RESEARCH ARTICLE

A Prospective Assessment of Opioid Utilization Post-Operatively in Orthopaedic Sports Medicine Surgeries

John M. Capelle, MD[1]; P. Jahnu Reddy, BS, MD[1]; Andy T. Nguyen, MD[1]; Heidi A. Israel, PhD, MD[1]; Christopher Kim, MD[1]; Scott G. Kaar, MD[1]

Research performed at Department of Orthopedic Surgery, Saint Louis University, Saint Louis, MO, USA

Received: 14 June 2020 *Accepted: 19 December 2020*

Abstract

Background: The healthcare system is plagued finding the balance between opioid use and abuse. Orthopaedic surgeons are expected to curtail the number of opioids prescribed in order to lower opioid abuse. We sought to prospectively evaluate opioid consumption following a wide range of sports orthopaedic surgical procedures to determine utilization patterns.

Methods: All patients receiving procedures within a one-year period were consented and then called daily for one week followed by weekly for up to two months or until the patients no longer were taking their opioid medication. We studied the number of opioids patient's took postoperatively and also collected information in regards to the patient and the surgical procedure.

Results: Included were 223 patients with a mean age of 32.9 years (range, 11 to 82). Surgeons prescribed a mean total of 59.5 pills, and patients reported consuming a mean total of 20.9 pills, resulting in a utilization rate of 40%. 94.4% of patients received no education on how to properly dispose of unused opioids. The mean SANE score was 53.9. The mean Pain Catastrophizing Scale score was 15.1. The mean Opioid Risk Tool was 3.3. The procedures were broken down into: 47.5% ligamentous knee repair, 18.4% shoulder arthroscopy/other shoulder, 7.6% meniscus, 7.6% shoulder arthroplasty, 5.4% distal biceps, 4.0% lower leg (ankle/foot/tibia) and 4.0% shoulder ORIF.

Conclusion: Over-prescribing opioids after sports orthopaedic surgeries is widespread. In this study, we found that patients are being prescribed 2.48 times greater opioid medications than needed following sports orthopaedic surgical procedures. We recommend surgeons take care when prescribing postoperative pain control and consider customizing their opioid prescriptions on the basis of prior opioid usage, anatomic location and procedure type. We also recommend educating the patients on proper disposal of excess opioids and consider involving pain management for patients likely to require prolonged opioid usage.

Level of evidence: II

Keywords: Musculoskeletal pain, Narcotic, Opioid consumption, Pain management, Sports medicine

Introduction

There is increasing evidence that musculoskeletal pain control can lead to prolonged opioid use leading to significant adverse effect for patients. While the narcotic epidemic has been heavily researched, there is limited data on opioid utilization status-post sports orthopaedic procedures. With growing concerns over opioid use comes the demand to critically assess current prescription habits and consider potential solutions to better meet the pain management needs of the patient (1-2).

Physicians are looking for ways to battle the opioid epidemic and a clear target area is the prescription of

Corresponding Author: Prati Jahnu Reddy, Department of Orthopaedic Surgery, St. Louis University, St. Louis, MO, USA
Email: Jahnu.reddy@health.slu.edu

AB&JS THE ONLINE VERSION OF THIS ARTICLE ABJS.MUMS.AC.IR

narcotics for postoperative pain management. According to the American Society of Consultant Pharmacists, millions of pounds of prescription medications go unused each year and numerous patients have a large supply of "leftover" medications in their medicine cabinets (3). Many factors contribute to this problem including a lack of prescribing guidelines for physicians, aggressive pain management regimens, inconsistent use of perioperative local anesthetics and inadequate disposal instructions for patients (2). Pain is profoundly subjective and poses significant difficulty to assess, as does the ability to identify patients at risk for dependence and abuse. Looking specifically at the realm of surgery, orthopaedists were found to be the third highest prescribers of opioids among US physicians in 2009, writing about 7.7% of all opioid prescriptions at that time (1). Orthopaedic surgical procedures often result in a significant amount of pain due to the manipulation of musculoskeletal tissue further emphasizing the difficulty with accurately controlling pain (2). In addition, numerous patients undergoing an orthopaedic procedure often have underlying chronic pain which can make pain management difficult. The fine balance of adequately controlling pain to accomplish postoperative goals and preventing the over prescription of narcotics has proven to be difficult to achieve (4). Understanding patterns of opioid consumption will allow physicians to determine if pain is being adequately managed in an outpatient orthopaedic setting as well as minimize the risk of over prescribing highly addictive drugs through structured prescribing guidelines.

The purpose of our study was to prospectively evaluate opioid consumption following sports orthopaedic procedures at our institution. The goal was to determine opioid utilization patterns to help to develop prescribing guidelines as well as identify risk factors associated with prolonged narcotic use.

Materials and Methods

Institutional review board approval was obtained. Two sports medicine fellowship-trained, orthopaedic surgeons practicing in an academic group performed surgery on a total of 375 patients of which 223 were included in our study from November 2017 to November 2018. Patients who met inclusion criteria for this study included those who were aged 10-100 years old and were prescribed narcotic analgesics in the postoperative period after undergoing one of the prespecified orthopaedic sports surgeries. The academic group treats patients with sports medicine injuries which occur in both athletes and non-athletes. No one was excluded based on age. The prespecified surgeries were: acromioplasty, rotator cuff repair, labral repair, proximal humerus fixation versus arthroplasty, elbow instability repair, elbow arthroplasty, hip arthroscopy, hip cam lesion repair, knee arthroscopy, knee ligament repair, knee meniscus repair, Achilles tendon repair, and knee cartilage repair procedures. Patients were not included in this study if they met any of the prespecified exclusion criteria including having a history of intellectual disability, incarcerated, having a primary language other than English, presently pregnant and any patient undergoing surgery considered to be on-call trauma. Pre-operative pain control included a multimodal combination of acetaminophen 975 mg, celecoxib 200 mg and pregabalin 75 mg. Post-operative pain control was achieved with hydrocodone/acetaminophen 5/325 mg or oxycodone/acetaminophen 5/325 mg with ketorolac 10 mg for five days. All procedures used general anesthesia with intraoperative narcotics in the form of fentanyl, morphine or hydromorphone.

The research team prospectively collected postoperative opioid consumption. Patients were consented in the preoperative holding area where they were also asked to fill out a standardized form. Multiple variables were collected and recorded through the patient questionnaire which included the following descriptors: pain scale, Single Assessment Numerical Evaluation (SANE) score, prior analgesics, current ethanol, tobacco, and illicit drug use, chronic narcotic user (>3 months of opioid use), workers compensation status, work/school status, pain catastrophizing scale (PCS), opioid risk tool, and how well they cope with pain (5, 6). The SANE score was used to evaluate patient perception of functionality pre-operatively on a scale of 0 to 100 with 100 being full functionality. The PCS is a self-reported questionnaire designed to assess the perception of pain in patients that has a score range of 0 to 52 with a higher score indicating more anxiety about pain (5). The opioid risk assessment tool is a self-reported screening questionnaire designed to assess risk of opioid abuse. A score below four represents low risk, score of four to seven represents moderate risk and a score greater than eight represents high risk (6). The patients were given five options for how they coped with pain: terribly, poorly, neutrally, moderately well, and extremely well. The surgeons and patients were not blinded and were asked to continue prescribing their normal number of narcotics. The surgeons were made aware that their patients would be regularly contacted to enquire about their narcotic usage. Patients included in the study were contacted by telephone once daily during the first postoperative week and then once weekly for the following seven weeks until the full eight-week postoperative follow-up period was completed or until it was communicated by the patient (or parent) that they no longer needed narcotic medications due to adequate pain control. Additional variables were collected from the electronic medical record through chart review: sex (male or female), insurance type (private or government managed), surgical details (procedure, body part, bone versus soft tissue, blood loss, length of procedure), surgery day of the week, surgery location (surgery center or hospital), pre-operative analgesics, anesthesia type (general, regional, both, intraoperative narcotics), quantity of opioid (hydrocodone and oxycodone) versus non-opioid (ketorolac, acetaminophen, celecoxib, and pregabalin) prescribed, and zip code of residence. All zip codes within St. Louis city were considered urban while zip codes outside of the city were considered rural.

The following data was solicited directly from the patient in the postoperative period by a member of

the research team: quantity of prescribed opioids used (no. of pills), pain scale, other analgesics taken, ethanol (quantity), tobacco (quantity), and illicit drug use (quantity), whether they returned to work or school and also how they believe they have coped with the pain (1-10). This information was collected once a day for the first post-operative week and then once a week for weeks two through eight. Additional data collected at post-operative week two included: date last prescribed opioid was consumed, quantity of leftover opioids (no. of pills), whether they were educated on proper disposal of unused opioids and whether the patient requested an additional narcotic analgesia prescription. This information was only collected once at the two week post-operative mark.

The opioids prescribed and studied in this study included oxycodone/acetaminophen, hydrocodone/acetaminophen, codeine/acetaminophen and tramadol. Of note, codeine/acetaminophen and tramadol were only used as a refill at follow-up visits. Additionally, a control group was not utilized in the study as it was purely observational and an intervention was not performed.

Primary endpoints collected were the quantity and duration of narcotic consumption. Secondary variables collected included pain scale, SANE score, prior analgesics, substance abuse history, workers compensation statues, employment status, PCS score, opioid risk assessment score, how well they cope with pain, patient demographic information, insurance type, surgical details, and zip code of residence.

Statistical Analysis

Descriptive statistics were used to describe the study sample and the number of preoperative and postoperative opioids prescribed and consumed. The average number of pills used and the average number of days were calculated in addition to other demographic and surgical data. Analysis of variance was also used to demonstrate significance between multiple groups ($P < 0.05$) and t-test was used to demonstrate significance between two groups ($P < 0.05$). Regression analysis was used to determine relationships between two continuous variables with a significant alpha value of 0.05. The regression analysis was deemed to have a low correlation if r^2 was between 0.30-0.50, a moderate correlation if the value was between 0.50-0.70 and a high correlation if the value was greater than 0.70 (7). The software used was IBM SPSS 25.0.

Results

A total of 223 patients (107 male and 116 females) with a mean age of 32.9 years (range, 11 to 82 years) were included in the study. Surgeons prescribed a mean total of 59.5 pills (range, 0 to 160 pills), and patients reported consuming a mean total of 20.9 pills (range, 0 to 207 pills) over a two-month period. When dividing the total number of pills consumed by the total number of pills prescribed, the utilization rate was 40%. When calculating the utilization rate for each patient and averaging those values, that rate was 33%. 94.4% of patients received no education on how to properly dispose of unused opioids. The mean surgery time was 94.4 minutes [Table 1]. The mean preoperative SANE score was 53.9. The mean Pain

Table 1. Summary of Surgery Pattern

Category	% of Patients
Procedure	
Ligamentous Knee Repair	47.5
Shoulder Arthroscopy/Other Shoulder	18.4
Meniscus	7.6
Shoulder Arthroplasty	7.6
Distal Biceps	5.4
Lower Leg (Ankle/Foot/Tibia)	4.0
Shoulder Open Reduction Internal Fixation (ORIF)	4.0
Intra-Articular Elbow	2.7
Hip	2.7
Surgery Day	
Monday	25.1
Tuesday	0.8
Wednesday	15.7
Thursday	45.3
Friday	13.0
Surgery Location	
Outpatient Surgical Center	45.3
Adult Inpatient Hospital	44.4
Pediatric Hospital	10.3
Anatomic Area of Surgery	
Lower Leg (Knee/Ankle/Foot)	56.5
Upper Leg (Hip)	5.4
Lower Arm (Elbow/Distal Biceps)	4.0
Upper Arm (Shoulder)	34.1
Surgery Type	
Open	17.2
Arthroscopic	82.8
Tissue Type	
Bone	14.8
Soft Tissue	67.7
Mixed	17.5
Anesthetic Block	
Regional	69.5
Intra-Articular	3.6
No Block	26.9
Intraoperative Narcotics	
Fentanyl	59.5
Fentanyl, Hydromorphone and Morphine	38.1
None	2.4
Estimated Blood Loss	
< 20 mL	68.3
20-110 mL	22.2
>100 mL	9.5
Pre-Operative Analgesics	
Ketorolac	86.8
Celecoxib	83.4
Acetaminophen	91.0
Average Surgery Time	94.4 Minutes

Catastrophizing Scale was 15.1. The mean Opioid Risk Tool score was 3.1. The mean preoperative pain scale was 3.6 and the mean eight week postoperative pain scale was 4.3. The distribution of procedures included in this study from most common to least common include: 47.5% ligamentous knee repair, 18.4% shoulder arthroscopy/other shoulder, 7.6% meniscus, 7.6% shoulder arthroplasty, 5.4% distal biceps tendon repair, 4.0% lower leg, 4.0% shoulder open reduction internal fixation, 2.7% elbow, and 2.7% hip [Table 1]. 30% of the patients were from an urban zip code and 70% of the patients were from a rural zip code. There were no observed complications or side effects in the study and there were no identified opioid over-doses that occurred.

Outliers

There were two patients who were removed from the dataset before analysis was conducted. The first patient had a sternoclavicular medial clavicle excision/ resection arthroplasty and reported taking a total of 207 pills when the individual was only prescribed 80 pills in total. The second patient had an arthroscopic shoulder labral repair and reported consuming 156 pills when the individual was only prescribed 51 pills in total. The mean number of pills consumed for the population was 20.9 with a standard deviation of 27.2 and these individuals were more than three standard deviations away from the mean. It is for this reason that they were removed before conducting further analysis but were retained for the descriptive statistics above (8).

Overall Opioid Consumption Pattern

Overall, 11.0% of patients did not take any of their prescribed medications while 89.0% of patients voluntarily discontinued the use of their prescription prior to its completion. 2.2% of patients continued taking their medication two-months postoperatively and 4.0% were prescribed additional narcotics. Prescribed 2.48 times the number of narcotics that they consumed. This was based on aggregate data and calculated by dividing the total number of pills prescribed by the total number of pill consumed. 14 patients did report consuming more pain medication than prescribed and the sources for the extra narcotics included primary care physicians, emergency departments and leftover medications from previous procedures.

Opioid Disposal Instructions

Only 5.6% of patients who filled their prescription received disposal information. The sources of disposal information listed included the physician, a veterinarian, and the pharmacy.

Opioid Consumption by Age

A regression analysis comparing patient age to the total number of narcotics consumed showed a significant relationship, however there was not a strong correlation with a r^2 value of 0.199 ($P < 0.05$). A similar analysis comparing age to total number of days consuming narcotics showed a correlation r^2 value of 0.351 indicating a significant relationship that increased age is associated with increased duration of narcotic usage ($P < 0.05$) with a low correlation ($r^2 > 0.3$). Patient's age was then divided into four categories: age up to 21, age 21-40, age 41-60 and age greater than 60. The mean number of narcotics consumed was 15.1, 21.4, 24.6, and 34.5 pills for the respective groups. The mean number of days consuming narcotics was 7.3, 11.5, 17.0 and 21.0 respectively. There was a significant difference in opioid consumption and duration of consumption between the up to 21 age group and the greater than 60 age group ($P < 0.05$). It was also noted that older age groups reported increased pain preoperatively when asked to rate their pain on a scale of 1-10 with 1 being no pain. Ages up to 21 reported a mean of 2.3, age 21-40 had a mean of 3.4, age 41-60 had a mean of 5.6 and age greater than 60 had a mean of 5.0. There was a significant difference in pain scale scores between the age groups particularly when comparing the up to 21 age group to the 21–40 and the greater than 60 age groups ($P < 0.05$).

Opioid Consumption by Procedure Type and Location

The mean number of narcotics consumed was 40.2 for shoulder arthroplasty, 29.7 for hip, 29.4 for shoulder ORIF, 27.9 for distal biceps repair, 19.2 for knee ligament repair, 13.7 for shoulder arthroscopy/other shoulder, 13.2 for intra-articular elbow, 8.5 for lower leg and 8.5 for meniscus repair. A few examples of "other shoulder" procedures that were included along with shoulder arthroscopies are labrum repair, humeral avulsion of the glenohumeral ligament (HAGL) repair and major pectoral tendon repair. There was a significant difference for opioid consumption between these groups particularly when comparing shoulder arthroplasty to shoulder arthroscopies/other shoulder procedures, meniscus repair, ligamentous knee repair, and lower leg procedures ($P < 0.05$). It was also found that shoulder arthroplasty patients consumed narcotics for the longest period at 25.4 days while patients with lower leg procedures consumed narcotics for the shortest period at 5.4 days ($P < 0.05$). The procedures were then split into lower leg (knee/ankle/foot), upper leg (hip), lower arm (elbow/biceps), and upper arm (shoulder) [Table 1]. The mean number of narcotics consumed for each group was 17.2, 22.3, 12.1 and 27.8 respectively. There was significant difference among these groups particularly when comparing upper arm procedures to lower leg procedures ($P < 0.05$). Procedure time was split into the following categories: 0-45 min, 46-90 min, 91-135 min, 136-180 min and greater than 180 min. The mean number of narcotics consumed was 10.8, 18.8, 26.8, 17.7, and 34.4 pills respectively. There was significant difference between patients who had procedures lasting longer than 180 minutes and patients who had procedures lasting up to 45 ($P < 0.05$). It was also found that patients with the longest procedures consumed narcotics for the longest duration with a mean of 19.8 days for procedures greater than 180 minutes.

Opioid Consumption by Sex

Male patients reported taking a mean number of 18.6

pills for 8.6 days, whereas female patients reported taking a mean number of 23.0 pills for 15.2 days postoperatively. There was no significance in opioid consumption based on sex ($P > 0.05$). The top three procedures done for both males and females was knee ligamentous repair, shoulder arthroscopy and meniscal repair. The spread for males was 49.5% knee, 25.2% shoulder and 8.4% meniscus. The spread for females was 45.7% knee, 30.1% shoulder and 6.9% meniscus.

Opioid Consumption by BMI

The mean body mass index (BMI) for our population was 28.7 with a standard deviation of 6.9 which is the in the overweight category (9). A regression analysis comparing BMI and number of narcotics consumed showed a correlation r^2 value of .062 indicating no significant correlation ($P > 0.05$). There was a significant relationship when comparing BMI to duration of narcotics consumed, however there was not a strong correlation with a r^2 value of .157 ($P < 0.05$). BMI was then split into four categories: normal weight (< 25), overweight (25–29.9), obese (30–40) and severely obese (> 40) (10). The mean number of pills consumed for each group was 17.2, 21.0, 26.9, and 14.8 respectively. There was no significant difference between these groups ($P > 0.05$). It was also found that normal weight patients consumed narcotics for a mean of 8.4 days while patients who were overweight consumed narcotics for the longest duration at 14.8 days ($P < 0.05$).

Opioid Consumption Based on Insurance Type

Based on insurance type, patients who had government managed insurance consumed a mean number of 21.2 pills while patients with private insurance consumed a mean number of 20.6 pills. There was no significance in opioid consumption based on insurance type ($P = .42$). Patients with public insurance consumed narcotics for 14.6 days and private insurance patients consumed narcotics for 8.6 days ($P < 0.05$ according to T-Test). It was notable that patients with public insurance had a higher opioid risk score with a mean of 3.7 while patients with private insurance had a mean score of 2.3 ($P < 0.05$).

Opioid Consumption Based on Return to Work or School

Patients who returned to work or school in two weeks or less consumed a mean number of 16.8 pills for an average duration of 9.5 days while patients who took longer than two weeks to return to work consumed a mean of 23.0 pills for an average duration of 15.6 days. The results were not significant for number of narcotics consumed ($P > 0.05$) but were significant for duration of consumption ($P < 0.05$).

Opioid Consumption Based on Nerve Block

Patients who received a nerve block consumed a mean number of 21.9 pills for an average duration of 12.3 days. Patients who did not receive a nerve block consumed an average of 18.2 pills for an average duration of 11.2 days. There was no significant difference between the two groups ($P > 0.05$).

Patient Perception of Pain Tolerance

3.1% of patients said they coped terribly, 7.3% poorly, 12.5% neutrally, 56.8% moderately and 20.3% extremely well [Table 2]. Patients that coped either terribly or poorly with pain consumed a mean number of 33.7 pills for 16.3 days while patients that coped either moderately well or extremely well consumed 19.2 pills for 11.9 days. The difference between these two groups was significant for number of pills consumed ($P > 0.05$) but not for duration of consumption ($P > 0.05$).

Single Assessment Numeric Evaluation Score

The mean score was 53.9 with a standard deviation of 24.8. The scores were split into two categories: SANE score of 33 or less and SANE score greater than 33. This represented having at least 33% functionality of the limb and was used to stratify patients that had significant decrease in limb function. It was hypothesized that the patients in the bottom third of limb functionality would consume the most narcotics and for the longest duration. The mean number of narcotics consumed for a SANE score less than or equal to 33 was 24.6 pills and consumption spanned an average of 14.6 days. For a SANE score greater than 33, the mean number of narcotics consumed was 18.9 for 11.0 days. There was a significant difference in amount and duration of consumption between the two groups ($P > 0.05$).

Table 2. Summary of Patient Demographic Information

Category	% of Patients
Sex	
Female	52.0
Male	48.0
Insurance	
Private	41.9
Government	58.2
Pre-operative Non-Narcotic Analgesic Use	69.3
Regular Alcohol Use	4.2
Regular Tobacco Use	2.1
Illicit Drug Use	2.1
History of Chronic Narcotic Use	10.9
Worker's Compensation	1.0
Employed/Attending School	72.3
Patient's Belief on How Well They Cope with Pain	
Extremely Well	20.3
Moderately Well	56.8
Neutrally	12.5
Poorly	7.3
Terribly	3.1

Opioid Risk Assessment Tool

The mean score for our population was 3.3 with a standard deviation of 4.8 indicating low risk for opioid abuse. A regression analysis comparing opioid risk tool score and number of narcotics consumed showed a correlation r^2 value of .035 indicating no significant correlation ($P > 0.05$). The correlation r^2 value comparing opioid risk tool score and duration of narcotics consumed was .092 indicating no significant correlation ($P > 0.05$). Patient's deemed as low risk consumed a mean of 19.0 pills for 11.5 days, intermediate risk patients consumed a mean of 22.1 pills for 10.5 days and patients with high risk consumed a mean of 24.3 pills for 15.5 days. There was no significant difference between the groups ($P > 0.05$).

Pain Catastrophizing Scale

The mean score among the patients was 15.1 with a standard deviation of 11.7. A regression analysis comparing pain catastrophizing score and number of narcotics consumed showed a correlation r^2 value of .096 indicating no significant correlation ($P > 0.05$. The correlation r^2 value comparing pain catastrophizing score and duration of narcotics consumed was .082 indicating no significant correlation ($P > 0.05$). Patients were then split into two categories: PCS score of up to 13 and PCS score of greater than 13. Patients with a score of 13 or less had little to no catastrophizing thoughts about pain (5). The mean number of pills consumed for the low PCS score group was 19.3 pills for an average duration of 12.0 days. The mean number of pills consumed for the group with a higher PCS score was 21.1 pills for an average duration of 11.7 days. There was no significant difference between these two groups ($P > 0.05$).

Opioid Consumption in Patients that Identified as Chronic Narcotic Users

10.9% of patients reported being chronic narcotic users and they took a mean number of 35.1 pills for an average of 22.4 days [Table 2]. Non-chronic narcotic users took a mean number of 18.4 pills for an average of 10.6 days. There was a significant difference both in the number of pills and in the duration of consumption between chronic narcotic users and non-chronic users ($P < 0.05$). It was also shown that chronic narcotic users were more likely to request additional narcotic medication at their two-week follow-up appointment. 7.1% of non-chronic narcotic users requested additional medication while 50% of chronic narcotic users requested additional medication (($P < 0.05$). When looking at the whole patient population, 14.3% of patients requested additional narcotics at their two-week follow up visit. Patients that requested additional narcotics took a mean number of 62.2 pills for an average duration of 27.8 days while patients that did not request additional medication took a mean of 19.5 pills for an average of 12.3 days. There was a significant difference between the two groups both in the number of narcotics consumed and the duration of consumption ($P < 0.05$).

Discussion

The United States faces a serious epidemic involving the overuse and abuse of prescription opioids (11). In recent years, institutions have tipped the scale toward overprescribing medication to treat pain. This is in part due to the establishment of pain as the fifth vital sign by the Joint Commission on Accreditation of Healthcare Organizations. Consequently, pain scores are now used as a quality measure for healthcare providers emphasizing that patient pain control needs to be appropriately addressed (12). Orthopaedic procedures require considerable alterations to musculoskeletal anatomy making postoperative pain management difficult. According to the *Journal of American Medical Association*, it is estimated that orthopaedic surgeons are the fourth highest opioid prescribers among all medical specialties (13). There has also been a recent shift toward viewing any kind of pain as an uncomfortable consequence as opposed to a necessary process for healing.

In this study, we examined postoperative opioid use

Table 3. Summary of SANE and Pain Score by Procedure Type

Procedure	Average Pre-Operative SANE Score (0-100)	Average Pre-Operative Pain Score (1-10 with 10 being most severe pain)	Average Pain Score at 2 weeks Post-Operative (1-10)
Ligamentous Knee Repair	58.6	2.8	3.3
Shoulder Arthroscopy/Other Shoulder	50.6	4.2	4.1
Meniscus	61.3	3.8	2.8
Shoulder Arthroplasty	45.0	5.2	5.6
Distal Biceps	42.0	4.6	3.6
Lower Leg (Ankle/Foot/Tibia)	51.7	3.3	1.2
Shoulder Open Reduction Internal Fixation (ORIF)	19.2	4.7	4.5
Intra-Articular Elbow	48.8	6.3	2.0
Hip	65.0	6.5	5.0

patterns following sports orthopaedic procedures and used the data to identify significant risk factors for prolonged opioid use. Several studies have shown the significant postoperative opioid demand particularly in shoulder arthroplasties (14-15). *Rao et al.* found the prevalence of continued opioid use at one year to be 39% among patients undergoing shoulder arthroplasty indicating dependence on prescriptions for pain control and for performing activities of daily living (ADLs)(16). Our study emphasized these results by showing that shoulder arthroplasties had the highest opioid consumption among all procedures measured (40.2 pills) and these patients consumed narcotics for the longest period of time (25.4 days). *Clarke et al*. showed that open procedures had a 2.5-fold higher risk of prolonged opioid use when compared to minimally invasive procedures (17). This is similar to the difference found in our study between open shoulder arthroplasties and minimally invasive procedures such as shoulder arthroscopies ($P < 0.05$).

The effect that age and sex had on opioid consumption was also recorded through our study. The highest rates of opioid consumption were among the older population specifically patients who had an age greater than 60. Jiang et al. found similar results and observed that patients in the 50-59 had the highest prevalence of chronic opioid usage (18). Older patients are more susceptible to the negative effects of pain than the younger patient population and this patient population has a higher incidence of chronic symptoms due to the degenerative wear and tear on their joints and muscles (19). The significant increase in pain scale scores among the older populations when compared to the youngest population indicates this increase in chronic symptoms. Patients in the under 21 age group had the lowest incidence of prolonged opioid consumption. Based on unofficial interviews, it was often stated that parents attempted to protect their child from excessive narcotic use and a majority of the under 21 age group lived with their parents. Females reported taking slightly higher number of pills for longer duration but this discrepancy was not significant when compared to male opioid use ($P < 0.05$). Thielke et al. found similar results and showed the prevalence of long-term opioid use is statistically similar among males and females (20).

Several preoperative evaluations were correlated to postoperative opioid use specifically the SANE score, the opioid risk assessment tool and the pain catastrophizing scale score. The SANE score is a simple one-question metric that is used to assess patient quantification of limb limitations (21). Increased opioid use was significantly correlated with patients who had a SANE score of less than 33. Decreased limb functionality indicates increased pain that hinders patients from performing their ADLs. Previous studies have not correlated SANE scores to opioid consumption. The opioid risk assessment tool was designed to account for known abuse risk factors such as sexual abuse history, family substance abuse history and psychiatric history to split patients into low, moderate or high risk for opioid abuse (22). The results of our study did not find a significant correlation between increased opioid abuse risk and increased opioid consumption in the post-operative period. This could be due to the majority of our patient population belonging in the low risk group and the study design being limited to a two-month period. The opioid risk assessment tool was designed to assess overall abuse risk not opioid use in the immediate postoperative setting (23). *Sullivan et al*. explored the role of pain-related psychological factors in predicting pain following total knee arthroplasties. They found that pain related fears did not predict post-surgical functional difficulties when the data was controlled for pre-surgical comorbidities (24). Similarly, our study also used the PCS score to measure patient's thoughts and feelings when they are in pain (24). We found that while patients may have difficulty coping with pain (increased PCS score), it did not significantly affect their amount or the duration of opioid consumption.

Several studies have aimed at quantifying the over-prescription of opioids particularly in orthopaedic procedures. A study out of Thomas Jefferson University conducted by *Kim et al.* looked at opioid utilization in 1,416 patients who had undergone upper extremity procedures. They found that 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 only 34% (2). Similar results were found in our study which resulted in a utilization rate of 40% but it should be noted that patients in our study consumed around double the number of pills. *Kim et al.* also found that there was no significant difference in opioid consumption based on sex, which is consistent with the findings in our study ($P > 0.05$). The voluntary discontinuation of prescription opioids was also analyzed by *Kim et al.* who found that 56.1% of patients discontinued their prescriptions prior to completion. Our study found a significantly higher number at 89.7% and only 2.2% were still taking their medication at two months post-operatively but we did prescribe more pills post-operatively. This is particularly important as leftover medications are often saved by patients for future use building on a culture of self-prescribing opioids for other instances of pain. It also becomes dangerous as patients often do not pay attention to expiration labels when pulling medications out of their cabinets (2-3).

Rogers et al. conducted a study on 250 patients who were undergoing elective outpatient upper-extremity surgery to evaluate pain control and quantify the leftover pain medication at two weeks post-operatively. Similar to our study, *Rogers et al.* conducted phone interviews periodically to assess pain control and remaining number of pills. They found that patients undergoing bone procedures reported the highest medication use while patients undergoing soft tissue procedures reported the lowest use. Their patients consumed a mean of 10 opioid pills while 19 pills were reported as unused (25). This considerable amount of unused medication was also discovered in our study where a high number of pills were reported as unused. This may be a community risk for potential unprescribed narcotic use.

Through our study and other past studies, it is clear that opioids are being overprescribed to patients, but

a clear challenge appears to be the safe disposal of unused narcotics (26-27). The FDA currently has several recommendations for the safe disposal of opioids including pharmacies, take-back programs or mixing them with an unpalatable substance before throwing them in the trash (28). *Kim et al.* found that only 5.3% of patients received any disposal information for excess opioids from their physician, nurse or pharmacists (2). Our study found similar results with only 5.6% of patients receiving safe disposal information. This is an evident gap in education and medical providers should strive to provide this vital piece of instruction in their post-operative guidelines.

There were some limitations to this study. First, the sample size is not large enough to be able to make recommendations per type of procedure. Secondly, there is the potential for faulty estimation of the opioid consumption from week two to week eight as we were relying on patient recall from the prior week. The patients could have over- or underestimated the number of pills they had taken. There is also the potential limitation secondary to the Hawthorne effect due to explaining the purpose of the project to the patients during the initial consent (29). The patients may be more likely to discontinue their opioids earlier knowing that someone is checking on their consumption patterns.

It is commonplace to prescribe opioid prescriptions after sports orthopaedic procedures. There is an increased prevalence of over-prescribing in an attempt to adequately control the patient's pain. It is important to take into account the patient's prior opioid history, the type of procedure and the anatomic location of the procedure when deciding how many opioids to prescribe. We also recommend providing education to the patient on how to adequately and safely dispose of excess opioids in order to reduce the available opioids on the market

John M. Capelle MD[1]
P. Jahnu Reddy BS MD[1]
Andy T. Nguyen MD[1]
Heidi A. Israel PhD MD[1]
Christopher Kim MD[1]
Scott G. Kaar MD[1]
1 Department of Orthopaedic Surgery, St. Louis University, St. Louis, MO, USA

References

1. Morris BJ, Mir HR. The opioid epidemic: impact on orthopaedic surgery. J Am Acad Orthop Surg. 2015; 23(5):267-271.
2. Kim N, Matzon JL, Abboudi J, Jones C, Kirkpatrick W, Leinberry CF, et al. A prospective evaluation of opioid utilization after upper-extremity surgical procedures: identifying consumption patterns and determining prescribing guidelines. J Bone Joint Surg Am. 2016; 89:(20)98.
3. Shrank WH. Our bulging medicine cabinets—the other side of medication nonadherence. N Engl J Med. 2011; 3-1591:(17)364.
4. Pasero C, McCaffery M. Orthopaedic postoperative pain management. J Perianesth Nurs. 2007; 22(3):160-174.
5. Sullivan MJ, Bishop SR, Pivik J. The pain catastrophizing scale: development and validation. Psychological assessment. 1995; 7(4):524.
6. Webster LR, Webster RM. Predicting aberrant behaviors in opioid-treated patients: preliminary validation of the Opioid Risk Tool. Pain Med. 2005; 42-432:(6)6.
7. Seber GA, Lee AJ. Linear regression analysis. John Wiley & Sons; 2012.
8. Ben-Gal I. Outlier detection. InData mining and knowledge discovery handbook 2005 (pp. 131-146). Springer, Boston, MA.
9. James PT, Leach R, Kalmara E, Shayeghi M. The worldwide obesity epidemic. Obes Res. 2001; 9(11):33-228.
10. Nuttall FQ. Body mass index: obesity, BMI, and health: a critical review. Nutr Today. 2015; 50(3):117.
11. Seth P, Rudd RA, Noonan RK, Haegerich TM. Quantifying the epidemic of prescription opioid overdose deaths. Am J Public Health. 2018; 108(4):500-2.
12. Morone NE, Weiner DK. Pain as the fifth vital sign: exposing the vital need for pain education. Clin Ther. 2013; 35(11):1728-32.
13. Labrum JT, Ilyas AM. The opioid epidemic: postoperative pain management strategies in orthopaedics. J Bone Joint Surg Am. 2017; 14:(8)5.
14. Westermann RW, Anthony CA, Bedard N, Glass N, Bollier M, Hettrich, CM, et al. Opioid consumption after rotator cuff repair. Arthroscopy. 2017; 33(8):1467-72.
15. Morris BJ, Laughlin MS, Elkousy HA, Gartsman GM, Edwards TB. Preoperative opioid use and outcomes after reverse shoulder arthroplasty. J Shoulder Elb Surg. 2015; 6-11:(1)24.
16. Rao AG, Chan PH, Prentice HA, Paxton EW, Navarro RA, Dillon MT, et al. Risk factors for postoperative opioid use after elective shoulder arthroplasty. J Shoulder Elb Surg. 2018; 8-1960:(11)27.
17. 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. Br Med J. 2014; 1251:(1)348.
18. Jiang X, Orton M, Feng R, Hossain E, Malhotra NR, Zager EL, et al. Chronic opioid usage in surgical patients in a large academic center. Ann Surg. 2017; 722:(4)265.

19. Dziechciaż M, Balicka-Adamik L, Filip R. The problem of pain in old age. Ann Agric Environ Med. 2013; 8-35:(1)1.
20. Thielke SM, Simoni-Wastila L, Edlund MJ, DeVries A, Martin BC, Braden JB, et al. Age and sex trends in long-term opioid use in two large American health systems between 2000 and 2005. Pain Med. 2010; 56-248:(2)11.
21. O'Connor CM, Ring D. Correlation of Single Assessment Numeric Evaluation (SANE) with other Patient Reported Outcome Measures (PROMs). Arch Bone Jt Surg. 2019; 303:(4)7.
22. Jones T, Lookatch S, Grant P, McIntyre J, Moore T. Further validation of an opioid risk assessment tool: the brief risk interview. J Opioid Manag. 2014; 10(5):353-64.
23. Nuckols TK, Anderson L, Popescu I, Diamant AL, Doyle B, Di Capua P, et al. Opioid prescribing: a systematic review and critical appraisal of guidelines for chronic pain. Ann Intern Med. 2014; 47-38:(1)160.
24. Sullivan M, Tanzer M, Stanish W, Fallaha M, Keefe FJ, Simmonds M, et al. Psychological determinants of problematic outcomes following total knee arthroplasty. Pain. 2009; 143(2):123-9.
25. Rodgers J, Cunningham K, Fitzgerald K, Finnerty E. Opioid consumption following outpatient upper extremity surgery. J Hand Surg. 2012; 50-645:(4)37.
26. Bicket MC, Long JJ, Pronovost PJ, Alexander GC, Wu CL. Prescription opioid analgesics commonly unused after surgery: a systematic review. JAMA Surg. 2017; 71-1066:(11)152.
27. Bartels K, Mayes LM, Dingmann C, Bullard KJ, Hopfer CJ, Binswanger IA. Opioid use and storage patterns by patients after hospital discharge following surgery. PloS One. 2016; 11(1):1-10.
28. Disposal of unused medicines: what you should know [Internet]. [Place unknown]: Food and Drug Administration; 2015 [updated 2019; cited 2020 May 15]. Available from: https://www.fda.gov/drugs/safe-disposal-medicines/.
29. Wickstrom G, Bendix T. The Hawthorne effect-what did the original Hawthorne studies actually show? Scand J Work Env Hea. 2000; 26(1):363-7.