Original Study

Effects of immediate post-operative pain medication on length of hospital stay: does it make a difference?

Aladine A. Elsamadicy[1], Owoicho Adogwa[2], Jared Fialkoff[2], Victoria D. Vuong[1], Ankit I. Mehta[3], Raul A. Vasquez[4], Joseph Cheng[5], Carlos A. Bagley[6], Isaac O. Karikari[1]

[1]Department of Neurosurgery, Duke University Medical Center, Durham, North Carolina, USA; [2]Department of Neurosurgery, Rush University Medical Center, Chicago, Illinois, USA; [3]Department of Neurosurgery, the University of Illinois at Chicago, Chicago, Illinois, USA; [4]Department of Neurosurgery, University of Kentucky, Lexington, Kentucky, USA; [5]Department of Neurosurgery, Yale University, New Haven, Connecticut, USA; [6]Department of Neurosurgery, University of Texas South Western, Dallas, Texas, USA

Correspondence to: Owoicho Adogwa, MD, MPH. Department of Neurosurgery, Rush University Medical Center, 1725 W Harrison, Suite 855, Chicago, Illinois, USA. Email: owoicho.adogwa@gmail.com.

Background: Patient reported outcomes and length of hospital stay (LOS) are being used as a proxy for hospital care. An extra day of hospitalization costs thousands of health care dollars. The choice of intraoperative pain medications has been associated with decreased pain scores in other surgical subspecialties. However, the effects of immediate post-operative patient-controlled analgesics (PCA)/intravenous (IV) pain medication on patient care are not well understood in spine surgery. The aim of this study is to determine the effects of different immediate post-operative pain medications on post-operative complications profile, LOS, and patient reported outcomes (PROs) after elective spine surgery.

Methods: The medical records of 230 patients (morphine: n=98, fentanyl: n=61, hydromorphone: n=71) undergoing elective spine surgery at a major academic medical center were reviewed. Patients were categorized by the immediate post-operative pain medication they were on, with the most common medications being PCA/IV morphine, fentanyl, and hydromorphone. Patient demographics, comorbidities, and post-operative complication rates were collected. All patients had retrospectively collected outcomes measures and a minimum of 6-month follow up. Patient reported outcomes instruments [Oswestry Disability Index (ODI), SF-36 and Neck/Back/Leg-Pain Visual Analog Scale (VAS-NP/BP/LP)] were completed before surgery, then at 3- and 6-month after surgery.

Results: Baseline characteristics were similar in all cohorts. Operative variables were also similar in all cohorts, with no difference in operative time, estimated blood loss (EBL), or fusion levels. Complication rates were similar between cohorts, with the fentanyl-cohort having an increased percentage of urinary tract infection (UTI) than the morphine and hydromorphone cohorts (16.39% *vs.* 5.15% *vs.* 5.63%, P=0.0277). The morphine-cohort had a decreased LOS than the fentanyl and hydromorphone cohorts (4.18 *vs.* 5.56 *vs.* 5.69 days, P=0.0376). There was a significant difference in the number of feet first ambulated by the patient post-operatively for the morphine and hydromorphone cohorts than the fentanyl-cohort (morphine: 118.44±18.15 *vs.* fentanyl: 59.26±20.78 *vs.* hydromorphone: 125.91±19.85, P=0.0420). There was no significant differences in 30-day hospital readmission rates between the cohorts, morphine-cohort did trend lower than the other cohorts (morphine: 5.10 *vs.* fentanyl: 11.48 *vs.* hydromorphone: 11.27, P=0.2492). There were no significant differences in PROs between the two cohorts in ODI, SF-36, and VAS-NP/BP/LP at baseline, 3- and 6-month.

Conclusions: Our study demonstrates that the choice of immediate post-operative pain medication can make a difference in the hospital course for patients. Identifying these types of factors might help increase patient care and reduce health care costs.

Keywords: Spine surgery; narcotics; length of hospital stay (LOS); patient reported outcomes (PROs); 30-day readmission

Submitted Oct 06, 2016. Accepted for publication Mar 22, 2017.
doi: 10.21037/jss.2017.04.04
View this article at: http://dx.doi.org/10.21037/jss.2017.04.04

Introduction

In the past decade, there has been a national effort to decrease the soaring health care expenditures and identify quality metrics to value hospital care. In surgery, length of hospital stay (LOS) has progressively become a cost-metric that is used to value the financial impact of procedures performed by a hospital (1,2). Along with economic considerations, LOS has also been used as a proxy for quality and even a predictor of morality after particular major surgeries (3,4). Therefore, identifying variables and risk-factors that lead to increased LOS is necessary to reduce the disparaging health care costs and quality of care after surgery.

In particular, post-operative pain has been associated with increased LOS and decrease patient reported outcomes (PROs). In a retrospective study of 411 patients who underwent orthopedic surgery, Morrison *et al.* found that post-operative pain scores was significantly associated with increased LOS and decreased ambulation status (5). Furthermore, prior studies have associated increased post-operative narcotic consumption with increasing post-operative pain (6). Patient-controlled analgesics (PCA) morphine, fentanyl, and hydromorphone are common post-operative pain medications that are used frequently after spine surgery. Appropriately control post-operative pain, while increasing patient satisfaction is a factor that providers and institutions are becoming increasingly emphasized (7). However, as prior studies have found associations between post-operative pain and LOS, the effect of the immediate post-operative pain medication administered is relatively unknown.

The aim of this study is to determine the effects of different immediate post-operative pain medications on the post-operative complications profile, LOS, and PROs after elective spine surgery.

Methods

This was a retrospective analysis of a prospectively collected database. A total of 230 medical records patients were retrospectively reviewed of adult patients undergoing elective spine surgery at a major academic medical center from 2008 to 2010. Institutional review board approval was obtained prior to study's initiation (Duke IRB Protocol: 00066331). All patients underwent elective spine fusion for degenerative disk disease or spinal deformity. All patients in this study had baseline, 6- and 12-month PROs data. The operating surgeon decided the postoperative pain medication with input by the anesthetist. Patients were categorized by the immediate post-operative pain medication they were given (morphine: n=98, fentanyl: n=61, hydromorphone: n=71). We identified all unplanned readmissions within 30 days of discharge after indexed spine surgery.

Demographic variables evaluated included patient age, gender, and body mass index (BMI). Co-morbidities included diabetes, chronic obstructive pulmonary disease (COPD), coronary artery disease (CAD), peripheral vascular disease (PVD), hypertension (HTN), atrial fibrillation (AFib), and congestive heart failure (CHF). Other preoperative variables collected were smoking status and baseline albumin level. Operative variables included length of surgery, number of vertebral levels involved, estimated blood loss (EBL) and urinary output (UOP). Post-operative complications included LOS, urinary tract infection (UTI), pneumonia, deep and superficial surgical site infections (SSI), deep venous thrombosis (DVT), pulmonary embolism (PE), cardio-pulmonary arrest, and 30-day readmission rate. Other post-operative variables collected were number of feet walked at first ambulation and number of feet walked at discharge date.

Patient reported outcomes metrics were collected and compared between both cohorts (morphine: n=98, fentanyl: n=61, hydromorphone: n=71) before surgery, then 3- and 6-month after surgery. Functional status was determined by the Oswestry Disability Index (ODI) (8). Neck, back and leg pain were assessed using the neck/back/leg-pain visual analog scale (VAS-NP, VAS-BP, VAS-LP) (9). SF-36 physical component score (PCS) and mental component score (MCS) was used for the assessment of physical and mental health status, respectively (10). These questionnaires have been validated, widely used and accepted in spine research.

Parametric data were expressed as means ± standard deviation (SD) and compared via ANOVA. Nominal data

were compared with the chi-square test. All tests were two sided and were statistically significant if the P value was less than 0.05. Statistical analysis was performed using JMP-12.0 by SAS.

Results

A total of 230 adult patients (morphine: n=98, fentanyl: n=61, hydromorphone: n=71) were included. There was no significant difference in age between all groups (morphine: 56.53±12.62 years *vs.* fentanyl: 58.80±13.56 years *vs.* hydromorphone: 54.32±13.85 years, P=0.1555) (*Table 1*). No significant differences in BMI between groups were observed (morphine: 29.65±6.19 *vs.* fentanyl: 30.80±7.42 *vs.* hydromorphone: 29.87±7.63, P=0.5882) (*Table 1*). More males were in the morphine cohort, compared to the fentanyl and hydromorphone cohorts (morphine: 42.86% male *vs.* fentanyl: 40.98% male *vs.* hydromorphone: 36.62% male, P=0.7134) (*Table 1*). No significant differences in albumin between groups were observed (morphine: 3.72±0.17 *vs.* fentanyl: 3.47±0.18 *vs.* hydromorphone: 3.51±0.16, P=0.5465) (*Table 1*). No significant differences in chronic steroid use between groups were observed (morphine: 12.24% *vs.* fentanyl: 11.48% *vs.* hydromorphone: 14.08%, P=0.8944) (*Table 1*). There were no significant differences between groups in the prevalence of other co-morbidities such diabetes, COPD, HLD, CAD, PVD, CHF HTN, AFib, and smoking status (*Table 1*).

There was no significant difference in mean ± SD duration of surgery (minutes) for the cohorts (morphine: 176.12±8.48 mins *vs.* fentanyl: 202.57±10.74 mins *vs.* hydromorphone: 194.94±9.96 mins, P=0.1211) (*Table 1*). The mean ± SD EBL (mL) for the groups were (morphine: 523.2±641.34 mL *vs.* fentanyl: 883.83±1,289.27 mL *vs.* hydromorphone: 714.09±1,049.27 mL, P=0.0871) (*Table 1*). There were no significant difference in the median number of levels operated on (P=0.0672) and UOP (P=0.4617) between patient cohorts (*Table 1*).

30-day readmission rates and post-operative complication profile

There was no significant difference in 30-day readmission rates between patient cohorts, but morphine patients tended towards lower rates (morphine: 5.10% *vs.* fentanyl: 11.48% *vs.* hydromorphone: 11.27%, P=0.2492) (*Table 1*). The morphine-cohort had a decreased length of in-hospital when compared to the fentanyl and hydromorphone cohorts (morphine: 4.18±0.43 days *vs.* fentanyl: 5.56±0.54 days *vs.* hydromorphone: 5.69±0.50 days, P=0.0376) (*Table 1*). Number of feet ambulated at discharge were similar between the cohorts (morphine: 244.88±16.49 ft. *vs.* fentanyl: 195.60±20.32 ft. *vs.* hydromorphone: 215.26±18.4 ft., P=0.1566) (*Table 1*). However there was a significance difference in number of feet first ambulated (morphine: 118.44±18.15 ft. *vs.* fentanyl: 59.26±20.78 ft. *vs.* hydromorphone: 125.91±19.85 ft., P=0.0420) (*Table 1*).

The prevalence of post-operative complications were similar between all cohorts except UTI which was significant (morphine *vs.* fentanyl *vs.* hydromorphone) UTI (5.15% *vs.* 16.39% *vs.* 5.63%, P=0.0277), pneumonia (1.03% *vs.* 3.28% *vs.* 2.82%, P=0.5830), deep SSI (1.02% *vs.* 3.28% *vs.* 1.41%, P=0.5522), superficial SSI (0.87% *vs.* 1.64% *vs.* 0.00%, P=0.5863), other infections (5.10% *vs.* 6.56% *vs.* 5.63%, P=0.9280) (*Table 1*). No patient had a DVT or PE (*Table 1*).

Pre-operative baseline pain, functional disability and quality of life in patients undergoing elective spine surgery

There were no significant differences in baseline functional disability and quality of life between the cohorts. The mean ± SD ODI score for morphine, fentanyl, and hydromorphone cohorts were 47.16±2.55, 45.00±3.20, 50.16±3.16, P=0.5152, respectively (*Table 2*). The mean ± SD VAS-NP score for morphine, fentanyl, and hydromorphone cohorts were 2.74±1.35, 5.68±2.18, 6.71±1.75, P=0.1750, respectively (*Table 2*). The mean ± SD VAS-LP score for morphine, fentanyl, and hydromorphone cohorts were 4.09±0.70, 2.67±1.19, 3.88±1.00, P=0.5845, respectively (*Table 2*). The mean ± SD VAS-BP score for morphine, fentanyl, and hydromorphone cohorts were 4.56±0.69, 5.17±1.15, 5.83±0.94, P=0.5484, respectively (*Table 2*). The mean ± SD SF-36 PCS score for morphine, fentanyl, and hydromorphone cohorts were 28.07±1.09, 28.64±1.33, 26.00±1.30, P=0.3192, respectively (*Table 2*). The mean ± SD SF-36 MCS score for morphine, fentanyl, and hydromorphone cohorts were 45.14±1.72, 43.21±2.11, 41.20±2.10, P=0.3496, respectively (*Table 2*).

3-month post-operative pain, functional disability and quality of life in patients undergoing elective spine surgery

There were no significant differences in 3-month post-

Table 1 Baseline preoperative, operative, and postoperative variables

Variable	Morphine (n=98)	Fentanyl (n=61)	Hydromorphone (n=71)	P value
Preoperative baseline variables				
Male (%)	42.86	40.98	36.62	0.7134
Age at surgery (years)	56.53±12.62	58.80±13.56	54.32±13.85	0.1555
BMI (kg/m^2)	29.65±6.19	30.80±7.42	29.87±7.63	0.5882
Albumin (g/dL)	3.72±0.17	3.47±0.18	3.51±0.16	0.5465
Chronic steroid use (%)	12.24	11.48	14.08	0.8944
Smoker (%)	26.53	16.39	19.72	0.2840
COPD (%)	2.04	0.00	1.41	0.5420
HLD (%)	16.33	18.03	11.27	0.5151
CAD (%)	9.18	13.11	7.04	0.4898
PVD (%)	2.04	6.56	5.63	0.3242
CHF (%)	1.02	0.00	2.82	0.3448
HTN (%)	52.04	59.02	45.07	0.2778
AFib (%)	0.00	1.64	4.23	0.1161
Operative variables				
Operative time (min)	176.12±8.48	202.57±10.74	194.94±9.96	0.1211
EBL (mL)	523.2±641.34	883.83±1,289.27	714.09±1,049.27	0.0871
UOP	402.74±52.85	483.88±63.42	490.76±58.89	0.4617
Fusion levels	2.69±0.31	3.33±0.39	3.79±0.36	0.0672
Postoperative variables				
LOS (days)	4.18±0.43	5.56±0.54	5.69±0.50	0.0376
UTI (%)	5.15	16.39	5.63	0.0277
Pneumonia (%)	1.03	3.28	2.82	0.5830
Deep surgical site infection (%)	1.02	3.28	1.41	0.5522
Superficial surgical site infection (%)	0.87	1.64	0.00	0.5863
Other infection (%)	5.10	6.56	5.63	0.9280
DVT (%)	0.00	0.00	0.00	0.00
PE (%)	0.00	0.00	0.00	0.00
First post-op ambulation (feet)	118.44±18.15	59.26±20.78	125.91±19.85	0.0420
Ambulation at discharge (feet)	244.88±16.49	195.60±20.32	215.26±18.4	0.1566
30-day readmission rate (%)	5.10	11.48	11.27	0.2492

Data expressed as mean SD or number (%); values significant at the P<0.05 level are in bold. BMI, body mass index; COPD, chronic obstructive pulmonary disease; HLD, hyperlipidemia; CAD, coronary artery disease; PVD, peripheral vascular disease; CHF, congestive heart failure; HTN, hypertension; Afib, atrial fibrillation; EBL, estimated blood loss; UOP, urinary output; UTI, urinary tract infection; DVT, deep vein thrombosis; PE, pulmonary embolism.

Table 2 Baseline, three-month, and six-month patient reported outcomes

Variable	Morphine (n=98)	Fentanyl (n=61)	Hydromorphone (n=71)	P value
Baseline patient reported outcomes measures				
ODI	47.16±2.55	45.00±3.20	50.16±3.16	0.5152
VAS-NP	2.74±1.35	5.68±2.18	6.71±1.75	0.1750
VAS-LP	4.09±0.70	2.67±1.19	3.88±1.00	0.5845
VAS-BP	4.56±0.69	5.17±1.15	5.83±0.94	0.5484
SF-36 PCS	28.07±1.09	28.64±1.33	26.00±1.30	0.3192
SF-36 MCS	45.14±1.72	43.21±2.11	41.20±2.10	0.3496
Three-month patient reported outcomes measures				
ODI	35.51±2.68	35.47±3.47	43.42±3.23	0.1281
VAS-NP	2.95±1.71	5.60±2.11	3.34±2.36	0.6058
VAS-LP	1.59±0.58	1.00±0.79	0.36±0.82	0.4746
VAS-BP	3.23±0.68	1.19±0.90	4.33±0.93	0.0545
SF-36 PCS	31.44±1.52	32.65±1.85	28.75±1.79	0.2974
SF-36 MCS	44.50±1.88	49.87±2.38	42.42±2.26	0.0691
Six-month patient reported outcomes measures				
ODI	37.07±3.12	40.09±4.37	39.17±3.80	0.8305
VAS-NP	6.84±13.90	4.42±3.63	3.88±3.31	0.7388
VAS-LP	1.11±0.69	1.22±0.98	3.09±0.89	0.1952
VAS-BP	1.78±0.76	2.67±1.07	3.00±0.97	0.5811
SF-36 PCS	33.17±1.50	31.80±2.12	29.84±1.85	0.3812
SF-36 MCS	43.85±2.23	45.20±3.09	42.84±2.75	0.8496

ODI, Oswestry Disability Index; VAS-NP, Neck-Pain Visual Analog Scale; VAS-BP, Back-Pain Visual Analog Scale; VAS-LP, Leg-Pain Visual Analog Scale; PCS, physical component score; MCS, mental component score.

operative pain, functional disability and quality of life between the cohorts. The mean ± SD ODI score for morphine, fentanyl, and hydromorphone cohorts were 35.51±2.68, 35.47±3.47, 43.42±3.23, P=0.1281, respectively (*Table 2*). The mean ± SD VAS-NP score for morphine, fentanyl, and hydromorphone cohorts were 2.95±1.71, 5.60±2.11, 3.34±2.36, P=0.6058, respectively (*Table 2*). The mean ± SD VAS-LP score for morphine, fentanyl, and hydromorphone cohorts were 1.59±0.58, 1.00±0.79, 0.36±0.82, P=0.4746, respectively (*Table 2*). The mean ± SD VAS-BP score for morphine, fentanyl, and hydromorphone cohorts were 3.23±0.68, 1.19±0.90, 4.33±0.93, P=0.0545, respectively (*Table 2*). The mean ± SD SF-36 PCS score for morphine, fentanyl, and hydromorphone cohorts were 31.44±1.52, 32.65±1.85, 28.75±1.79, P=0.2974, respectively (*Table 2*). The mean ± SD SF-36 MCS score for morphine, fentanyl, and hydromorphone cohorts were 44.50±1.88, 49.87±2.38, 42.42±2.26, P=0.0691, respectively (*Table 2*).

6-month post-operative pain, functional disability and quality of life in patients undergoing elective spine surgery

There were no significant differences in in 6-month post-operative pain, functional disability and quality of life between the cohorts. The mean ± SD ODI score for morphine, fentanyl, and hydromorphone cohorts were 37.07±3.12, 40.09±4.37, 39.17±3.80, P=0.8305,

respectively (*Table 2*). The mean ± SD VAS-NP score for morphine, fentanyl, and hydromorphone cohorts were 6.84±13.90, 4.42±3.63, 3.88±3.31, P=0.7388, respectively (*Table 2*). The mean ± SD VAS-LP score for morphine-, fentanyl-, and hydromorphone-cohorts were 1.11±0.69, 1.22±0.98, 3.09±0.89, P=0.1952, respectively (*Table 2*). The mean ± SD VAS-BP score for morphine-, fentanyl-, and hydromorphone-cohorts were 1.78±0.76, 2.67±1.07, 3.00±0.97, P=0.5811, respectively (*Table 2*). The mean ± SD SF-36 PCS score for morphine-, fentanyl-, and hydromorphone-cohorts were 33.17±1.50, 31.80±2.12, 29.84±1.85, P=0.3812, respectively (*Table 2*). The mean ± SD SF-36 MCS score for morphine-, fentanyl-, and hydromorphone-cohorts were 43.85±2.23, 45.20±3.09, 42.84±2.75, P=0.8496, respectively (*Table 2*).

Discussion

In this retrospective cohort study, our study demonstrates that the choice of immediate post-operative pain medication administered was associated with varying LOS after elective spine surgery. Specifically, we found that patients who are administered PCA morphine immediately after surgery had a shorter LOS, compared to patients administered fentanyl or hydromorphone.

Previous studies have demonstrated various associations between the efficacies of different pain medications on post-operative pain and complication profiles after surgery. However, most studies do not find any differences. In a prospectively, randomized-controlled trial of 636 patients who underwent a major surgery, Viscusi *et al.* found that there was no significant differences in pain satisfaction after 24 hrs between PCA fentanyl versus PCA morphine (P=0.36) (11). Furthermore, the authors also found no significant differences in the last VAS score measured (P=0.45) (11). Similarly, in another prospective study of 50 gynecological surgery patients receiving either PCA morphine or PCA hydromorphone after surgery, Hong *et al.* found no significant differences in the side effect profiles between the cohorts, which included nausea, vomiting, or pruritus (12). Furthermore, the authors showed no differences in post-operative pain scores 8 hours after surgery (12). Conversely, there are some studies that identified differences in complication profiles between different post-operative pain medications. In a prospective study of 90 children who were administered either morphine *vs.* fentanyl *vs.* hydromorphone after orthopedic surgery, Goodarzi *et al.* demonstrated that patients administered morphine after surgery experienced higher rates of respiratory depression, prolonged somnolence, urinary retention than patients who were administered fentanyl or hydromorphone (13). Furthermore, the authors concluded that hydromorphone was associated with the least side-effects compared to morphine and fentanyl (13). Our study did not demonstrate a difference in post-operative PROs, but did show an increased complication incidence of UTI in the fentanyl cohort compared to the other cohorts.

There are not many studies that have demonstrated differences in LOS based on the type of post-operative pain medication administered. In a retrospective cohort study of 329 patients who underwent abdominal surgery and whose post-operative pain regiment was either acetaminophen versus non-acetaminophen (i.e., morphine, fentanyl, and hydromorphone), Madere *et al.* showed no significant differences in LOS between the cohorts. However, the authors did observe a significant difference in pain scales, with the non-acetaminophen cohort having lower pain (14). Interestingly, in a study of 174 patients who underwent total joint arthroplasty, Sing *et al.* demonstrated that patients who are preoperatively opioid users have significantly longer LOS when compared to patients who were not opioid users (15). Our understanding of how pain medications effect LOS remains relatively unknown. However, our study demonstrated that patients who were administered morphine had a shorter LOS, compared to patients who were administered fentanyl or hydromorphone.

Other various studies have attempted to find an association between different administration techniques of pain medication regiments and LOS; however, there are conflicting results. In a retrospective study of 198 undergoing surgery, Brown *et al.* did not find a significant difference in LOS between patients who were administered their pain medication PCA *vs.* non-PCA (16). However, the authors did show that patients on PCA used significantly more medication than patients on a non-PCA (16). Conversely, in another study identifying the use of PCA and intramuscular (IM) analgesia, Conner *et al.* demonstrated that patients that used PCA had a shorter LOS compared to patients who received their analgesia via IM (17). In a retrospective study of 50 consecutive patients who underwent posterior spinal instrumentation and fusion, Van Boerum *et al.* found that patients who received their analgesia via epidural were discharged earlier than patients who were on PCA (18). Conversely, in a prospective study of 74 patients who underwent lumbar spinal fusion, Fisher *et al.* demonstrated no significant difference in overall

patient satisfaction and LOS between patients receiving their analgesia via PCA versus epidural (19).

Overall, there is no consensus on the type and administration technique of post-operative pain medications to significantly reduce post-operative pain. The selection of post-operative analgesia is a complex decision made by the provider that may need to incorporate various factors including patient characteristics and surgical approach to identify the optimal regiment. There have been some studies suggesting that preoperative subjective pain tolerance strongly predicts acute pain level after surgery (20). However, further studies are necessary to adequately identify the most appropriate pain regiment and type of pain medication that will achieve superior post-operative outcomes and decrease LOS after surgery.

This study has limitations, ensuing possible implications for its interpretation. Patients were not randomized to the three test conditions (morphine, fentanyl, hydromorphone), which may contribute to biased selection. Additionally, the amount of analgesic titrated into each patient were not standardized for each group. The duration and quality of pain were not observed in this study. While pre- and perioperative variables were prospectively recorded into the study registry at the time of surgery, these variables were retrospectively analyzed for the purpose of this study and are subject to the weakness of a retrospective analysis. Despite these limitations, this study has demonstrated that the choice of opioid analgesic might have implications in postoperative recovery and LOS.

Conclusions

Our study demonstrates that the choice of immediate post-operative pain medication can make a difference in the hospital course for patients. Identifying these types of factors might help increase patient care and reduce health care costs.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: Institutional review board approval was obtained prior to study's initiation (Duke IRB Protocol: 00066331).

References

1. Krell RW, Girotti ME, Dimick JB. Extended length of stay after surgery: complications, inefficient practice, or sick patients? JAMA Surg 2014;149:815-20.
2. Cohen ME, Bilimoria KY, Ko CY, et al. Variability in length of stay after colorectal surgery: assessment of 182 hospitals in the national surgical quality improvement program. Ann Surg 2009;250:901-7.
3. Wright CD, Gaissert HA, Grab JD, et al. Predictors of prolonged length of stay after lobectomy for lung cancer: a Society of Thoracic Surgeons General Thoracic Surgery Database risk-adjustment model. Ann Thorac Surg 2008;85:1857-65; discussion 1865.
4. Farjah F, Lou F, Rusch VW, et al. The quality metric prolonged length of stay misses clinically important adverse events. Ann Thorac Surg 2012;94:881-7; discussion 887-8.
5. Morrison RS, Magaziner J, McLaughlin MA, et al. The impact of post-operative pain on outcomes following hip fracture. Pain 2003;103:303-11.
6. Rivkin A, Rivkin MA. Perioperative nonopioid agents for pain control in spinal surgery. Am J Health Syst Pharm 2014;71:1845-57.
7. Uquillas CA, Capogna BM, Rossy WH, et al. Postoperative pain control after arthroscopic rotator cuff repair. J Shoulder Elbow Surg 2016;25:1204-13.
8. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976) 2000;25:2940-52; discussion 2952.
9. Zanoli G, Strömqvist B, Jönsson B. Visual analog scales for interpretation of back and leg pain intensity in patients operated for degenerative lumbar spine disorders. Spine (Phila Pa 1976) 2001;26:2375-80.
10. Ware JE Jr. SF-36 health survey update. Spine (Phila Pa 1976) 2000;25:3130-9.
11. Viscusi ER, Reynolds L, Chung F, et al. Patient-controlled transdermal fentanyl hydrochloride vs intravenous morphine pump for postoperative pain: a randomized controlled trial. JAMA 2004;291:1333-41.
12. Hong D, Flood P, Diaz G. The side effects of morphine and hydromorphone patient-controlled analgesia. Anesth Analg 2008;107:1384-9.
13. Goodarzi M. Comparison of epidural morphine, hydromorphone and fentanyl for postoperative pain control in children undergoing orthopaedic surgery.

Paediatr Anaesth 1999;9:419-22.
14. Tyler C. Madere, Jennifer B. Mendez, Sarah T. Nordmeyer, et al. Evaluation of intravenous acetaminophen on length of stay in abdominal surgery patients. Hospital Pharmacy 2016;51:230-6.
15. Sing DC, Barry JJ, Cheah JW, et al. Long-Acting Opioid Use Independently Predicts Perioperative Complication in Total Joint Arthroplasty. J Arthroplasty 2016;31:170-4:e1.
16. Brown ST, Bowman JM, Eason FR. A comparison of patient-controlled analgesia versus traditional intramuscular analgesia in postoperative pain management. J Intraven Nurs 1993;16:333-8.
17. Conner M, Deane D. Patterns of patient-controlled analgesia and intramuscular analgesia. Appl Nurs Res 1995;8:67-72.
18. Van Boerum DH, Smith JT, Curtin MJ. A comparison of the effects of patient-controlled analgesia with intravenous opioids versus Epidural analgesia on recovery after surgery for idiopathic scoliosis. Spine (Phila Pa 1976) 2000;25:2355-7.
19. Fisher CG, Belanger L, Gofton EG, et al. Prospective randomized clinical trial comparing patient-controlled intravenous analgesia with patient-controlled epidural analgesia after lumbar spinal fusion. Spine (Phila Pa 1976) 2003;28:739-43.
20. Cuff DJ, O'Brien KC, Pupello DR, et al. Evaluation of factors affecting acute postoperative pain levels after arthroscopic rotator cuff repair. Arthroscopy 2016;32:1231-6.

Cite this article as: Elsamadicy AA, Adogwa O, Fialkoff J, Vuong VD, Mehta AI, Vasquez RA, Cheng J, Bagley CA, Karikari IO. Effects of immediate post-operative pain medication on length of hospital stay: does it make a difference? J Spine Surg 2017;3(2):155-162. doi: 10.21037/jss.2017.04.04

Contributions: (I) Conception and design: O Adogwa, AA Elsamadicy; (II) Administrative support: IO Karikari, CA Bagley, J Cheng, RA Vasquez, AI Mehta; (III) Provision of study materials or patients: IO Karikari, CA Bagley; (IV) Collection and assembly of data: O Adogwa, AA Elsamadicy, J Fialkoff, VD Vuong; (V) Data analysis and interpretation: O Adogwa, AA Elsamadicy; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

