ผลการระงับปวดในห้องพักฟื้นของผู้ป่วยที่มารับการผ่าตัดกระดูกสันหลังส่วนเอว ภายหลังจากนำแนวปฏิบัติการจัดการความปวดแบบจำเพาะกับการผ่าตัดกระดูกสันหลัง ของมหาวิทยาลัยขอนแก่นมาใช้

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บทคัดย่อ

การผ่าตัดกระดูกสันหลังส่วนเอวทำให้เกิดการบาดเจ็บต่อเนื้อเยื่อ ข้อต่อ และกล้ามเนื้อ ส่งผลให้เกิดอาการปวดเฉียบพลันหลังผ่าตัดได้ระดับรุนแรง จากการทบทวนข้อมูลภายในหน่วยงานช่วง พ.ศ. 2560-2562 พบสัดส่วนผู้ป่วยที่มีความปวดระดับปานกลางถึงรุนแรงในห้องพักฟื้น (PACU) สูงร้อยละ 70.5-74.4 หน่วยงานจึงพัฒนาแนวปฏิบัติการระงับปวดจำเพาะสำหรับการผ่าตัดกระดูกสันหลัง (KKU PROSPECT) และนำมาใช้ตั้งแต่ พ.ศ. 2563 เพื่อยกระดับมาตรฐานการระงับปวดหลังผ่าตัดในผู้ป่วยกลุ่มนี้ การศึกษานี้เป็นการวิจัยย้อนหลังเชิงพรรณนาในผู้ป่วยอายุ ≥18 ปี จำนวน 179 ราย ที่เข้ารับการผ่าตัดกระดูกสันหลังส่วนเอวแบบไม่เร่งด่วน ณ โรงพยาบาลศรีนครินทร์ ผู้วิจัยรวบรวมข้อมูลพื้นฐานและข้อมูลการผ่าตัด พร้อมตัวชี้วัด ได้แก่ คะแนนความปวดเมื่อมาถึง PACU และก่อนออกจาก PACU ปริมาณการใช้มอร์ฟีนใน PACU ชนิดของยาระงับปวดที่ได้รับ อัตราการปฏิบัติตามแนวทาง และภาวะแทรกซ้อน ผลการศึกษาพบว่า ค่ามัธยฐาน (พิสัยควอไทล์) ของคะแนนความปวดเมื่อมาถึง PACU เท่ากับ 3 (0-7) โดยมีผู้ป่วยที่มีความปวดระดับปานกลางถึงรุนแรงร้อยละ 45.8 ขณะที่สัดส่วนผู้ป่วยที่ไม่ปวด หรือปวดน้อยก่อนออกจาก PACU เพิ่มเป็นร้อยละ 82.1 ค่ามัธยฐาน (พิสัยควอไทล์) ของปริมาณมอร์ฟีนที่ใช้ใน PACU เท่ากับ 6 (3-8) มิลลิกรัม และต่ำกว่าอย่างมีนัยสำคัญทางสถิติในกลุ่มที่มาถึงด้วยอาการปวดน้อยเมื่อเทียบกับกลุ่มที่มาถึงด้วยอาการปวดปานกลางถึงรุนแรง [3 (1-6) เทียบกับ 8 (6-10) มิลลิกรัม, $p<0.0001$] ไม่พบภาวะแทรกซ้อนจากการได้รับมอร์ฟีน การปฏิบัติตามแนวทางครบถ้วนอยู่ที่ร้อยละ 38.6 ไม่ครบเนื่องจากมีข้อห้ามใช้ยาร้อยละ 29.1 และไม่ครบแม้ไม่มีข้อห้ามร้อยละ 32.4 การนำแนวปฏิบัติ KKU PROSPECT มาใช้สัมพันธ์กับการควบคุมความปวดระยะต้นที่ดีขึ้นหลังผ่าตัดกระดูกสันหลังส่วนเอว อย่างไรก็ตาม ประสิทธิผลอาจเพิ่มได้อีกหากยกระดับการปฏิบัติตามแนวทางให้ครอบคลุมยาพื้นฐานมากขึ้น สื่อสารให้ผู้ป่วยตระหนัก และมีส่วนร่วมในการจัดการความปวด ปรับแบบฟอร์มคำสั่งยาให้ใช้งานง่าย และสอดคล้องหลักฐานปัจจุบัน รวมทั้งติดตามคุณภาพอย่างต่อเนื่อง

คำสำคัญ: การผ่าตัดกระดูกสันหลังส่วนเอว; ความปวดหลังผ่าตัด; การระงับปวด; ห้องพักฟื้น; การจัดการความปวดเฉพาะหัตถการ

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Postoperative pain in the recovery room among patients undergoing lumbar spine surgery after implementing Khon Kaen University Procedure-Specific Pain Management (KKU PROSPECT) Guidelines

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Abstract

Lumbar spine surgery commonly causes significant acute postoperative pain due to soft tissue, joint, and muscle injury. An institutional internal audit (2017-2019) showed that 70.5-74.4% of patients experienced moderate-to-severe pain (NRS ≥4) in the PACU. In 2020, we introduced the Khon Kaen University Procedure-Specific Pain Management for Spine Surgery (KKU PROSPECT) pathway to standardize analgesia for this population. We conducted a retrospective descriptive study of 179 adults undergoing elective lumbar spine surgery at Srinagarind Hospital to assess early postoperative analgesic outcomes following pathway implementation. Data collected included baseline and operative variables, NRS scores on PACU arrival and before discharge, morphine consumption, analgesic modalities used, protocol adherence, and complications. On arrival, the median NRS was 3 (IQR 0-7), with 45.8% reporting NRS ≥4; before discharge, 82.1% had none-to-mild pain. Median PACU morphine use was 6 mg (IQR 3-8), significantly lower in patients arriving with none-to-mild pain compared with those with moderate-to-severe pain (3 [1-6] vs 8 [6-10] mg; $p<0.0001$). No opioid-related complications were observed. Pathway adherence was complete in 38.6% of cases, incomplete due to contraindications in 29.1%, and incomplete without contraindications in 32.4%. Implementation of the KKU PROSPECT pathway was associated with improved early postoperative pain control. Further gains may be achieved by increasing adherence (e.g., using prescriber prompts and simplified order sets), strengthening patient education, updating recommendations to reflect current evidence, and continuing systematic quality monitoring.

Keywords: lumbar spine surgery; postoperative pain; analgesia; post-anaesthesia care unit; procedure-specific pain management

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Introduction

Spinal disorders requiring surgical interventions represent a significant health concern affecting both men and women, particularly among working-age adults and the elderly. The most commonly affected region is the lumbar spine (53%), followed by the cervical spine (27%)[1]. A predominant symptom in this patient population is low back pain, especially among individuals aged 20-60 years[2]. Recent evidence, however, indicates an increasing prevalence of low back pain in younger individuals[3]. The majority of cases are attributed to age-related degenerative changes and occupational or postural factors, which contribute to chronic low back pain and may be accompanied by lower-extremity numbness or weakness. These symptoms directly impair activities of daily living and diminish overall quality of life.

Spinal surgery causes substantial trauma to tissues, joints, muscles, and vertebral structures, resulting in severe acute postoperative pain. Inadequate pain management can adversely affect multiple physiological systems. Cardiovascular consequences include tachycardia and elevated blood pressure, along with increased myocardial oxygen consumption[4]. Respiratory complications may include atelectasis and impaired gas exchange. Gastrointestinal and metabolic sequelae include reduced bowel motility, while psychological effects such as anxiety and insomnia may also occur[5]. These factors collectively delay postoperative recovery, prolong hospital length of stay, and increase healthcare costs. Moreover, poorly controlled acute postoperative pain may progress to chronic postsurgical pain, a challenging condition associated with long-term impairment in quality of life[6].

The rate of lumbar spine surgery has risen rapidly, largely due to population aging. Projections indicate that by 2025, the number of adults and older individuals requiring spinal surgery will increase by up to 59%[7]. According to the 2022 statistics from the Strategy and Planning Division, Ministry of Public Health of Thailand, 6,738 inpatients were treated for spinal and intervertebral disc disorders, with numbers expected to continue rising in parallel with national demographic trends[8]. Internal data from Srinagarind Hospital, Faculty of Medicine, Khon Kaen University, similarly demonstrate a yearly increase in spinal surgeries, with 438, 581, and 684 cases reported in 2021-2023, respectively. The majority of these procedures involved the lumbar spine, accounting for 58.2%, 58.0%, and 62.7% of cases in each respective year[9-11].

Data from the Department of Anesthesiology between 2017 and 2019 reveal that patients undergoing spinal surgery experienced moderate to severe postoperative pain in the post-anesthesia care unit (PACU). The proportion of patients reporting pain scores ≥4 in the PACU was 72.7%, 70.5%, and 74.4% in each respective year. Due to the high burden of postoperative pain management in this population, a procedure-specific pain management guideline was developed in 2020: the “Khon Kaen University Procedure-Specific

Pain Management for Spine Surgery (KKU PROSPECT)" (Figure 1). This guideline incorporates the principles of multimodal analgesia (MMA), combining acetaminophen, non-steroidal anti-inflammatory drugs (NSAIDs), dexamethasone, ketamine, and local anesthetics administered either via surgeon-performed local infiltration analgesia (LIA) or anesthesiologist-performed erector spinae plane block (ESPB). The primary objectives of this protocol are to enhance postoperative analgesia and to reduce perioperative opioid consumption.

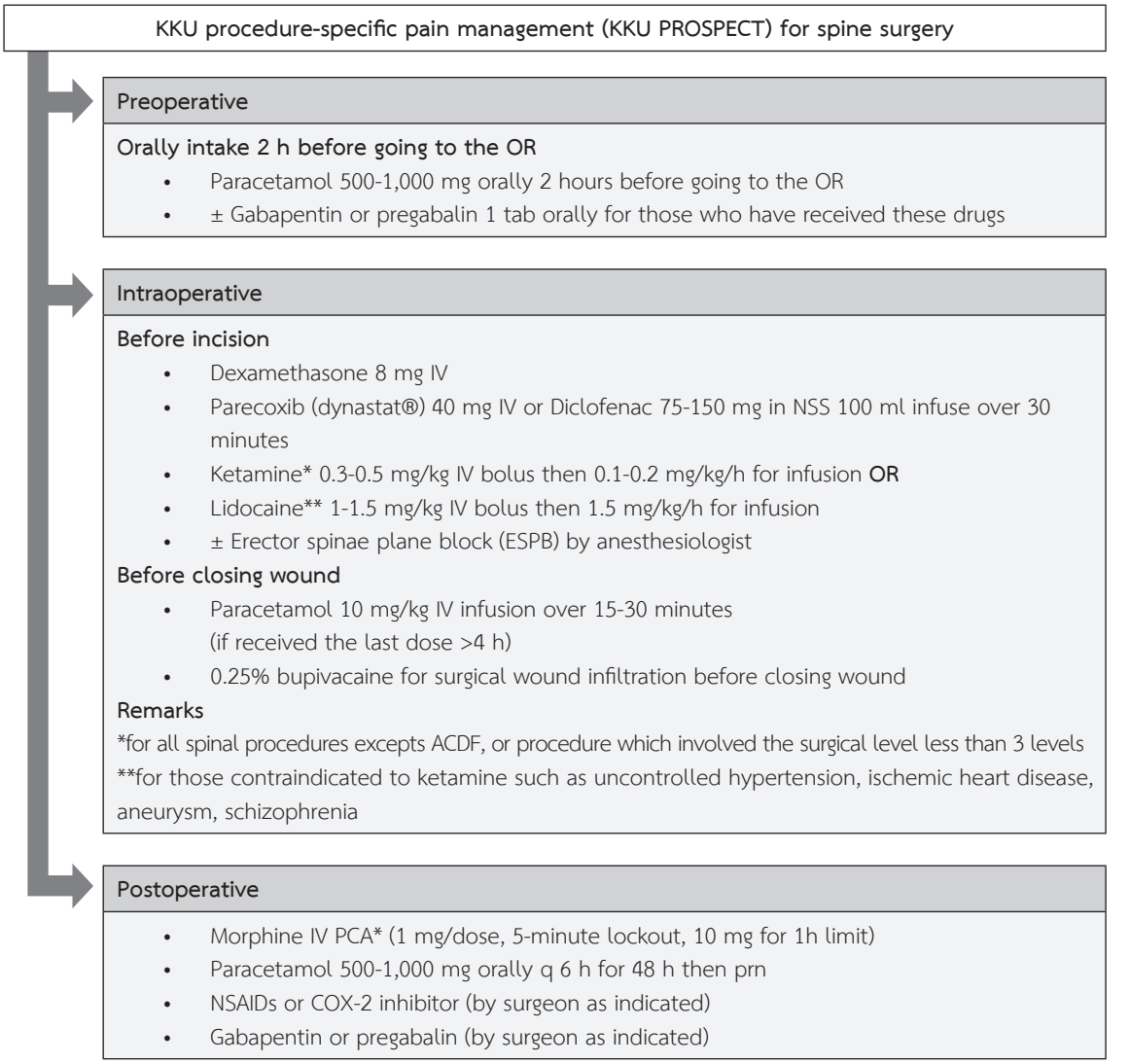

Figure 1 Khon Kaen University Procedure-Specific Pain Management for Spine Surgery (KKU PROSPECT) indicating multimodal analgesia strategy during preoperative, intraoperative and postoperative period

This protocol was adapted from the PROSPECT (Procedure-Specific Pain Management) guidelines for laminectomy and complex spine surgery[12-15], which have been published in international peer-reviewed journals. The modifications were made to ensure suitability within the Thai healthcare context, including the selection of medications listed in the National List of Essential Medicines and covered by national healthcare reimbursement schemes, thereby promoting equitable access to analgesic management for all patient groups. The protocol has been implemented in the department since January 2022, following structured training sessions for healthcare personnel to ensure correct and consistent application.

The objective of this study is to evaluate the effectiveness of postoperative analgesia following lumbar spine surgery under the KKU PROSPECT protocol, as well as to identify potential challenges and barriers encountered during its implementation. The findings will be used to further refine and enhance pain management strategies for patients undergoing spine surgery, with the goal of improving overall analgesic outcomes and quality of care.

Materials and Methods

This study employed a retrospective descriptive clinical design and included patients aged ≥18 years who underwent elective lumbar spine surgery under general anesthesia and received postoperative pain management according to the KKU PROSPECT pathway. Data was collected from surgeries performed between June 2022 and December 2023 at Srinagarind Hospital, Faculty of Medicine, Khon Kaen University.

Eligibility criteria consisted of adult patients undergoing elective lumbar spine procedures who were subsequently admitted to the post-anesthesia care unit (PACU). Exclusion criteria were patients who received spinal anesthesia or epidural anesthesia as surgical anesthesia, or were transferred directly to an intensive care unit without PACU admission.

A total of 191 lumbar spine surgeries were identified within the study period. Of these, 179 cases met the inclusion criteria and had no exclusion factors; these constituted the final study cohort. Data collection commenced following approval from the Khon Kaen University Human Research Ethics Committee (HE681012), and the study was registered with the Thai Clinical Trials Registry (TCTR20251117011).

All patients underwent general anesthesia (GA) and received multimodal analgesia (MMA) according to the KKU PROSPECT protocol as follows:

1. Preoperative period:

Patients were administered oral paracetamol 500-1,000 mg, depending on body weight, 2 hours before surgery. Those who were already taking gabapentin or pregabalin as part of their chronic pain regimen continued their usual dose.

2. Intraoperative period:

Before skin incision, patients received 8 mg of intravenous dexamethasone and

either 40 mg of intravenous parecoxib or 75-150 mg of diclofenac diluted in 100 mL of 0.9% normal saline and infused intravenously.

For surgeries involving three or more lumbar levels, patients received intravenous ketamine 0.3-0.5 mg/kg as a bolus followed by an infusion at 0.1-0.2 mg/kg/h. If ketamine was contraindicated—such as in cases of poorly controlled hypertension, ischemic heart disease, aneurysm, schizophrenia, or other relevant contraindications—intravenous lidocaine was used instead (1-1.5 mg/kg bolus followed by 1.5 mg/kg/h infusion). Only one agent (ketamine or lidocaine) was selected. The infusion was discontinued once the surgeon began wound closure.

Once wound closure began, intravenous paracetamol 10 mg/kg was administered only if more than 4 hours had passed since the patient's last oral dose. The surgeon then performed local infiltration analgesia using 0.25% bupivacaine in an appropriate volume, ensuring that the total dose did not exceed 2 mg/kg.

3. Postoperative period:

Patients received oral paracetamol 500-1,000 mg every 6 hours during the first 48 hours postoperatively, after which it was prescribed on an as-needed basis. NSAIDs or selective COX-2 inhibitors, as well as gabapentin or pregabalin, were considered according to the surgeon's assessment of indications and contraindications for each patient. For those undergoing surgery involving three or more lumbar levels, intravenous patient-controlled analgesia (IV PCA) with morphine was considered, using a regimen of 1 mg per demand, a 5-minute lockout interval, and a maximum dose of 10 mg per hour.

At the end of surgery, the anesthesiologist discontinued anesthetic agents, reversed neuromuscular blockade, and extubated the patient following standard criteria before transferring them to the post-anesthesia care unit (PACU). Upon PACU arrival, patients underwent routine monitoring, including blood pressure, heart rate, electrocardiography, respiratory rate, oxygen saturation, level of consciousness, and pain assessment using the numeric rating scale (NRS).

For patients with an NRS ≥4, opioid analgesics either fentanyl 0.5-1 mcg/kg or morphine 0.05-0.1 mg/kg were administered to relieve pain, followed by reassessment every 15 minutes. Opioid administration was accompanied by close monitoring for adverse effects, including respiratory depression (respiratory rate and oxygen saturation monitoring) and sedation, with opioids given only when the sedation score was <2. If patients experienced nausea or vomiting, ondansetron or metoclopramide was administered at the discretion of the anesthesiologist. If the NRS remained ≥4 despite opioid treatment, an additional opioid dose or an alternative analgesic agent was considered as appropriate.

Data for analysis was extracted from the hospital's electronic records and recorded in a structured data collection form, including:

1. General patient information: sex, age, height, weight, body mass index (BMI), the American Society of Anesthesiologists'

Physical Status (ASA-PS), type of surgery, number of lumbar levels operated, duration of surgery, estimated blood loss, and intraoperative opioid consumption.

2. Opioid consumption in the PACU: total morphine dose in milligrams. For patients receiving fentanyl, doses were converted to morphine equivalents using the conversion of 10 mcg IV fentanyl = 1 mg IV morphine.[16]

3. Pain scores on PACU arrival and before PACU discharge.

4. Opioid-related adverse effects, including nausea and vomiting score (0 = none, 1 = mild, 2 = requiring treatment, 3 = persistent symptoms despite treatment), sedation score (0 = alert, 1 = occasional drowsiness, 2 = drowsy/easily arousable, 3 = unarousable), and respiratory depression, defined as respiratory rate <8 breaths per minute.

5. Analgesic administration according to the KKU PROSPECT pathway, recording the types and number of analgesic agents each patient received.

After data collection was completed, statistical analysis was performed. Categorical variables were summarized as percentages and compared using the Chi-squared test or Fisher's exact test, as appropriate. Continuous variables were assessed for normality using the Kolmogorov–Smirnov test. Normally distributed data were reported as mean ± standard deviation, while non-normally distributed data were reported as median with interquartile range (IQR). Between-group comparisons were performed using the independent t-test or Mann–Whitney U test, depending on data distribution. All analyses were conducted using Stata version 17.0 (StataCorp LLC, College Station, TX), with statistical significance set at $p<0.05$.

Results

Baseline demographic and surgical characteristics of the study population are summarized in Table 1. The cohort consisted predominantly of middle-aged to older adults undergoing elective lumbar spine surgery, with most patients classified as ASA physical status II. Decompressive laminectomy was the most common procedure, and the majority of surgeries involved one to two operated lumbar levels. Operative duration and estimated blood loss were within ranges typical for elective lumbar spine surgery.

Table 1 Demographic data and surgical details

Characteristics	Frequency (%)/mean ± SD (n = 179)
Sex	
Female	98 (54.8)
Male	81 (45.2)
Age (years)	57.2 ± 13.23
<20	1 (0.5)
20-39	23 (12.9)
40-59	74 (41.3)
≥60	81 (45.3)
ASA PS	
I	32 (17.9)
II	134 (74.9)
III	13 (7.2)
BMI (kg/m^2)	25.1 ± 4.1
Type of surgery	
Decompressive laminectomy	117 (65.4)
Spinal fusion	62 (34.6)
Number of operated spinal level(s)	
1	54 (30.2)
2	80 (44.6)
3	34 (19.0)
4	10 (5.6)
5	1 (0.6)
Duration of surgery (minutes)	145.8 ± 53.8
Blood loss (mL)	237.2 ± 271.0

Table 2 shows the distribution of NRS pain scores on arrival to the PACU and before discharge. The distribution of pain scores shifted toward lower intensity before discharge, with a higher proportion of patients reporting none-to-mild pain and fewer patients reporting severe pain compared with arrival. The median NRS remained the same at both time points.

Table 2 NRS at arrival and before leaving PACU

	PACU arrival (n = 179)	Before leaving PACU (n = 179)
NRS (median (IQR))	3 (0-7)	3 (2-3)
Number of patients in each pain intensity (n, (%))	3 (0-7)	3 (2-3)
NRS 0 (no pain)	64 (35.8)	27 (15.1)
NRS 1-3 (mild)	33 (18.4)	120 (67.0)
NRS 4-6 (moderate)	29 (16.2)	28 (15.6)
NRS 7-10 (severe)	53 (29.6)	4 (2.3)

Table 3 shows morphine consumption during PACU stay. Morphine use differed according to pain intensity at PACU arrival, with higher consumption observed among patients presenting with moderate-to-severe pain compared with those presenting with none-to-mild pain.

Table 3 Morphine consumption during PACU stay

	Morphine consumption (mg) (median (IQR))	*p*-value
Overall (n = 179)	6 (3-8)	-
Classified by pain intensity at PACU arrival		
No pain (n = 64)	2 (0-5)	-
Mild pain (n = 33)	3 (0-5)	-
Moderate pain (n = 29)	6 (3-8)	-
Severe pain (n = 53)	7 (4-9)	-
Classified by target pain intensity (NRS <4, ≥4)		
None to mild pain (n = 97)	3 (1-6)	<0.0001[a]
Moderate to severe pain (n = 82)	8 (6-10)	

[a]*Wilcoxon rank-sum test (two-sided)*

Table 4 summarizes adherence to the KKU PROSPECT pathway and the number of analgesic agents received. Only a minority of patients received the complete set of recommended analgesic components, whereas incomplete adherence occurred both in the presence and absence of documented contraindications. Patients with complete adherence more frequently received a greater number of analgesic modalities, while those with incomplete adherence tended to receive fewer agents.

Table 4 Protocol adherence and number of analgesic agents received

Protocol adherence	Number of analgesic agent(s) received					Total n (%)
	1, n (%)	2, n (%)	3, n (%)	4, n (%)	5, n (%)	
Complete	0 (0.0)	0 (0.0)	0 (0.0)	51 (73.9)	18 (26.1)	69 (38.6)
Incomplete (contraindication)	3 (5.8)	27 (51.9)	16 (30.8)	6 (11.5)	0 (0.0)	52 (29.0)
Incomplete (no contraindication)	1 (1.7)	10 (17.2)	37 (63.8)	10 (17.2)	0 (0.0)	58 (32.4)
Overall	4 (2.2)	37 (20.7)	53 (29.6)	67 (37.4)	18 (10.1)	179 (100)

No opioid-related adverse effects were observed in the PACU; specifically, no patients met criteria for respiratory depression, excessive sedation, or nausea and vomiting.

Discussion

This retrospective descriptive study evaluated early postoperative analgesic outcomes in the PACU following implementation of the procedure-specific KKU PROSPECT pathway for elective lumbar spine surgery. Compared with pre-implementation data from 2017-2019, the proportion of patients presenting to the PACU with moderate-to-severe pain (NRS ≥4) decreased from 70.5-74.4% to 45.8%, indicating improved early pain control associated with pathway implementation. Nevertheless, more than half of patients still reported NRS ≥4 on arrival, consistent with previous reports showing that postoperative pain after spine surgery remains a significant challenge despite advances in multimodal analgesia[12-14]. These findings suggest that while the pathway improves outcomes, further optimization is necessary to achieve desired pain control targets.

Pain control improved substantially during PACU stay. The median NRS before discharge was 3 (IQR 2-3), and the proportion of patients reporting none-to-mild pain increased from 45.8% on arrival to 82.1% at discharge. This likely reflects active PACU-based pain management, including repeated pain assessment, opioid titration, and the cumulative effects of non-opioid analgesics. However, the persistence of moderate-to-severe pain in a subset of patients before discharge indicates that optimal pain control was not universally achieved, underscoring the need for continued refinement of perioperative analgesic strategies.

Morphine consumption in the PACU differed significantly according to pain severity on arrival. Patients presenting with moderate-to-severe pain required substantially higher morphine doses than those with none-to-mild pain (median 8 mg vs 3 mg, $p<0.0001$). Although no opioid-related adverse events were observed, increased opioid requirements inherently raise the risk of undesirable effects, particularly in older adults and patients with hepatic or renal impairment[14]. These findings reinforce the importance of effective multimodal analgesia to reduce reliance on opioids while maintaining adequate pain control.

The KKU PROSPECT pathway aligns with PROSPECT recommendations[12,13] in key principles, particularly the use of paracetamol and NSAIDs or selective COX-2 inhibitors as foundational analgesics and the role of local infiltration analgesia. However, deviations exist due to institutional context, medication availability, and national reimbursement policies. In addition, certain components of the pathway such as routine dexamethasone administration, discretionary use of gabapentinoids, and the limited use of techniques recommended for complex spine surgery may warrant reassessment to ensure closer alignment with current evidence and procedure-specific recommendations.

Adherence to the KKU PROSPECT pathway was suboptimal, with only 38.6% of patients receiving the complete set of recommended analgesic components. Incomplete adherence resulted from both clinical contraindications and non-clinical factors, including prescription omission, variability in provider practice, and financial barriers related to medication coverage. Overall, effective postoperative pain control appeared to be multifactorial rather than dependent on a single intervention. Patients receiving a greater number of analgesic modalities targeting different pain pathways were more likely to achieve acceptable pain control during PACU stay. These findings support the core concept of multimodal analgesia and highlight the need to improve pathway adherence and optimize component selection to further enhance postoperative pain outcomes after lumbar spine surgery.

Conclusions

Implementation of the KKU PROSPECT pathway has contributed to improved acute postoperative pain control following lumbar spine surgery; however, the established targets have not yet been fully achieved. Refining the pathway in accordance with current evidence and reassessing the roles of individual analgesic agents and techniques may further enhance analgesic effectiveness. Strengthening guideline adherence—through clearer prescribing tools and streamlined order sets—may also improve compliance. Ongoing monitoring and periodic evaluation of outcomes will be essential to ensure continuous improvement and to enable the pathway to meet its intended pain management objectives in the future.

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