-mg equivalent, and Tylenol #3 (acetaminophen and codeine) with 30 mg of codeine. For the purposes of this study, each of these prescription opioid pills was treated as equivalent to the other.

The following surgical data were collected: the type of procedure and the type of anesthesia. The type of procedure was subcategorized as a soft-tissue procedure (i.e., carpal tunnel or trigger finger release), fracture procedure (i.e., any fracture reduction with internal fixation), or joint procedure (i.e., arthroscopy, arthrodesis, or arthroplasty). The types of anesthesia were divided into local anesthesia, local anesthesia with sedation, regional anesthesia with or without sedation, and general anesthesia. Finally, patient demographic characteristics, such as age, sex, and type of insurance, were also collected.

Statistical Analysis
The overall data were examined by descriptive statistics between the means. The mean number of pills used and the mean total number of days used were calculated on the basis of patient demographic characteristics (age, sex, and insurance type), procedure, anesthesia, injection, and volume of injection. The percentage of the total prescription used was calculated by dividing the number of pills taken by the total number of pills prescribed. Single-factor analysis of variance (ANOVA) was conducted to assess significance (p < 0.05) between the categorical variables and the continuous variables (number of pills and number of days). Post hoc comparisons were performed using
A total of 1,416 patients (639 male patients and 777 female patients) with a mean age of 56 years (range, 18 to 93 years) were included (Table I). Surgeons prescribed a mean total of 24 pills (median, 20 pills [range, 0 to 110 pills]) per surgical procedure. Overall, the mean postoperative reported opioid consumption was 8.1 pills (median, 4 pills [range, 0 to 90 pills]) for a mean time of 3.1 days, resulting in a utilization rate of 34%.

### Overall Opioid Consumption Pattern
Overall, 28.3% of patients did not take any of their prescribed medications. An additional 56.1% of patients voluntarily discontinued the use of their prescription prior to its completion. In contrast, 11.0% of patients completed the entirety of their prescription, and 0.6% were still taking their medication at the time of their first postoperative visit. Finally, 4.0% did not wish to participate and did not respond.

### Opioid Consumption by Age
The mean reported number of opioid pills consumed was highest (13.4 pills) among patients in the age group of 30
to 39 years (p < 0.001 according to ANOVA). Although the ANOVA and visual inspection of the graph make it clear that there is a real trend, pairwise tests between adjacent age groups (adjusted for 8 multiple comparisons) were only significant (p = 0.03) for the age groups of 60 to 69 years and 70 to 79 years. In fact, 47.3% of patients in the age groups of 30 to 39 years consumed their entire prescription. Subsequently, there was a decrease in opioid consumption in each successive age interval thereafter (from the ages of 40 to 89 years), with the lowest amount consumed in the age group of 80 to 89 years. There was a paradoxical increase in opioid consumption in the age group of 90 to 100 years, although this was a small sample group of only 4 patients (Fig. 1).

Patients in the age range of 30 to 39 years had the highest reported mean opioid consumption for both soft-tissue procedures, at 11.6 pills, and joint procedures, at 19.2 pills. Patients in the age group of 18 to 19 years who received treatment for fracture fixation reported the highest mean consumption, at 18.9 pills.

On the basis of the anatomic location, patients in the age group of 18 to 19 years who received treatment for fracture fixation reported the highest mean consumption, at 18.9 pills. Patients in the age group of 50 to 59 years showed the highest opioid consumption (32.5 pills) for upper arm and shoulder procedures. Lastly, patients in the age group of 20 to 29 years reported the highest mean opioid consumption (13.8 pills) for hand and wrist procedures.

**Opioid Consumption by Sex**

Male patients reported taking a mean number of 8.6 pills for 3.4 days, whereas female patients reported taking a mean number of 7.9 pills for 2.9 days postoperatively (Fig. 2). There was no significance in opioid consumption based on sex (p = 0.20).

**Opioid Consumption by Insurance**

Based on insurance type, patients who self-pay or have Medicaid reported consuming the greatest amount of opioids, at a mean number of 25.6 pills (p < 0.001 according to ANOVA) for 7.5 days. Patients with Workers’ Compensation reported consuming the next greatest amount, with a mean consumption of 16 pills for 7.2 days. Patients with private insurance carriers consumed a mean number of 8.1 pills for 4.7 days, and Medicare patients, traditionally representing patients who are ≥65 years of age, reported having consumed the least

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. of Patients</th>
<th>Mean No. of Pills Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpal tunnel release</td>
<td>380</td>
<td>4.2</td>
</tr>
<tr>
<td>Trigger finger release</td>
<td>155</td>
<td>3.8</td>
</tr>
<tr>
<td>Mass excision</td>
<td>95</td>
<td>4.7</td>
</tr>
<tr>
<td>Fracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal radial open reduction internal fixation</td>
<td>114</td>
<td>13.7</td>
</tr>
<tr>
<td>Metacarpal open reduction internal fixation</td>
<td>46</td>
<td>9.6</td>
</tr>
<tr>
<td>Finger pinning</td>
<td>23</td>
<td>8.1</td>
</tr>
<tr>
<td>Joint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implant removal</td>
<td>39</td>
<td>12.3</td>
</tr>
<tr>
<td>Carpometacarpal arthroplasty</td>
<td>31</td>
<td>21.5</td>
</tr>
<tr>
<td>Tendon repair</td>
<td>28</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Fig. 1

The mean number of pills and days by age. The error bars indicate the standard deviation.
amount, with a mean number of 5.4 pills for 3 days (Fig. 3). Post hoc comparisons between groups showed significant differences between patients with private insurance and those with Medicare (p < 0.001), between patients with private insurance and those with Workers’ Compensation (p < 0.001), and between patients with Medicare and those with Workers’ Compensation (p < 0.001).

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. of Patients</th>
<th>No. of Pills Taken</th>
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</thead>
<tbody>
<tr>
<td>Hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trigger finger release</td>
<td>155</td>
<td>3.8</td>
</tr>
<tr>
<td>Mass excision</td>
<td>58</td>
<td>4.3</td>
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<tr>
<td>Metacarpal open reduction internal fixation</td>
<td>46</td>
<td>9.6</td>
</tr>
<tr>
<td>Wrist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpal tunnel release</td>
<td>380</td>
<td>4.2</td>
</tr>
<tr>
<td>Distal radial open reduction internal fixation</td>
<td>114</td>
<td>13.7</td>
</tr>
<tr>
<td>De Quervain tenosynovitis</td>
<td>40</td>
<td>7.9</td>
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<tr>
<td>Elbow or forearm</td>
<td></td>
<td></td>
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<tr>
<td>Cubital tunnel release</td>
<td>42</td>
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<td>Lateral epicondyle debridement</td>
<td>23</td>
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<td>Distal biceps repair</td>
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<td>11.1</td>
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<tr>
<td>Shoulder or upper arm</td>
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<td>Acromioplasty rotator cuff</td>
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<tr>
<td>Humeral open reduction internal fixation</td>
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<td>53.5</td>
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<tr>
<td>Distal clavicle resection</td>
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<td>31.0</td>
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</table>
Opioid Consumption by Procedure Type
Patients who underwent soft-tissue procedures reportedly consumed the least amount of opioids postoperatively, with a mean number of 5.1 pills (p < 0.001, ANOVA) for 2.2 days, compared with those who underwent fracture procedures (13.0 pills for 4.5 days) or joint procedures (14.5 pills for 5.0 days) (Fig. 4). When compared with adjacent groups, there were significant differences between patients who underwent soft-tissue procedures and those who underwent fracture procedures (p < 0.001) and between patients who underwent soft-tissue procedures and those who underwent joint procedures (p < 0.001). The most common surgical procedures performed in these categories are listed in Table II.

Opioid Consumption by Anatomic Site
Patients who had undergone hand and wrist surgical procedures reported the least opioid consumption, with those who had undergone hand surgical procedures having a mean number of 7.7 pills for 2.9 days and those who had undergone wrist surgical procedures having a mean number of 7.5 pills for 3.1 days (p < 0.001). However, post hoc pairwise comparisons adjusted for 3 multiple comparisons showed significance for procedures on the wrist compared with those on the elbow (p = 0.008). Patients who had undergone upper arm and shoulder surgical procedures had the greatest mean reported opioid consumption with 22.0 pills for 6.0 days. Patients who had undergone elbow and forearm surgical procedures had a reported mean opioid consumption of 11.1 pills for 4.0 days (Fig. 5). The most common surgical procedures in these categories are listed in Table III.

Opioid Consumption by Anesthesia Type
Patients who had undergone surgical procedures with only local anesthesia reportedly consumed the fewest opioids (p < 0.001), at a mean number of 4.5 pills for 2.0 days, compared with patients who had undergone surgical procedures with anesthesia with sedation (5.7 pills for 2.6 days), those who had undergone surgical procedures with general anesthesia (12.5 pills for 4.0 days), and those who had undergone surgical procedures with regional anesthesia (15.0 pills for 4.8 days) (Fig. 6). When a post hoc pairwise comparison was used to compare adjacent groups (6 groups), all groups were found to be significant (p < 0.001), except when patients who underwent local anesthesia were compared with those who underwent local anesthesia with sedation (p = 0.118) and when patients who underwent regional anesthesia were compared with those who underwent general anesthesia (p = 0.621). However, it should be noted that patients typically undergoing general or regional anesthesia do so for more involved or painful surgical procedures such as fracture, joint, or upper arm...
surgical procedures. Hence, the relationship between opioid consumption and anesthesia type is an inherently biased one.

### Opioid Disposal Instructions

Only 5.3% of patients who filled their prescription received disposal information (n = 75). The sources of disposal information listed included the physician, recovery room nurses, and the pharmacy.

### Discussion

There is a growing epidemic in the United States involving the misuse of prescription opioids. In 2013, *The Journal of the American Medicine Association* reported that there had been 38,329 drug overdose deaths in the United States in 2010, and 75.2% of these deaths involved prescription opioids. Americans, who make up 4.6% of the world’s population, consume 80% of the global opioid supply. As the United States reports substantial opioid abuse, the number of opioid-related deaths continues to grow internationally with increasing availability of opioids. A Global Burden of Diseases, Injuries, and Risk Factors Study found that there were an estimated 43,000 deaths worldwide in 2010 due to opioid abuse.

Several studies have shown that opioids are being inadvertently overprescribed to patients postoperatively across all specialties, but especially in orthopaedic surgical procedures 1,6,11. Stanek et al. 12 studied opioid-prescribing patterns by implementing a new prescribing protocol for patients undergoing common upper-extremity surgical procedures. An educational card with a multimodal pain management plan was given to participating physicians with specific opioid recommendations. No narcotics were recommended for small procedures such as Mohs excisions, trigger finger releases, or retinacular cyst, nevi, lump, or bump excision. Ten narcotic pills were recommended for small procedures such as mucous cyst excisions, carpal tunnel releases, de Quervain releases, Dupuytren excisions, nonoperative hand fractures, and small joint arthrodeses. Twenty narcotic pills were recommended for wrist ganglion excisions, hand fracture fixation, basal joint arthroplasty, and tendon surgical procedures. Finally, 40 narcotic pills were recommended for larger surgical procedures such as wrist arthrodeses and reconstructions 12. After implementing the new protocol, Stanek et al. found a decrease in opioid prescribing of 15% for trigger finger release, 20% for metacarpal fracture repair, 48% for wrist cyst excision, and 39% for de Quervain release 12.

In a study of 250 patients, Rodgers et al. evaluated patient pain control after elective outpatient upper-extremity surgical procedures and quantified the number of leftover pain medications up to 14 days postoperatively 11. The authors found that bone procedures resulted in the greatest opioid consumption (14 pills) and soft-tissue procedures had the lowest consumption (9 pills). Overall, a mean of 10 opioid pills were consumed per patient, and 19 pills were left unused and available for potential abuse 11. Similar results were found in our study, in which only 11.0% of 1,416 patients completed the entirety of their prescription. Moreover, surgeons in our series prescribed a mean number of 24 pills, but the reported mean postoperative consumption was only 8.1 pills, resulting in a utilization rate of 34%. The result was that 66% of the prescription was available for potential diversion or abuse. In fact, during our study period alone, with 9 surgeons over 6 months, a total of 21,788 theoretically unused prescribed opioid pills was delivered into the community. Results from the 2010 National Survey on Drug Use and Health showed that about 5.1 million drug users (of 22.6 million illicit drug users) used prescription pain relievers; only 1 in 6 or 17.3% recorded that they had received the drugs through a prescription from their doctor 11.

One of the challenges of excess opioid prescribing is safe disposal. Per the U.S. Food and Drug Administration (FDA), certain opioids can be flushed away, but others require deliberate elimination 14. The FDA currently recommends that opioids be disposed of via pharmacy or community take-back programs or by mixing them in the household trash with substances such as coffee grounds or cat litter in a sealed bag. A complete list of which medicines can be flushed away is available on the FDA web site 14. However, the U.S. Environmental Protection Agency (EPA) discourages flushing any medications away to avoid contamination of the water supply 15. Unfortunately, unclear opioid disposal practices were
found to be common in our study population. Only 5.3% of
the 1,416 patients received any disposal information for excess
opioids from their physician, nurses, or pharmacists. McCauley et al. similarly reported findings from a web-based intervention
study that was designed to improve patient knowledge of safe
medication use, storage, and disposal\(^7\). Of 62 patients, they
found that one-third were unaware of the unsafe nature of
retained leftover opioid pills and almost half of their cohort
did not know where to or how to properly dispose of pre-
scription opioids\(^8\). In our cohort, 94% of patients did not
receive safe disposal information. Medical staff should be
more aware and vigilant in properly educating patients on
safe disposal of excess opioid medication.

Patients undergoing orthopaedic surgical procedures
have been shown to have higher pain postoperatively compared
with those undergoing surgical procedures in other special-
ties\(^9\). Ringwalt et al. found that orthopaedic surgeons have
the highest odds (7.1 to 1) of prescribing opioids to Medicare
patients compared with other medical providers, such as den-
tists or emergency medicine physicians\(^9\). Yet it has been shown
that orthopaedic surgeons have the highest patient return rate
to the hospital for persistent postoperative pain\(^9\). Our findings
support these facts, as the study surgeons were routinely prescrib-
ing excess of their patients’ needs and utilization. Upon infor-
ma
tly surveying the participating surgeons, the most common
reasons given for prescribing the amount that they did were to
avoid undermanaging postoperative pain, to minimize patient
calls, and to limit hospital readmissions. However, this “defen-
sive” overprescribing increases the number of opioids in the com-

munity available for potential diversion or abuse. Based on our
series, risk factors for increased opioid consumption include
younger age (patients in the age group of 30 to 39 years consumed
the greatest opioids), certain insurance types (self-pay, Medicaid,
and Workers’ Compensation), fracture or joint surgical pro-
duress, and surgical procedures involving the upper arm.

Opioid consumption was found to be most strongly
statistically related to procedure type and anatomic location.
Therefore, based on our study findings, we recommend
that surgeons consider these general guidelines for pre-
scribing opioids postoperatively after outpatient upper-

extremity surgical procedures to optimize the number of
opioids dispensed: ≤10 opioids for hand and wrist soft-
tissue surgical procedures, ≤20 opioids for hand and wrist
fracture or joint surgical procedures, ≤15 opioids for elbow
and forearm soft-tissue surgical procedures, ≤20 opioids
for elbow and forearm fracture or joint surgical procedures,
and ≤30 opioids for upper arm and shoulder surgical
procedures.

There were some limitations to this study. First, because
of the subjective nature of patient recall, some patients may
have overestimated or may have underestimated the number
of pills and/or number of days that the opioid was used. Fur-
thermore, our study included all patients who were undergo-
ing an upper-extremity procedure, and therefore, it may have
included patients with chronic pain who were currently tak-
ing opioids and had a predisposed tolerance for opioids. In
addition, information on preoperative nicotine use was not
collected. Nicotine can potentially affect postoperative opioid
consumption and pain experience. Lastly, a few patients did
not fill out the entirety of the survey, thereby potentially
skewing the results (specifically, of 1,416 enrolled patients,
16 patients did not report the total number of pills used,
115 patients did not report the total number of days that the
pills were taken, and 56 patients did not report the reason for
discontinuation).

In conclusion, the pattern of prescribing high volumes
of opioid pills is a common practice among orthopaedic surgeons.
Overprescribing delivers excess opioids into the community,
leaving them vulnerable to potential diversion or abuse. To avoid
overprescribing opioids and to limit potential abuse, surgeons
should consider the patient’s preoperative opioid experience and
should establish prescribing standards on a case-by-case basis
depending on the nature and location of the surgical procedure,
the type of anesthesia, and the age of the patient. •

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