

Are We Prescribing Our Patients Too Much Pain Medication?

Best Predictors of Narcotic Usage After Spinal Surgery for Scoliosis

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Background: Physicians play a role in the current prescription drug-abuse epidemic. Surgeons often prescribe more postoperative narcotic pain medication than patients routinely need. Although narcotics are effective for severe, acute, postoperative pain, few evidence-based guidelines exist regarding the routinely required amount and duration of use post-hospital discharge.

Methods: Patients in a prospective cohort undergoing posterior spinal fusion for idiopathic scoliosis were asked preoperatively to rate their pain level, the level of pain expected each week postoperatively, and their pain tolerance. Post-discharge pain scores and narcotic use were reported at weekly intervals for 4 weeks postoperatively. Demographic data, preoperative Scoliosis Research Society (SRS)-22 scores, operative details, perioperative data, and self-reported pain levels were analyzed with respect to their association with total medication use and refills received. Disposal plans were also assessed.

Results: Seventy-two patients were enrolled, and 85% completed the surveys. The mean patient age was 14.9 years; 69% of the patients were female. The cohort was divided into 3 groups on the basis of total medication usage. The mean number of pills used in the middle (average-use) group was 49 pills. In postoperative week 4, narcotic usage was minimal (a mean of 2.9 pills by the highest-use group). Also by this time point, pain scores had, on average, returned to preoperative levels. Older age, male sex, a higher body mass index, and a higher preoperative pain score were associated with increased narcotic use. Sixty-seven percent of the patients planned to dispose of their unused medication, although only 59% of those patients planned on doing so in a manner recommended by the U.S. Food and Drug Administration.

Conclusions: Postoperative narcotic dosing may be improved by considering patient age, weight, sex, and preoperative pain score. The precise estimation of individual narcotic needs is complex. Patient and family education on the importance and proper method of narcotic disposal is an essential component of minimizing the availability of unused postoperative medication.

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The nonmedical use of prescription narcotics has become a major problem in the United States. In 2010, more than 12 million people reported misuse of these medications¹; opioids have been implicated in as many as 420,000 emergency room visits per year² and 16,651 overdose-related deaths³. While emergency room visits due to opioid misuse are infrequent among children between the ages of 12 and 17 years (38 per

100,000), there is an eightfold increase as children transition to young adulthood (306 per 100,000 for those 21 to 24 years of age)². Around 11% of high school seniors have reported a history of nonmedical use of opioid narcotics⁴. Access to these medications is largely through easily obtainable supplies, such as leftover medication prescribed for family members and/or for previous procedures as well as diversion from friends and family⁵⁻⁸.

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TABLE I Patient Characteristics

	Value
Preop.	
Age* (yr)	14.9 ± 2.4
Sex (no. [%])	
Female	42 (69%)
Male	19 (31%)
Weight* (kg)	57.6 ± 17.2
BMI* (kg/m ²)	21.2 ± 4.8
Curve magnitude* (deg)	57.0 ± 10.1
Pain level (VAS, 0-100)*	13.7 ± 20.7
SRS-22*	
Total	4.0 ± 0.4
Pain	4.1 ± 0.7
Mental health	4.1 ± 0.8
Intraop.*	
No. of levels fused	10 ± 2
No. of osteotomies	5 ± 2
EBL (mL)	863 ± 550
Surgical duration (hr)	5.8 ± 2.0
Postop.	
Pain level (VAS, 0-10)*	
POD 1	4.1 ± 1.7
Day of discharge	4.2 ± 1.9
No. of pills prescribed at discharge*	61 ± 14
No. (%) of patients receiving refills	17 (27.9%)
No. of pills prescribed with refill*	42 ± 12
Total no. of pills used*	55 ± 37
No. of pills remaining*	20 ± 14

*The values are given as the mean and the standard deviation.
EBL = estimated blood loss.

Despite the large scale of the opioid epidemic, there is relatively limited evidence-based guidance available to surgeons to direct both the amount and duration of typical postoperative narcotic use following surgery. The few reports that do exist suggest that surgeons substantially overprescribe pain medication postoperatively^{9,10}. Bates et al. reported that 67% of patients had unused medication and only took about half of the prescribed amount after urologic procedures. Especially concerning is the recognition that as many as 91% of patients may keep unused medication for future use⁹. Similarly, Rodgers et al. found that nearly two-thirds of prescribed medication went unused after outpatient upper-extremity surgery¹⁰.

Postoperative pain in adolescent patients undergoing major spinal surgery has been the subject of extensive study in the inpatient realm¹¹⁻¹⁷. However, the typical post-hospital opioid requirement and pain trends for these patients remain unknown.

The aim of the present study was threefold. First, we sought to characterize the typical early post-hospital discharge course following posterior spinal fusion for patients treated for

idiopathic scoliosis, specifically evaluating the amount of pain and narcotics taken during the first month postoperatively in a population of otherwise healthy children. The second goal was to identify factors associated with excessive opioid use such that these patients could potentially be identified preoperatively and the appropriate dosing of medication could be determined accordingly. Third, we sought to analyze plans for the disposal of unused medication.

Materials and Methods

Patient Selection

All patients scheduled to undergo posterior spinal fusion at a tertiary care children's hospital, as performed by 2 senior surgeons, were assessed for eligibility. Patients were eligible to participate if they had a diagnosis of idiopathic scoliosis (adolescent or juvenile-onset), were able to comply with our standard postoperative protocol for pain management, and were able to complete several short questionnaires preoperatively and postoperatively. Patients were consecutively recruited to the study between February 2014 and May 2015. Of the 72 patients who enrolled, 61 (85%) completed the surveys and were included in the analysis (Fig. 1). Assent (for minors) and informed consent were obtained prior to enrollment. The study was approved by our institutional review board.

Postoperative Protocol, Study Flow, and Data Collection

Enrolled patients were given a single preoperative survey within a few weeks prior to surgery that included questions about current and expected postoperative pain. The Scoliosis Research Society (SRS)-22 questionnaire was also completed preoperatively, but data were not available for all patients¹⁸. On the day of surgery, all patients underwent posterior spinal fusion performed using a standard technique and were subsequently admitted to the hospital, where a standardized multimodal pain protocol was initiated as follows: morphine patient-controlled analgesia (PCA) with a continuous basal dose and on-demand dose, gabapentin, and 24-hour transdermal clonidine immediately postoperatively. On the morning of postoperative day (POD) 1, the basal dose was discontinued, the PCA remained for on-demand dosing, up to 3 doses of ketorolac were given, and patients were started on oral oxycodone-acetaminophen and valium. On POD 2, patients were fully transitioned from the PCA to oral oxycodone-acetaminophen, the dosing of which was adjusted, as needed, according to pain level, opioid sensitivity, and patient weight. The patients were typically discharged to home on POD 3 or 4, with prescriptions for oxycodone-acetaminophen (5/325) and valium and with office follow-up in 1 month. The patients were encouraged to use their inpatient dose for the first 2 to 3 days after discharge and then wean as tolerated, with the goal of no longer taking narcotic medication by 2 weeks from surgery. Acetaminophen was used to help patients wean from narcotic medication, and families were instructed on maximum dosages for this.

Following surgery, an immediate postoperative survey was completed by the senior surgeon to identify intraoperative surgeon-perceived variables that could influence narcotic use. After hospital discharge, patients received weekly (from the date of surgery) electronic surveys for 4 weeks postoperatively, which allowed prospective self-reporting of pain level, number of pills taken, and refills received. Prescriptions for other narcotic pain medications were also reported and the number of those pills was included in the total pill numbers. Doses taken were calculated on the basis of the prescription information provided and patient surveys. For example, a patient who took 40 pills from a prescribed dosage of 1.5 tablets of oxycodone-acetaminophen every 4 hours was reported as having taken 26.7 doses of medication. Perioperative data were also acquired for analysis. The surveys used are shown in the Appendix.

Statistical Analysis

All data and survey management was performed securely online with the REDCap (Research Electronic Data Capture) tool¹⁹. Data were exported electronically from the REDCap database and analysis was performed with SPSS software (version 22; IBM). A chi-square test was completed to assess the

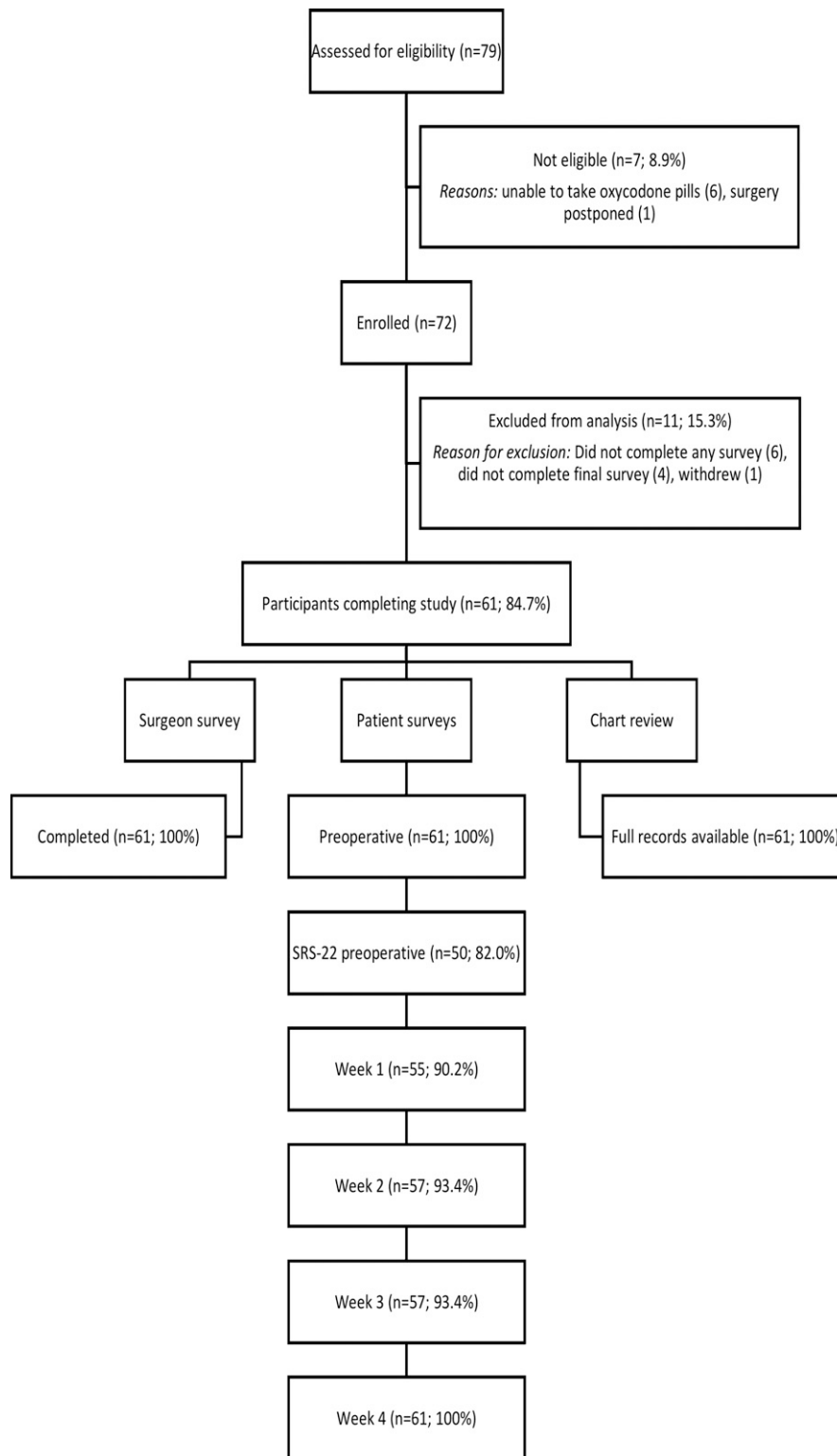


Fig. 1

Flow diagram of study participants.

association between categorical variables and refills received ("yes" or "no"). A 1-way, between-groups analysis of variance was conducted for continuous variables. Patients were divided into 3 groups according to pill usage: low use

(the bottom 25 percentiles), average use (the middle 50 percentiles), and high use (the top 25 percentiles). A Bonferroni post-hoc test was conducted to determine between-group differences when p values were <0.05. An independent-samples

TABLE II Analysis of Factors Associated with Low, Average, and High Pill Use

	Pill Use			P Value
	Low, N = 17	Average, N = 29	High, N = 15	
Preop. variable				
Age* (yr)	14.0 ± 2.5	14.7 ± 2.3	16.4 ± 1.9	0.012
Male sex	11.8%	24.1%	66.7%	0.002
Weight* (kg)	50.7 ± 10.7	55.6 ± 15.4	69.5 ± 21.1	0.004
BMI* (kg/m ²)	19.6 ± 3.1	20.7 ± 4.4	23.7 ± 6.3	0.042
Curve magnitude* (deg)	52.6 ± 6.6	58.9 ± 11.1	58.2 ± 10.2	0.109
Pain level (VAS, 0-100)*	5.8 ± 7.3	10.6 ± 17.6	28.7 ± 28.6	0.003
SRS-22*				
Total	4.0 ± 0.4	4.1 ± 0.3	3.9 ± 0.4	0.200
Pain	4.2 ± 0.7	4.1 ± 0.6	3.8 ± 0.9	0.397
Mental health	3.9 ± 0.9	4.3 ± 0.7	3.9 ± 0.8	0.303
Intraop. variable*				
No. of levels fused	10 ± 2	11 ± 2	11 ± 2	0.509
No. of osteotomies	4.2 ± 1.8	5.1 ± 1.4	4.6 ± 1.8	0.215
EBL (mL)	740 ± 344	770 ± 345	1,182 ± 881	0.032
Surgical duration (hr)	4.8 ± 1.3	6.2 ± 2.0	6.2 ± 2.3	0.052
Postop. variable*				
Discharge dosing level (no. of pills per prescribed dose)	1.1 ± 0.3	1.4 ± 0.4	1.6 ± 0.3	<0.001
Pain level (VAS, 0-10)				
POD 1	3.5 ± 1.2	4.3 ± 2.0	4.4 ± 1.5	0.185
Day of discharge	3.7 ± 1.8	4.2 ± 1.9	4.8 ± 1.7	0.269
No. of pills used	22 ± 9	49 ± 10	104 ± 39	<0.001
No. of doses used	24 ± 14	36 ± 7	69 ± 36	<0.001
No. of pills prescribed at discharge	53 ± 12	61 ± 12	69 ± 13	0.003
Total no. of pills prescribed	53 ± 12	66 ± 14	117 ± 39	<0.001
Length of stay (days)	3.4 ± 0.6	3.3 ± 0.6	3.3 ± 0.6	>0.9
*The values are given as the mean and the standard deviation. EBL = estimated blood loss.				

t test was conducted to assess the association between continuous variables for refills received ("yes" or "no"). Significance was set at $p < 0.05$.

Results

Study Population

Seventy-two patients were enrolled in the study (Fig. 1). Of those, 6 (8.3%) did not complete any of the surveys, 4 (5.6%) were unable to complete the final survey, and 1 (1.4%) withdrew from the study in the early postoperative period, leaving 61 (84.7%) of the patients available for inclusion in the final analysis. Nine of these patients missed 1 or more of the surveys during postoperative weeks 1 to 3 (for a total of 14, or 7.7%, of 183 surveys missing during those weeks); however, all 61 of the patients completed the final survey at postoperative week 4.

Demographic data are shown in Table I. The mean age of the cohort was 14.9 years, the majority (42 patients; 69%) were female, and the mean measurement of deformity in the coronal plane, using the Cobb method, was 57°. Patients had a mean of 10 levels fused, routinely underwent multiple Ponte-type os-

teotomies as part of the procedure (mean, 5 osteotomies), and all underwent segmental instrumentation with pedicle screws as part of the fusion procedure. Patients were discharged to home with a mean of 61 (range, 30 to 80) pills.

Self-Reported Pain

As assessed by patients on a visual analog scale (VAS) of 0 to 100 (with a lower score indicating less pain), the mean preoperative pain level (and standard deviation) was 13.7 ± 20.7 (range, 0 to 75). While patients' expected postoperative pain and actual self-reported pain levels followed similar trajectories, the actual pain scores were significantly lower for all weeks (Fig. 2). By week 4, the actual pain scores (mean, 11.8 ± 12.9) had returned to preoperative levels ($p = 0.537$).

Postoperative Narcotic Use

The mean total number of pills used in each group was as follows: low, 22 ± 9 pills; average, 49 ± 10 pills; and high, 104 ± 39 pills ($p < 0.001$). The mean number of pills prescribed per

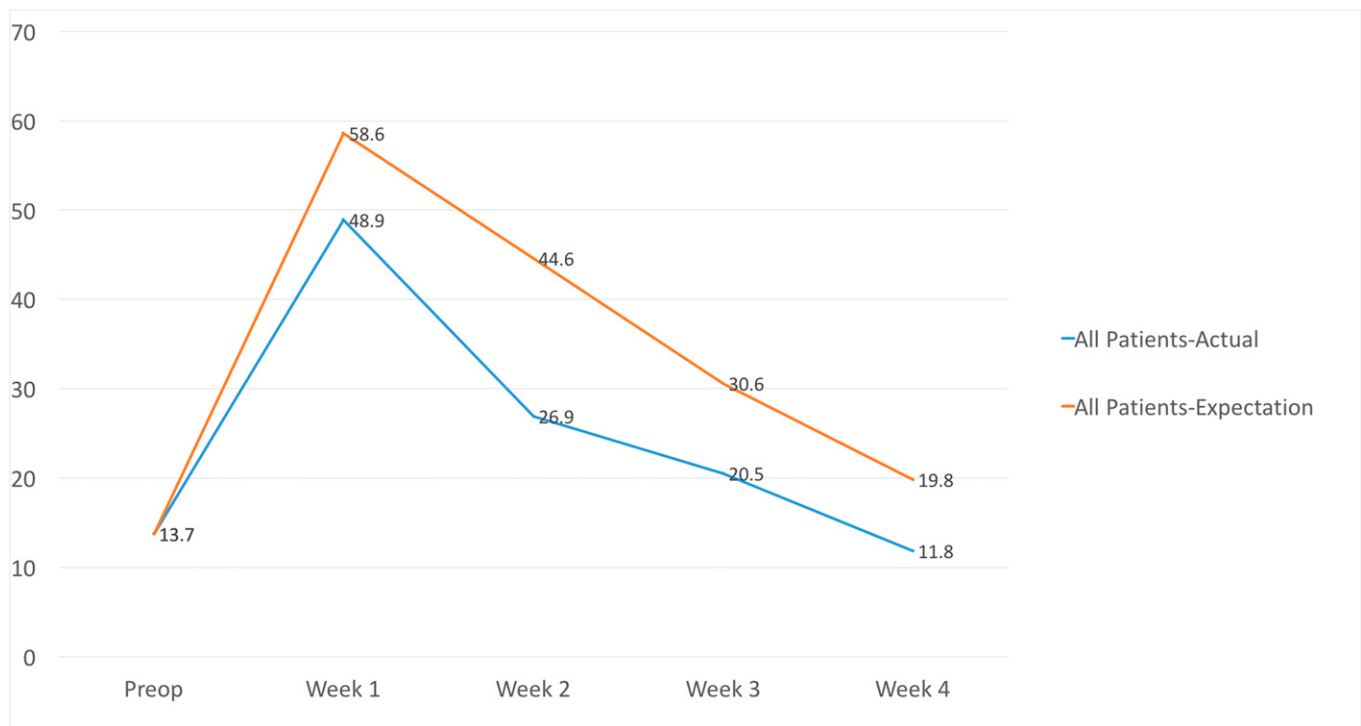


Fig. 2

Mean expected versus actual patient-reported pain level by week. Actual patient-reported pain was significantly lower than expected pain during each of the 4 weeks (week 1, $p = 0.019$; week 2, $p < 0.001$; week 3, $p = 0.007$; and week 4, $p = 0.010$). Week 3 ($p = 0.059$) and week 4 ($p = 0.537$) were identified as the time when patients reported a pain level similar to that reported preoperatively.

dose was lower in the low-use group compared with the average and high-use groups (low, 1.1; average, 1.4; and high, 1.6 pills per dose; $p < 0.001$). When adjusting for dosing, an increased narcotic requirement was still observed in the high-use group (mean, 69 doses) compared with the low-use and average-use groups (24 and 36 doses, respectively; $p < 0.001$) (Table II).

Weekly narcotic use varied substantially among the groups (Fig. 3) but, for each group, was noted to decrease during the first 3 weeks. In postoperative week 3, the high-use group continued using a greater number of pills (low, 1.1; average, 3.2; and high, 16.9 pills per week; $p = 0.001$). However, by week 4, there was no significant difference in narcotic use among the groups

and few pills were being used (low, 0.1; average, 1.0; and high, 2.9 pills per week; $p = 0.245$).

Several potential factors associated with pill use were identified among patients who required more medication postoperatively. Male sex was associated with increased narcotic use ($p = 0.002$). The high-use group both was older than the low-use group (mean age, 16.4 compared with 14.0 years) and had a higher body mass index (BMI) (23.7 compared with 19.6 kg/m²). Mean weight was significantly higher in the high-use group compared with both the low and average-use groups ($p = 0.004$). Preoperative pain was also associated with postoperative narcotic use, with the high-use group reporting more preoperative

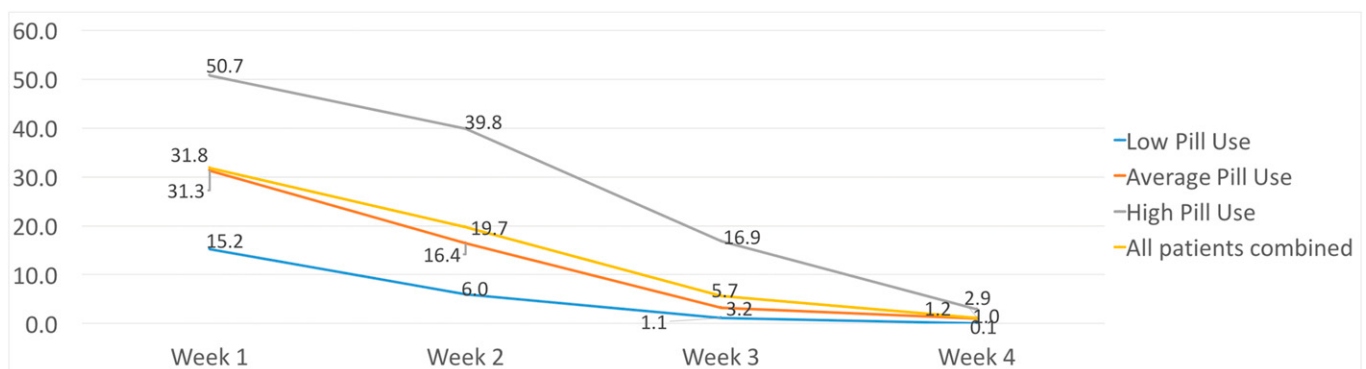


Fig. 3

Mean number of pills used by week.

TABLE III Analysis of Factors Associated with Receiving Refills

	Received Refill		P Value
	Yes	No	
No. (%) of patients	17 (27.9%)	44 (72.1%)	
Preop. variable			
Age* (yr)	15.9 ± 1.9	14.5 ± 2.5	0.038
Sex (no.)			0.095
Female	9	33	
Male	8	11	
Weight* (kg)	67.5 ± 22.4	53.8 ± 13.1	0.027
BMI* (kg/m ²)	23.9 ± 6.1	20.1 ± 3.8	0.027
Curve magnitude* (deg)	58.8 ± 9.6	56.3 ± 10.2	0.374
Pain level (VAS, 0-100)*	27.4 ± 28.9	8.4 ± 13.6	0.018
SRS-22*			
Total	3.8 ± 0.4	4.1 ± 0.4	0.059
Pain	3.8 ± 0.8	4.2 ± 0.6	0.075
Mental health	4.2 ± 0.6	4.0 ± 0.8	0.606
Postop. variable* (no.)			
Pills prescribed at discharge	61.9 ± 15.1	60.5 ± 13.1	0.704
Discharge dosing level (no. of pills per prescribed dose)	1.6 ± 0.4	1.3 ± 0.3	<0.001
Total pills used	93.1 ± 44.7	40.5 ± 18.5	<0.001
Total doses used	61.3 ± 38.7	32.9 ± 12.9	0.009

*The values are given as the mean and the standard deviation.

pain than the low and average-use groups (28.7 compared with 5.8 and 10.6, respectively; $p = 0.003$). A multiple linear regression analysis of these significant factors explained only about half of the variance in pill use. Self-reported pain tolerance was not identified as a predictive factor for postoperative narcotic use ($p = 0.347$). Surgeon assessment of anticipated narcotic need also was not predictive of actual use ($p = 0.255$).

Factors Associated with Receiving Refills

Refills were prescribed for 17 (27.9%) of the patients; 44 (72.1%) did not receive refills. Several factors were associated with the need for a refill, including age (mean, 15.9 for those who received a refill compared with 14.5 years for those who did not; $p = 0.038$), weight (mean, 67.5 compared with 53.8 kg; $p = 0.027$), BMI (mean, 23.9 compared with 20.1 kg/m²; $p = 0.027$), and a higher preoperative pain score (mean, 27.4 compared with 8.4; $p = 0.018$) (Table III). Patients who received refills tended to have lower scores for the total and pain domains of the SRS-22 questionnaire ($p < 0.1$), but these differences were not significant. A similar number of pills was prescribed at the time of discharge in each group (61.9 compared with 60.5 pills for those who did and did not receive refills, respectively; $p = 0.704$); however, patients receiving refills had higher baseline dosing requirements (mean, 1.6 pills per dose compared with 1.3 pills per dose; $p < 0.001$). These patients also took a greater total number of pills (mean, 93.1 compared with 40.5; $p < 0.001$) and used more doses (mean, 61.3 compared with 32.9; $p = 0.009$).

Narcotic Disposal

Although most of the patients (41, or 67%), planned to dispose of unused medication, 20 (33%) planned to keep the medication for future use. Eight of these patients planned to keep the medication for no more than 3 months; 2 of the patients, for 3 to 6 months; and 9 of the patients, until the expiration date. Only 1 patient planned to keep the medication indefinitely. Neither high narcotic usage ($p = 0.127$) nor receiving a medication refill ($p = 0.744$) was identified as a factor associated with failure to dispose of unused medication. Of the patients planning to dispose of the medication, 24 (59%) planned to utilize a proper disposal method, as recommended by the U.S. Food and Drug Administration (FDA)²⁰; only 7 (17%) planned to utilize a medication take-back program to do so.

Discussion

This study evaluated a group of pediatric patients undergoing posterior spinal fusion for predictors of higher narcotic medication requirements after hospital discharge. It also sought to better characterize their typical pain trajectory, medication requirements, and disposal plans, with the goal of both optimizing patient comfort and education while minimizing the risk for excessive narcotic use.

One inherent challenge to the study of postoperative pain is that pain is a complex process. It is difficult to predict and is shaped by culture, biology, and psychology. Nota et al. evaluated pain in postoperative orthopaedic patients and found that depression and greater opioid use led to lower satisfaction

scores with pain management²¹. Culture also shapes the perception of pain. When comparing Dutch and American patients with ankle fractures, Dutch patients received less narcotic pain medication²² but also reported less pain and higher satisfaction with their pain control²³. Patients' perceived control of their situation substantially affects their pain perception and medication use²⁴. These types of psychological findings and the findings of Connelly et al., that increased anxiety led to slower improvements in pain scores¹⁴, makes one question the reliability of pain scores for predicting narcotic needs.

It is clear from our data that there is no single factor that allows one to easily predict postoperative narcotic requirements. As expected, there was a wide spectrum of postoperative use. We evaluated multiple demographic, intraoperative, and postoperative factors that were associated with increased narcotic use. We did not find an association between number of levels fused, number of osteotomies, in-hospital pain level, and self-reported pain tolerance with postoperative narcotic use. Surgeon assessment of anticipated narcotic needs was also unreliable. Certain demographic factors, such as a higher weight and BMI, male sex, older age, and greater preoperative pain were associated with more postoperative pill use, although these factors did not account for all of the variability. In an attempt to further account for this result, we converted pill use to actual doses used on the basis of the narcotic dosing at the time of discharge. We found that patients in the top quartile of narcotic use not only took more pills but also used a greater number of doses than the other groups. Because of the complex nature of pain and narcotic dosing, prescriptions must be individualized for each patient. Physicians should also be aware that a group of patients may require more medication than average for unclear reasons.

The current study had several limitations. We followed patients only for 4 weeks postoperatively but, by this time, most patients had pain scores comparable to those at baseline and had discontinued their use of narcotic medication. The most important limitation and source of potential error and bias was the reliance on self-reporting of medication use. There was no independent way to verify the accuracy of the numbers. However, both pill use and pain scores followed trajectories in line with past clinical experience, suggesting that these data are likely reliable. Additionally, the surveys were designed to track pill use. Pill requirements are obviously very different for a younger patient weighing 50 kg than for a mature 100-kg male patient, so we also evaluated the number of doses used as determined by the prescription provided. We chose the pill-use metric because it provided a straightforward way for patients to report their weekly narcotic use. Although initial consideration was given to standardization with use of morphine equivalence tables, we elected not to do so because of their variability and lack of acceptance²⁵⁻²⁷. Furthermore, we felt that a simple, practical metric such as the number of pills used would make it easy for the patient and family to assess the variable and would provide the most clinically relevant data to surgeons.

Among the strengths of the current study, it was prospective, included consecutively recruited patients, and controlled variations by means of a single diagnosis and procedure involving a standardized surgical technique and standardized postoperative pain management protocol. The study characterized pain levels as well

as typical narcotic requirements after surgery for a spectrum of patients. Both narcotic use and actual pain levels steadily dropped over a 4-week period. Although the top quartile of patients used more medication for a longer period of time, by the fourth week, the average pill use was minimal in each group. Pain scores also returned to their preoperative levels. Further refills after this point should be considered with caution. We believe that this study may serve as a valuable reference for both patients and surgeons in preoperative counseling and postoperative surveillance.

Although some narcotic use is inevitable after a major procedure, the surgeon must consider that even legitimate narcotic use by adolescents may increase the potential for abuse by up to 33%²⁸. Furthermore, many patients who abuse narcotics obtain them from family and friends⁵, and 11% of high school seniors have reported a history of nonmedical opioid use⁴. Interestingly, although approximately one-third of the patients planned to keep the medication for future use, we did not find an association between narcotic requirement and disposal plans. When asked, 67% of the patients said they planned to dispose of the unused medications and 80% indicated they would do so by 3 months postoperatively. Only 1 patient (2%) planned to keep the unused medication indefinitely. However, of those planning disposal, only 59% planned to use a method suggested by the FDA, such as a local drug take-back program, mixing it with an "unpalatable" substance and then throwing it into the trash, or flushing it down the toilet²⁰. Relatively few patients are aware of local take-back programs and proper disposal methods. We consider discussion of narcotic use and disposal to be an important component of the 1-month postoperative visit, as most patients should have no further need for opioids beyond this time point. This important educational opportunity could help decrease abuse of narcotics.

In conclusion, postoperative narcotic dosing may be improved by considering patient weight, sex, age, and preoperative pain level. It is important to recognize that there is no single reliable predictor of postoperative opioid requirements and ultimately, there is no practical way of managing postoperative pain without at least some patients having narcotic medication left over. It is important to balance patient comfort and safety with the scope of the opioid epidemic. The results of our study suggest that the most practical way to limit misuse would be through a combination of patient-based dosing, careful consideration of refill necessity, and effective patient education. Around 1 month postoperatively, we suggest careful assessment of narcotic use and educating patients about proper disposal methods.

Appendix

 The survey questions asked of patients and the primary surgeon are available with the online version of this article as a data supplement at jbjs.org. ■

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