Postoperative pain-related outcomes and perioperative pain management in China: a population-based study

Yanhong Liu,[a,b,h] Saisong Xiao,[b,c,h] Huikai Yang,[a,d,h] Xuecai Lv,[a] Aisheng Hou,[a] Yulong Ma,[a] Yandong Jiang,[e] Chongyang Duan,[f] and Weidong Mi,[a,b,g,*] CAPOPS Group

[a]Department of Anesthesiology, The First Medical Center of Chinese PLA General Hospital, Beijing, 100853, China
[b]Medical School of Chinese People's Liberation Army, Beijing, 100853, China
[c]Department of Anesthesia, Dongzhimen Hospital, Beijing University of Chinese Medicine, Beijing, 100700, China
[d]School of Medicine, Nankai University, Tianjin, 300071, China
[e]Department of Anesthesiology, McGovern Medical School, University of Texas, Houston Health Science Center, Houston, TX, 77030, USA
[f]Department of Biostatistics, School of Public Health, Southern Medical University, Guangzhou, 510515, China
[g]National Clinical Research Center for Geriatric Diseases, Chinese PLA General Hospital, Beijing, 100853, China

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Summary

Background Postoperative pain poses a significant challenge to the healthcare system and patient satisfaction and is associated with chronic pain and long-term narcotic use. However, systemic assessment of the quality of postoperative pain management in China remains unavailable.

Methods In this cross-sectional study, we analyzed data collected from a nationwide registry, China Acute Postoperative Pain Study (CAPOPS), between September 2019 and August 2021. Patients aged 18 years or above were required to complete a self-reported pain outcome questionnaire on the first postoperative day (POD1). Perioperative pain management and pain-related outcomes, including the severity of pain, adverse events caused by pain or pain management, and perception of care and satisfaction with pain management were analyzed.

Findings A total of 26,193 adult patients were enrolled. There were 48.7% of patients who had moderate-to-severe pain on the first day after surgery, and pain severity was associated with poor recovery and patient satisfaction. The systemic opioid use was 68% on the first day after surgery, and 89% of them were used with intravenous patient-controlled analgesia, while the rate of postoperative nerve blocks was low.

Interpretation Currently, almost half of patients still suffer from moderate-to-severe pain after surgery in China. The relatively high rate of systemic opioid use and low rate of nerve blocks used after surgery suggests that more effort is needed to improve the management of acute postoperative pain in China.

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Keywords: Acute postoperative pain; China; Postoperative pain-related outcomes; Perioperative pain management

Introduction

Around 300 million surgeries are performed annually for different reasons worldwide.[1] However, postoperative pain, as a major surgical complication, poses a significant challenge to the healthcare system by leading to poor outcomes, disability, lengthy hospitalization, and financial burden.[2,3] Inadequate treatment of acute postoperative pain can lead to further complications, such as respiratory tract infections, psychological symptoms, deep vein thrombosis, and chronic pain.[4,5] Furthermore, the financial burden caused by managing postoperative pain and its complications and the social burden caused by absenteeism is also significant. Therefore, preventing acute postoperative pain and improving its management is crucial.

In recent years, many studies on acute pain in the perioperative period have been carried out in Europe, the United States, and other countries or regions,[6,7] all of

*Corresponding author. Department of Anesthesiology, The First Medical Center of Chinese PLA General Hospital, Beijing, 100,853, China.
E-mail address: wwdd1962@aliyun.com (W. Mi).
[h]These authors contributed equally to this study.

Research in context

Evidence before this study

With the development of anesthesia, postoperative pain management has received more and more attention, but compared to western countries, China still lacks a systematic postoperative pain management system, including strategies for identification, prevention, and reporting of high-risk patients, and has never conducted a nationwide survey on the current situation of acute postoperative pain management, which has to a certain extent hindered the development of pain management in China. To this end, we have formed the CAPOPS (China Acute Postoperative Pain Study) Group to conduct a nationwide survey on the status of acute postoperative pain management.

Added value of this study

CAPOPS is the largest survey database on postoperative pain in China and the largest study on the current status of acute postoperative pain in the Asian population. The study analyzed the current status of postoperative acute pain management in China, summarized some of our achievements in postoperative acute pain management, and revealed the current shortcomings and future directions for development and change.

Implications of all the available evidence

From the results of the study, it was found that the current situation of acute postoperative pain in China differs significantly from that of western countries. The reasons for these differences may be multifaceted, but the high proportion of opioid use, the low rate of regional block analgesia, and the high rate of postoperative patient-controlled analgesia with adverse effects still exist. We believe that the CAPOPS database will make a useful contribution to the construction of a postoperative acute pain management system in China and will also provide useful reference data for other related disciplines worldwide.

which have reported a high prevalence of moderate-to-severe pain after surgery and severe pain significantly affects patient activity, mental state, and sleep. Most studies have found a high satisfaction rate with pain treatment in patients with moderate-to-severe pain,[8–13] However, many patients still report dissatisfaction with pain management.[6] The number of surgeries in China is nearly 70 million per year.[14] Most of the published studies on acute postoperative pain in China mainly limited in specific region or a certain type of surgery, and the patient sample were much small.[15–17] In the PAIN-OUT China study,[18–20] we studied acute postoperative pain in 2520 patients from 12 hospitals, from which we got a preliminary understanding of acute postoperative pain in China. Considering the large number of hospitals in China and the significant variation in medical levels among regions, in this study we conducted a survey with 122 research centers to evaluate the current status of acute postoperative pain in China. This study aimed to determine the efficacy of postoperative pain management in China and identify factors associated with sub-optimal post-operative pain management.

Methods

In this observational, cross-sectional study, we analyzed data from a nationwide registry, China Acute Postoperative Pain Study (CAPOPS). CAPOPS is a multicenter registry (https://mazuidata.medbit.cn) in China established to evaluate and analyze acute postoperative pain management and patient-reported outcomes to identify the factors influencing patients' satisfaction with pain treatment and improve pain management. CAPOPS was registered at www.chictr.org.cn (ChiCTR1900025237) on August 17th, 2019, and initiated in September 2019. The CAPOPS registry enrolled surgical patients from 122 centers in China between September 2019 and August 2021. Participating centers were recruited through a call published in eight provinces/regions in mainland China. Among the 122 participating centers (eTable 1 in the Supplement), there were 115 (94.3%) tier 3 hospitals (tertiary hospitals), and 7 (5.7%) were tier 2 hospitals (secondary hospitals, eTable 2 in the Supplement). The protocol for the present study was first reviewed and approved by the Institutional Review Boards (IRB) of the Chinese PLA General Hospital and then approved by each participating center. Written or oral consent was obtained from each participant according to the requirements of the local ethics committee. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines has been followed in this study (STROBE checklist in the Supplement).

Subjects

Patient inclusion criteria for CAPOPS were as follows: patients underwent elective surgery; aged 18 years or above; were on the first postoperative day (POD1) and back on the ward for at least 6 h; consented to take part in a survey assessing pain-related outcomes related with their surgery. Patients were excluded if they did not consent to participate in this study or if their consciousness and cognitive status were compromised to make a judgment on whether to participate in this study.

Patients with missing or "unrated" evaluation of the worst pain, the degree of the mildest pain greater than the worst pain, missing information on anesthesia method, and missing duration of surgery were excluded from the current analysis.

Data collection

Patients were approached once by a trained investigator on POD1. Investigators could include all patients who comply with the inclusion criteria if they have sufficient time to collect data. Otherwise, the investigators were required to select the patients using simple random sampling method. The investigator needed to determine the total number of patients available for interview on that day and assigned a number to each patient. Sample size was decided by the investigator based on the available time for data collection on that day. By using a random number generator or random number tables, a subset of patients was then selected randomly.

During the interview, patients were required to complete the Chinese version of the International Pain Outcome Questionnaire (IPO-Q in the Supplement).[21] The IPO-Q consists of 13 questions evaluating four outcome domains and they include: 1) intensity of pain, including the worst and the least pain scores since surgery (rated on numeric rating score, NRS, 0 = null, 10 = worst possible), the percentage of time spent in severe pain (0%–100%); 2) interference of pain with activities (changing position in bed, taking a deep breath or coughing, getting out of bed, and sleep, the extent also determined by a score analogous to the NRS score (0–10)) and with emotional well-being (anxiety and helplessness, as determined by the NRS score >0); 3) side effects of pain treatment, including nausea, drowsiness, itching, and dizziness, as determined by the NRS score >0; and 4) perception of care, treatment satisfaction and involvement in pain treatment decision-making with NRS (0–10), whether patients wished for more treatment (yes/no) and received information about pain treatment options (yes/no). Patients were also asked about the existence and severity of a persistent painful condition lasting 3 months before surgery. The questionnaire's psychometric properties have been validated in English and translated, using standardized methodology, into 29 languages.[21]

The investigator reviewed the patient's medical records and filled in the process questionnaire, which included patient demographics, comorbidities, pre-admission opioid use, analgesic given peri-operatively, and type of anesthesia and surgery. Data were entered online at the participating centers and reviewed by the central center to perform additional data quality checks. In case of missing data or irregularities, an inquiry would be made.

Outcomes

The primary outcome was the prevalence of moderate-to-severe pain on POD1, which was defined as the worst pain score rated on a numeric rating score (NRS, 0 = no pain, 10 = maximum pain) ≥4.[22,23] Post-operative mild, moderate, and severe pain was graded according to the worst pain score on a scale of 0–3, 4–6, and 7–10, respectively[10]; Secondary outcomes included interference of pain, side effects of pain treatment, and perception of pain treatment.

Statistical analysis

Continuous variables were summarized by presenting the median and interquartile range (IQR) for the total number of patients who contributed values. Categorical variables were summarized by presenting each category's frequency and proportion of patients. Difference in demographics, anesthesia and analgesia methods, and patient reported outcomes other than the worst pain between patients with mild pain and those with moderate-to-severe pain was assessed using the $\chi 2$ test or Fisher's exact test (categorical variable), student's t-test, or Mann–Whitney U test (continuous variable) depending on the data distributions and variances, where the normality of data was tested with Shapiro–Wilk test. A complete case analysis was used given the relatively low rate of missing data. Statistical significance was defined using a 2-sided significance level of $\alpha = 0.05$.

Because of the large sample sizes in this study, it is possible to achieve statistical significance in situations where the observed differences are clinically meaningless.[24] Therefore, effect size was reported as Cohen's d for t test and as Cramer's v for $\chi 2$ test[25,26] to evaluate the clinical significance of the observed differences. As suggested by Cohen, a small, moderate, or large meaningful difference exists when effect size of Cohen's d equals or exceeds ±0.2, 0.5, or 0.8, respectively.[25,27] For $\chi 2$ test, a small, moderate, or large meaningful difference exists when effect size of Cramer's v equals or exceeds ±0.1, 0.3, or 0.5, respectively.[26,27] Effect sizes are guides rather than absolutes, and interpreting the response requires personal judgment regarding the practical or clinical importance of the effect.

The prevalence of moderate-to-severe pain in different surgical specialties and in different surgical procedures were estimated with odd ratios (ORs) and 2-sided P values, with values less than 0.05 considered significant. Because of the potential for type I error due to multiple comparisons, Bonferroni correction was used to adjust the P value.

Statistical analyses were performed with SAS software, version 9.4(SAS Institute, Cary, NC).

Role of the funding source

The funder had no role in study design, data collection, data analysis and interpretation of data, nor in the writing of the report and the decision to submit the paper for publication.

Results

In this study, 27,735 cases of surgical patients from 122 centers in eight provinces/regions in mainland China

were screened. A flow chart was drawn according to the inclusion and exclusion criteria of the database (Fig. 1). As shown in Table 1, a total of 26,193 patients entered the final analysis with a median age of 52.0 years (IQR 37.0–63.0) and a median body mass index (BMI) of 24.7 kg/m^2 (IQR 22.3–27.3), and 15,744 (60.1%) cases were women.

Prevalence of moderate-to-severe acute postoperative pain

Overall, 48.7% of the study population had moderate-to-severe acute postoperative pain (worst pain score: 4–10), including 4108 cases (32.2%) with severe postoperative pain (worst pain score: 7–10). There were slight variations in demographics between patients with mild postoperative pain and those with moderate-to-severe pain. The percentage of females was slightly higher in patients with moderate-to-severe pain (7752 cases, 60.8%) than in those with mild pain (7992 cases, 59.5%). The difference in gender proportion was statistically significant between two groups of patients, but the effect size was only 0.0133. A total of 3648 patients had a history of chronic pain prior to surgery, and 2090 of them had moderate-to-severe postoperative pain, and the intensity of pre-existing chronic pain was higher in patients with moderate-to-severe pain than in those with mild pain, which was a medium to small effect size. The median prognostic assessment time was 23.3 h (20.5–26.4) after surgery (Table 1).

The regions with a prevalence of higher than 50% include Beijing, Tianjin, and Guangzhou, while the regions with a prevalence of lower than 50% were Henan, Hebei, Shandong, Liaoning, and Jiangsu (Table 1).

Patients were recruited from 13 surgical specialties, of which orthopedics, general surgery, and gynecology were the most common (Fig. 2A and eTable 3 in the Supplement). The highest prevalence of moderate-to-severe pain was reported in patients from the burn and plastic surgery department (73.1%), followed by thoracic surgery (62.9%), obstetrics (62.0%), and orthopedics (54.1%). The prevalence of postoperative moderate-to-severe pain in patients admitted to these surgical departments was significantly

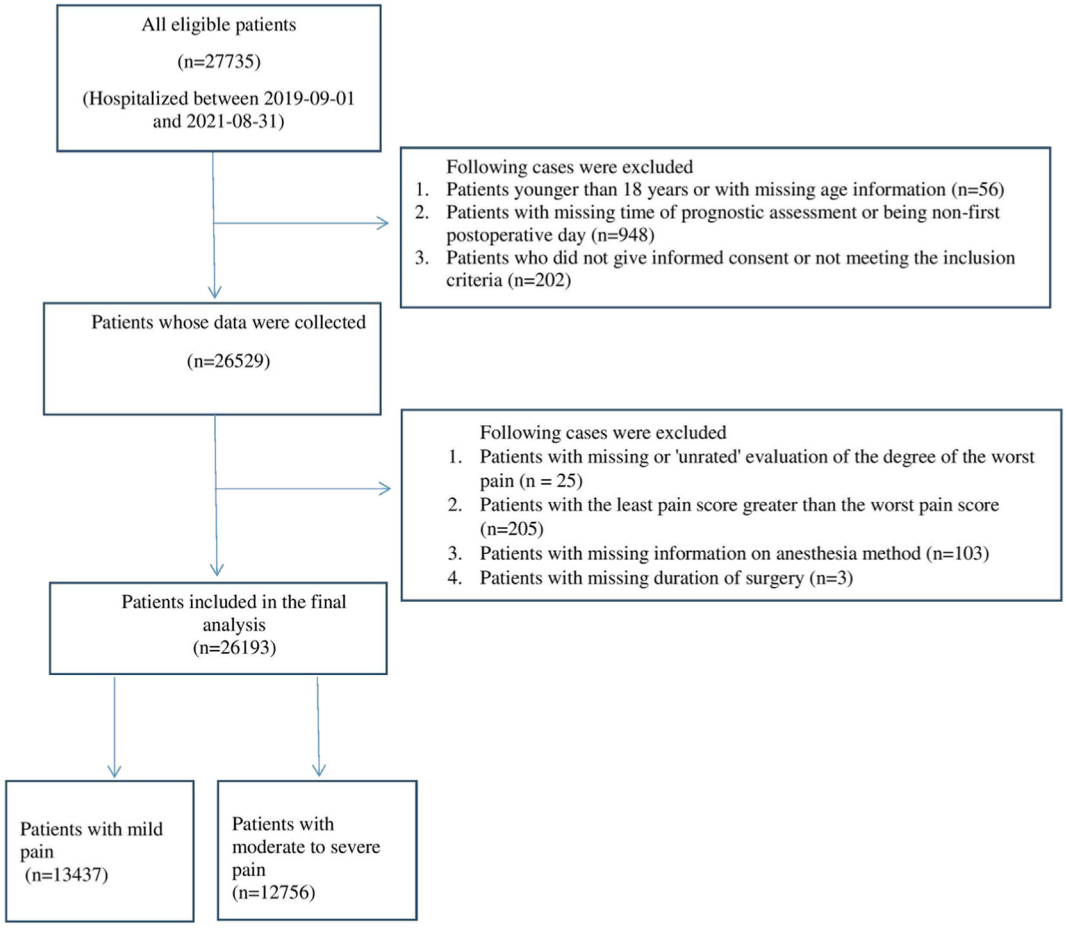

Fig. 1: Case-screening flowchart.

	Total	Degree of the worst pain 0–3	Degree of the worst pain 4–10	*P*-value	Effect size
	(n = 26,193)	(n = 13,437)	(n = 12,756)		
Age (years), n (%)					
<65	20,544 (78.4%)	10,562 (78.6%)	9982 (78.3%)	0.4906	0.0043
≥65	5649 (21.6%)	2875 (21.4%)	2774 (21.7%)		
Gender, n (%)					
Female	15,744 (60.1%)	7992 (59.5%)	7752 (60.8%)	0.0326	0.0133
male	10,449 (39.9%)	5445 (40.5%)	5004 (39.2%)		
BMI* (kg/m^2), median (IQR)	24.7 (22.3–27.3)	24.6 (22.3–27.3)	24.8 (22.3–27.4)	0.0078	0.0253
<18.5, n (%)	945 (3.6%)	442 (3.3%)	503 (3.9%)	0.0002	0.0273
[18.5 24), n (%)	10,055 (38.4%)	5293 (39.4%)	4762 (37.3%)		
[24,28), n (%)	9932 (37.9%)	5079 (37.8%)	4853 (38.0%)		
≥28, n (%)	5261 (20.1%)	2623 (19.5%)	2638 (20.7%)		
History of chronic pain prior to surgery, n (%)	3648 (13.9%)	1558 (11.6%)	2090 (16.4%)	<0.0001	−0.0691
Pre-existing chronic pain: intensity (n = 3606), median (IQR)	5.0 (3.0–7.0)	4.0 (3.0–7.0)	5.0 (3.0–7.0)	<0.0001	0.2992
Use of opioids prior to admission, n (%)	49 (0.2%)	18 (0.1%)	31 (0.2%)	0.0337	0.0161
Use of corticosteroids prior to admission, n (%)	42 (0.2%)	19 (0.1%)	23 (0.2%)	0.4315	0.0049
Pre-operative comorbidities, n (%)	8670 (33.1%)	4149 (30.9%)	4521 (35.4%)	<0.0001	0.0485
Cardiovascular disease	6078 (23.2%)	2985 (22.2%)	3093 (24.2%)	<0.0001	0.0867
Diabetes mellitus	2254 (8.6%)	1032 (7.7%)	1222 (9.6%)		
Malignancy	1364 (5.2%)	562 (4.2%)	802 (6.3%)		
Multiple trauma	335 (1.3%)	168 (1.3%)	167 (1.3%)		
Mental illness	299 (1.1%)	140 (1.0%)	159 (1.2%)		
Pulmonary disease	364 (1.4%)	149 (1.1%)	215 (1.7%)		
Other surgeries	212 (0.8%)	85 (0.6%)	127 (1.0%)		
Gastrointestinal disorders	245 (0.9%)	125 (0.9%)	120 (0.9%)		
Renal diseases	99 (0.4%)	47 (0.3%)	52 (0.4%)		
Fibromyalgia	2 (0.0%)	1 (0.0%)	1 (0.0%)		
Surgical specialties, n (%)					
Burn and plastic surgery	301 (1.1%)	81 (0.6%)	220 (1.7%)	<0.0001	0.1963
Thoracic surgery	2617 (10.0%)	971 (7.2%)	1646 (12.9%)		
Obstetrics	2015 (7.7%)	766 (5.7%)	1249 (9.8%)		
Orthopedics	7960 (30.4%)	3654 (27.2%)	4306 (33.8%)		
Hepatobiliary surgery	1700 (6.5%)	940 (7.0%)	760 (6.0%)		
Otorhinolaryngology	368 (1.4%)	207 (1.5%)	161 (1.3%)		
Gynecology	3077 (11.7%)	1798 (13.4%)	1279 (10.0%)		
General surgery	5137 (19.6%)	3024 (22.5%)	2113 (16.6%)		
Urology	1550 (5.9%)	958 (7.1%)	592 (4.6%)		
Neurosurgery	983 (3.8%)	679 (5.1%)	304 (2.4%)		
Oral and Maxillofacial Surgery	82 (0.3%)	59 (0.4%)	23 (0.2%)		
Cardiovascular surgery	376 (1.4%)	278 (2.1%)	98 (0.8%)		
Ophthalmology	27 (0.1%)	24 (0.2%)	3 (0.0%)		
Duration of surgery (min), median (IQR)	120.0 (70.0–185.0)	115.0 (68.0–180.0)	120.0 (75.0–188.5)	<0.0001	0.0919
Regions, n (%)					
Beijing	10,635 (40.6%)	5027 (47.3%)	5608 (52.7%)	<0.0001	0.0849
Shandong	4025 (15.4%)	2214 (55.0%)	1811 (45.0%)		
Henan	4616 (17.6%)	2573 (55.7%)	2043 (44.3%)		
Liaoning	2685 (10.3%)	1445 (53.8%)	1240 (46.2%)		
Hebei	2351 (9.0%)	1207 (51.3%)	1144 (48.7%)		
Tianjin	1133 (4.3%)	526 (46.4%)	607 (53.6%)		
Jiangsu	607 (2.3%)	387 (63.8%)	220 (36.2%)		
Guangdong	141 (0.5%)	58 (41.1%)	83 (58.9%)		

Data are shown as n(%) or median (interquartile ranges), respectively. BMI*, body mass index, categorized according to China criteria of weight for adults.[28]

Table 1: **Demographic and clinical features of enrolled cases.**

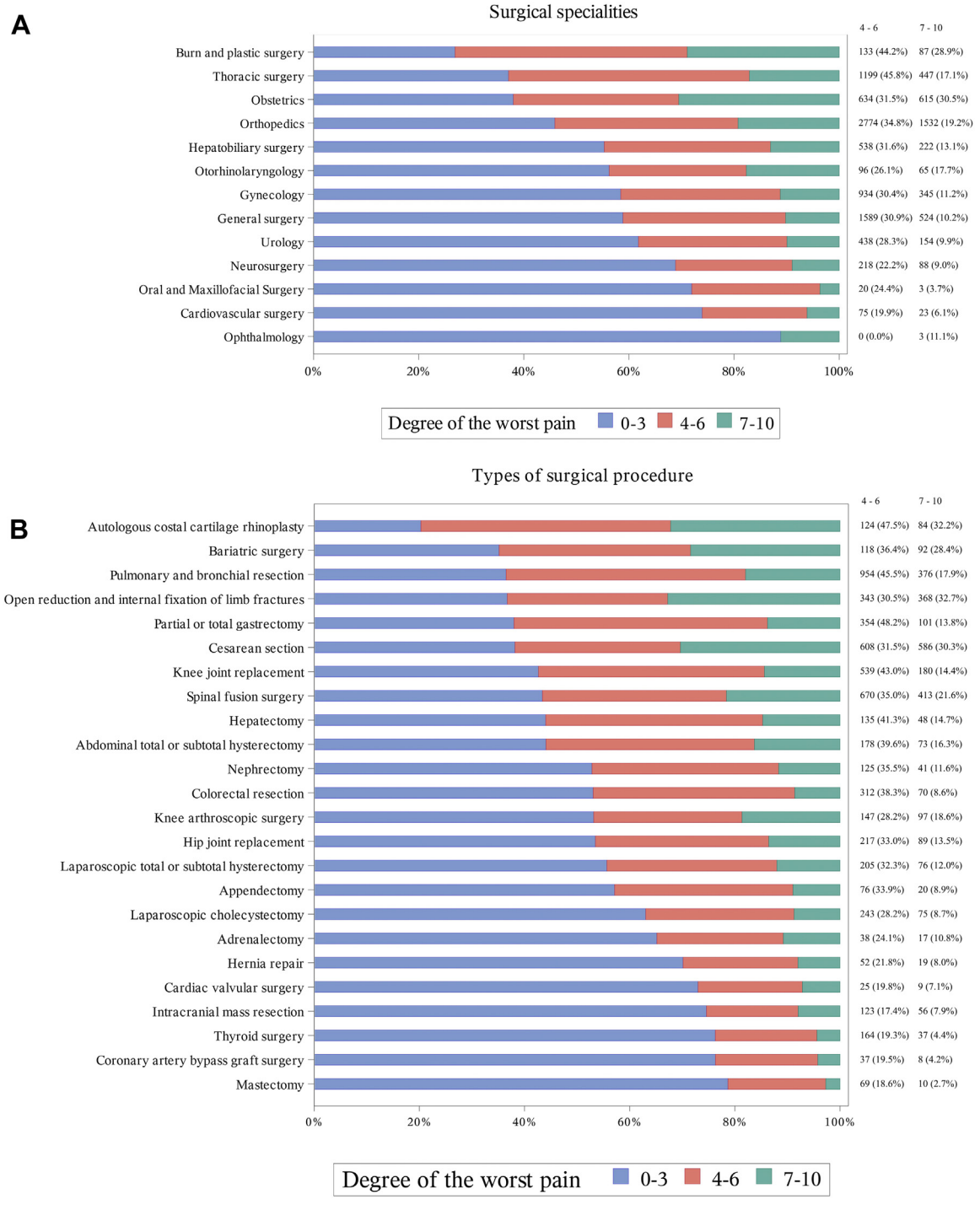

Fig. 2: The prevalence of mild, moderate, and severe acute postoperative pain in different surgical specialties (panel A) and in different surgical procedures (panel B). Panel A shows that obstetrics and burn and plastic surgery has the highest proportion of cases with severe pain (28.90% and 30.52%, respectively), while thoracic surgery and burn and plastic surgery have the highest proportion of cases with moderate pain (45.82% and 44.19%, respectively). Panel B shows that open reduction and internal fixation of limb fractures, cesarean section, and bariatric surgery have the highest prevalence of severe pain (32.74%, 30.33%, and 28.40%, respectively), partial or total gastrectomy, autologous costal cartilage rhinoplasty, and pulmonary and bronchial resection have the highest prevalence of moderate pain (48.23%, 47.51%, and 45.54%, respectively).

higher compared with that in gynecological patients. The prevalence of moderate-to-severe pain varies significantly in different surgical specialties.

We further analyzed the variation of pain severity after 24 surgical procedures with a sample size of more than 100 in our datasets (Fig. 2B and eTable 4 in the Supplement). The prevalence of moderate-to-severe postoperative pain was higher than 60% in patients who received autologous costal cartilage rhinoplasty (79.69%), bariatric surgery (64.81%), pulmonary and bronchial resection (63.48%), open reduction and internal fixation of limb fractures (63.26%), partial or total gastrectomy (61.99%), and cesarean section (61.80%). Although lower than cesarean section, the prevalence of moderate-to-severe pain on POD1 was greater than 40% in patients who received knee joint replacement, spinal fusion surgery, hepatectomy, abdominal total or subtotal hysterectomy, nephrectomy, colorectal resection, knee arthroscopic surgery, hip joint replacement, laparoscopic total or subtotal hysterectomy, and appendectomy. For patients with hernia repair, cardiac valvular surgery, intracranial mass resection, thyroid surgery, coronary artery bypass graft surgery, and mastectomy, the prevalence of moderate-to-severe pain was lower than 30%.

Other pain-related outcomes

Patients reported median least pain score was 1.0 (0.0–2.0), with 1590 cases (6.1%) >3. The percentage of time in severe pain was 10% (0–30%), with 5225 cases (20.0%) >30%. The proportions of pain affecting patients' deep breathing/coughing, sleeping, and in-bed activities in the overall population were 60.6%, 43.0%, and 76.6%, respectively. 38.6% of the patients got out of bed on POD1, and 67.8% of them reported pain interference with out-bed activities.

Patients with moderate-to-severe pain had lower rates of ambulation compared to those with mild pain (35.1% vs. 41.9%, $P < 0.01$). Patients with moderate-to-severe pain reported higher scores for interference of pain with activities. For patients with moderate to severe pain, pain-related anxiety (49.2% vs. 25.5%, $P < 0.01$) and helplessness (35.8% vs. 16.0%, $P < 0.01$) were significantly higher than patients with mild pain, with a medium effect size for difference in anxiety and a small effect size for difference in helplessness.

Among the side effects of pain treatment, nausea, dizziness, and drowsiness were common, with a prevalence of 34.7%, 34.7%, and 29.7%, respectively. Itching was relatively rare. Patients with moderate-to-severe pain had a higher prevalence of the above side effects of postoperative pain treatment than patients with mild pain, with small to medium effect sizes for difference in nausea, dizziness, and drowsiness (Table 2).

There was a statistically significant difference between the two groups in information about treatment options (72.0% vs. 78.1%), but the effect size was

	Total	Degree of the worst pain 0–3	Degree of the worst pain 4–10	*P*-value	Effect size
	n = 26,193	n = 13,437	n = 12,756		
Intensity of pain, median (IQR)					
Least pain score	1.0 (0.0–2.0)	0.00 (0.0–1.0)	2.0 (0.0–3.0)	<0.0001	0.9740
Percentage of time in severe pain (%)	10.0 (0.0–30.0)	10.0 (0.0–20.0)	30.0 (10.0–50.0)	<0.0001	0.9905
Interference of pain with activities and emotional well-being, median (IQR)					
Interference with activities in-bed	3.0 (2.0–5.0)	2.0 (1.0–3.0)	4.0 (3.0–6.0)	<0.0001	1.0773
Getting out of bed, n (%)	10,099 (38.6%)	5627 (41.9%)	4472 (35.1%)	<0.0001	0.0701
Pain interference with out-bed activities	2.0 (1.0–4.0)	2.0 (1.0–3.0)	3.0 (2.0–5.0)	<0.0001	0.9650
Pain interference with breathing deeply/coughing	2.0 (1.0–4.0)	2.0 (1.0–3.0)	3.0 (2.0–5.0)	<0.0001	0.9176
Pain interference with sleeping	2.0 (1.0–5.0)	1.0 (1.0–2.0)	3.0 (2.0–5.0)	<0.0001	0.7807
Anxiety, n (%)	9698 (37.0%)	3422 (25.5%)	6276 (49.2%)	<0.0001	0.3328
Helplessness, n (%)	6717 (25.6%)	2151 (16.0%)	4566 (35.8%)	<0.0001	0.2786
Side effects, n (%)					
Nausea	9089 (34.7%)	4095 (30.5%)	4994 (39.2%)	<0.0001	0.1828
Drowsiness	7776 (29.7%)	3216 (23.9%)	4563 (35.8%)	<0.0001	0.1726
Itching	2374 (9.1%)	1031 (7.7%)	1343 (10.5%)	<0.0001	0.0901
Dizziness	9076 (34.7%)	4060 (30.2%)	5016 (39.3%)	<0.0001	0.1853
Perception of care					
Information about treatment options, n (%)	19,675 (75.1%)	10,494 (78.1%)	9181 (72.0%)	<0.0001	0.0708
Wish for more treatment, n (%)	5790 (22.1%)	2152 (16.0%)	3638 (28.5%)	<0.0001	0.1506
Satisfaction, median (IQR)	9.0 (8.0–10.0)	10.0 (9.0–10.0)	8.0 (7.0–10.0)	<0.0001	0.6291
Participate in treatment decision-making, median (IQR)	9.0 (7.0–10.0)	10.0 (8.0–10.0)	8.0 (5.0–10.0)	<0.0001	0.2921

Data are shown as n(%) or median (interquartile ranges, IQR), respectively.

Table 2: **Other pain-related outcomes.**

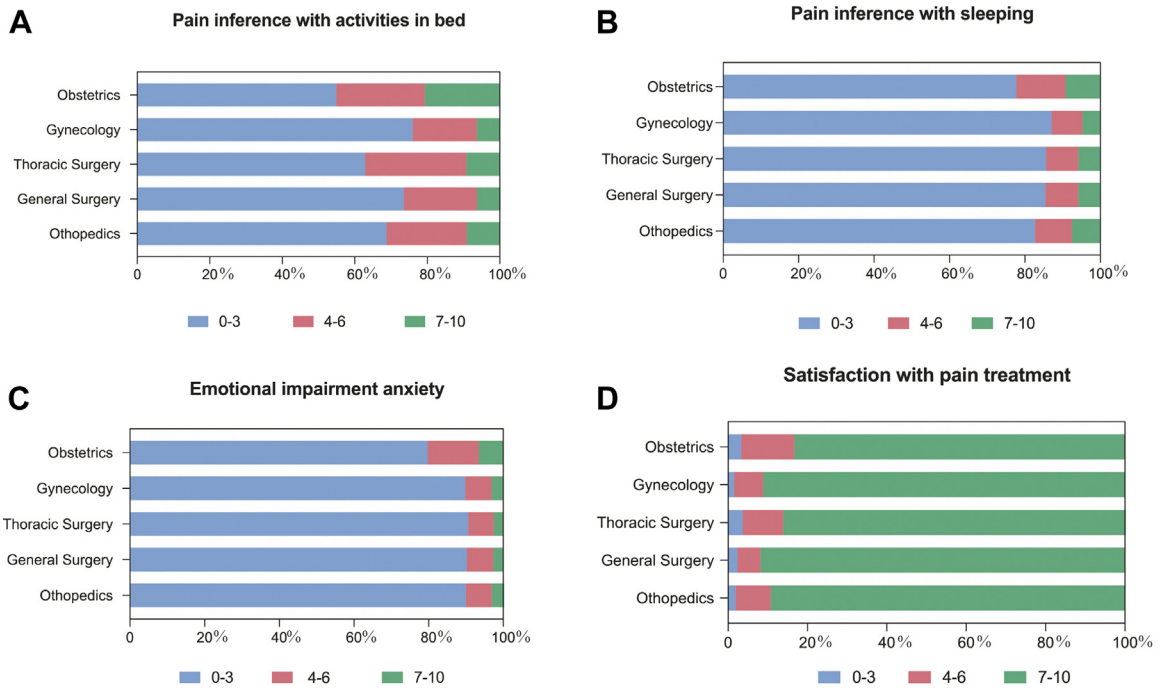

Fig. 3: The distribution of patient reported pain-related outcomes in five disciplines (Obstetrics, Gynecology, Thoracic Surgery, General Surgery, and Orthopedics). Panel A shows pain inference with activities in bed. Panel B shows pain inference with sleeping. Panel C shows Emotional impairment anxiety. Panel D shows satisfaction with pain treatment.

negligible. The average satisfaction with pain treatment was 9[8–10] on a scale of 0–10. Patients with moderate-to-severe pain have significantly lower satisfaction (8 [7–10] vs. 10 [9–10]), this is a medium to large effect size. Similarly, a higher proportion of patients with moderate-to-severe pain wished for more treatment than those with mild pain (28.5% vs. 16.0%, $P < 0.0001$), and this is a small to medium effect size. Patients with moderate-to-severe pain had lower participated in pain treatment decision-making (8 [5–10] vs. 10 [9–10]) than those with mild pain, and this is a small to medium effect sizes (Table 2). The distribution of patient reported pain-related secondary outcomes in five departments with the largest number of patients was shown in Fig. 3.

Anesthesia and analgesia characteristics of the enrolled patients

Our study found that 25.1% of patients were given preoperative medication. Most of the pre-op medications were sedatives (19.3%), followed by non-opioid analgesics (12.6%) and opioid analgesics (11.1%). The use of preoperative opioid analgesics and sedatives in patients with moderate-to-severe pain was significantly lower than that in patients with mild pain, but these effect sizes were negligible (Table 3).

There were 21,465 cases who were administered general anesthesia alone or a combination of general anesthesia and regional anesthesia. Among them, 5209 cases (24.3%) were given a combination of general anesthesia and regional anesthesia. There were 9937 cases who were given regional anesthesia alone or a combination of regional anesthesia and general anesthesia, accounting for 37.9% of all cases. Only 10.4% of cases were administered local anesthetic infiltration intraoperatively. Opioids were the most commonly used intraoperative analgesics (86.1%). The rate of non-opioid analgesic use was 65.4%. Compared with patients with mild pain, patients with moderate-to-severe pain had a higher proportion of combined regional and general anesthesia, a higher rate of intraoperative local anesthetic infiltration, and a lower rate of intraoperative opioid use, but these effect sizes were negligible (Table 3).

Similarly, opioids were also the most frequently used analgesics after surgery (63.7%), followed by non-opioid analgesics (50.8%). Postoperative opioid analgesics were still mainly used in patient-controlled analgesia (PCA) manner (14,897/16,686, 89.3%). The use of postoperative local anesthetics was low (3.3%). We categorized postoperative pain treatment into three categories: opioid analgesic, nonopioid analgesic, and local anesthetics, and found that 75.5% of patients received at least one postoperative analgesia, and the percentage of patients with two or more analgesics was 41.3%. Postoperative use of opioids, nonopioid analgesics, local

	Total	Degree of the worst pain 0–3	Degree of the worst pain 4–10	*P*-value	effect size
	n = 26,193	n = 13,437	n = 12,756		
Pre-operative medication	6573 (25.1%)	3459 (25.7%)	3114 (24.4%)	0.0131	−0.0153
Opioid analgesics	2915 (11.1%)	1767 (13.2%)	1148 (9.0%)	<0.0001	−0.0660
Non-opioid analgesics	3309 (12.6%)	1697 (12.6%)	1612 (12.6%)	0.984	0.0001
Sedatives	5048 (19.3%)	2779 (20.7%)	2269 (17.8%)	<0.0001	−0.0367
Anesthesia method					
General anesthesia	16,256 (62.1%)	8893 (66.2%)	7363 (57.7%)	<0.0001	0.0873
Regional anesthesia	4728 (18.1%)	2140 (15.9%)	2588 (20.3%)		
General + regional anesthesia	5209 (19.9%)	2404 (17.9%)	2805 (22.0%)		
Intraoperative local anesthetic infiltration	2723 (10.4%)	1148 (8.5%)	1575 (12.3%)	<0.0001	0.0623
Intraoperative analgesics					
Opioid analgesics	22,553 (86.1%)	11,656 (86.7%)	10,897 (85.4%)	0.0021	−0.0191
Non-opioid analgesics	17,141 (65.4%)	8732 (65.0%)	8409 (65.9%)	0.1109	0.0099
Postoperative analgesics					
Opioid analgesics	16,686 (63.7%)	8024 (59.7%)	8662 (67.9%)	<0.0001	0.0851
Nonopioid analgesics	13,300 (50.8%)	6371 (47.4%)	6929 (54.3%)	<0.0001	0.0690
Regional anesthesia	876 (3.3%)	321 (2.4%)	555 (4.4%)	<0.0001	0.0545
Postoperative patient-controlled analgesia					
Opioid analgesics	14,897 (56.9%)	7431 (55.3%)	7466 (58.5%)	<0.0001	0.0326
Non-opioid analgesics	6250 (23.9%)	3214 (23.9%)	3036 (23.8%)	0.8222	−0.0014
Postoperative analgesic modalities					
No use	6388 (24.4%)	4074 (30.3%)	2314 (18.1%)	<0.0001	0.1454
One method	8995 (34.3%)	4106 (30.6%)	4889 (38.3%)		
Two methods	10,563 (40.3%)	5161 (38.4%)	5402 (42.3%)		
Three methods	247 (0.9%)	96 (0.7%)	151 (1.2%)		
Number of pain evaluations received within 60 min of receiving analgesic treatment					
0	6715 (25.6%)	3091 (23.0%)	3624 (28.4%)	<0.0001	−0.0619
≥1	1.0 (1.0–2.0)	1.0 (1.0–2.0)	1.0 (1.0–2.0)	0.2465	0.0380

Data are shown as n(%) or median (interquartile ranges, IQR), respectively.

Table 3: **Anesthesia and analgesic characteristics of enrolled patients.**

anesthetics, and PCA was higher in patients with moderate-to-severe pain compared with patients with mild pain. These effect sizes were negligible. The proportion of using two or more multimodal forms of analgesia was higher in patients with moderate-to-severe pain, and this is a small to medium effect size. A higher proportion of patients with moderate-to-severe pain did not receive pain evaluation within 60 min of receiving analgesic treatment compared to those with mild pain (28.4% vs. 23.0%, $P < 0.0001$), but the effect size was negligible (Table 3).

Discussion

The prevalence of moderate-to-severe postoperative pain varies worldwide. According to the literature, the prevalence of moderate-to-severe postoperative pain in the United States and Europe is 86%[6] and 70%.[7] In this observational study, we analyzed patients' reported acute postoperative pain outcomes from the CAPOPS registry, which is the largest database of its kind in China and is based on the Pain-Out project by the European Commission's 7th Framework Programme.[7] We found that the prevalence of moderate-to-severe acute postoperative pain in surgical patients in China was 48.7%, which is significantly lower than those reported in North America and Europe. Multiple studies have reported that Asian populations have better tolerance to pain and require fewer analgesics than their western counterparts.[29–32] In Asian populations, it has also been suggested that Chinese surgical patients have a higher tolerance to pain compared with other Asian populations.[29] Whether these differences is a function of variation in patient/caregivers culture or healthcare provider care is not sure and warrants further investigation. However, since our results also show that moderate-to-severe pain is strongly associated with multiple outcomes, including patients' postoperative physical activity, sleeping, emotion, adverse effects of pain treatment, and patient satisfaction, we believe that improved management of acute pain is urgently needed in China.

Identifying high-risk patients for acute postoperative pain is crucial in the management of acute postoperative pain. There are quite a few literature showing that

female patients are more susceptible to pain than male patients.[33–36] Females generally have a higher risk of developing chronic pain after surgery, and their response to routine pain management is poorer compared to males.[37–39] Our result shows that the prevalence of postoperative pain was slightly more common in females than males. However, the effect size was relatively small, and therefore its clinical significance is limited. This was supported by other researches, in which female gender is not necessarily a strong indicator for worst pain after surgery,[40,41] and postoperative pain scores during rest and movement were almost equal between men and women.[37] Besides the female gender, as shown in our results, other notable factors associated with acute postoperative pain include a history of chronic pain prior to surgery, pre-admission daily opioid use, longer duration of surgery, and high BMI. Further multivariate analysis may help us identify the risk factors affecting acute postoperative pain in Chinese surgical patients.

The prevalence of moderate-to-severe pain varied substantially across regions in our study. Beijing, as the capital of China, has rich medical resources, but the rate of moderate-to-severe pain in Beijing remained above 50%. China currently has a wide variation in the level of medical care between regions,[42] and the medical approach among different medical institutions varies greatly. Therefore, further analysis of the reasons for the differences in pain prognosis between different medical institutions will help us to improve analgesic management.

Surgical factors are one of the most important factors affecting acute postoperative pain, and the degree of postoperative pain varies greatly among patients from different surgical specialties and undergoing different surgeries. This study suggested that surgical patients from burn and plastic surgery had the highest proportion of moderate-to-severe postoperative pain, followed by thoracic surgery, obstetrics, orthopedics, and abdominal surgery, all higher than 50%. In this study, there were 301 cases of burn and plastic surgery, of which 261 cases underwent autologous costal cartilage rhinoplasty, with 209 patients' worst pain scores greater than 3 points (80.0%). A previous study[43] suggests that chest wall pain is very common after autologous costal cartilage rhinoplasty and brings great discomfort to patients, which persists for several weeks after surgery. Therefore, it is suggested that we should pay more attention to postoperative pain in such patients. Since most patients undergoing bariatric surgery are young women with obesity, the pain in such patients is also very significant.[44,45] Postoperative pain in patients undergoing thoracic and abdominal surgery, open fractures, and cesarean section, which are traditionally traumatic and painful stimuli, remains poorly controlled. There are also procedures that are considered less invasive, such as appendectomy (93% of which are laparoscopic appendectomy) and laparoscopic cholecystectomy, where postoperative pain is not as low as expected, Similar observation was described by Gerbershagen et al.[46]

It has been suggested that a more intense multimodal perioperative pain treatment for patients and minimizing opioid use in patients with a high risk of postoperative pain may improve postoperative pain in surgical patients with minimal side effects, better functional recovery, shortened hospitalization length, and lower incidence of chronic pain.[47–50] In this study, preoperative chronic pain was present in 13.93% (3648 cases) of patients with a median pain score of 5 (IQR 3–7), and the use of opioid analgesics before admission was only 0.19% (49 patients), suggesting that preoperative pain is insufficiently treated in China, and opioids are rarely used in these patients. This makes the surgical patient population in China, distinct from those in North America,[51] overwhelmingly opioid naive, which could have affected the patterns of opioid prescribing and pain management for patients undergoing surgical procedures. In this study, we found that, in preoperative medication, patients with moderate-to-severe postoperative pain were significantly less likely to use opioids and sedatives before surgery than patients with mild pain (9.0% vs. 13.5%, 17.8% vs. 20.7%). Systemic use of opioids in the ward was 63.7%, and 89.3% of them were used with intravenous PCA. The rate of the systemic use of opioids and PCA was higher than in other countries.[18] For example, Benhamou et al. reported a pain survey in seven European countries in which PCA was used mainly in patients after major orthopedic or abdominal surgery, and the rate of use was less than 50%.[52] And similar results were reported by Fletcher et al. in a survey of pain conditions in 76 surgical centers in France.[53] Correspondingly, the use of local anesthetics in nerve blocks was relatively rare in the ward. In our future studies, we will need to follow up with the patients in the long term to understand the effect of peri-operative opioid prescription and pain management on long-term opioid use.

A good multimodal analgesia approach requires a sound collaboration between clinicians and patients and their families. The degree of patient participation in the pain treatment process is correlated with patient satisfaction and pain relief.[54] The results of the current study suggest that patients with moderate-to-severe pain have significantly lower awareness of pain treatment (72.0% vs. 78.1%, $P < 0.0001$) and participation in pain treatment decision-making (8 [5–10] vs. 10 [8–10], $P < 0.0001$) than those with mild pain. Furthermore, pain assessments are essential components for the quality of pain management.[55] We noted that a high proportion of patients with moderate-to-severe pain did not receive pain evaluations within 60 min of receiving analgesic treatment (28.4% vs. 23.0%, $P < 0.0001$), which may also be a factor affecting the pain prognosis of these patients. We will need to pay more attention to

the communication with patients and the evaluation of pain, so that patients can be more involved in pain treatment decision-making.

Limitations of the study include the followings. The primary source of this study was the tertiary hospitals located mainly in developed areas of eastern China, and the data from the western region and primary hospitals are lacking. Therefore, the results may not represent the pain prognosis situation in primary hospitals and remote areas. However, the areas covered in this study are the most densely populated areas in China, with a total number of anesthesiologists representing more than one-fourth of the country. As the largest post-operative pain survey in China to date, we utilized random sampling to minimize the bias, and the results could reflect to some extent on the current state of postoperative pain management in China. In future studies, we aim to expand the scope of the study to obtain data that would better represent the current situation of acute postoperative pain in China. Furthermore, the follow-up period in this study was only one day. Further studies with longer follow-up periods are required to assess chronic postoperative pain and long-term opioid use.

Conclusions

This study showed that almost half of the patients suffered from moderate-to-severe pain after surgery in China, although the proportion was lower than that in European and America. The 68% rate of systemic opioid use on the first postoperative day was significantly higher than that reported in Europe and America, especially the high rate of opioid use via intravenous PCA. The use of regional analgesias, such as postoperative nerve blocks, is low. Therefore, although the survey results showed that patients had high overall satisfaction, there is still a need to improve the management of acute postoperative pain in China. More effort is needed to advance the concept of multimodal analgesia, reduce opioid use, and involve patients more in pain treatment decision-making.

Contributors

Dr. Mi had full access to all of the data in the study and take responsibility for the integrity of the data and accuracy of the data analysis.

Concept and design: Weidong Mi, Yanhong Liu; Acquisition of the data: Xuecai Lv, Aisheng Hou, CAPOPS Group; Analysis or interpretation of data: Yanhong Liu, Saisong Xiao, Huikai Yang, Xuecai Lv, Aisheng Hou, Yulong Ma; Drafting of the manuscript: Yanhong Liu, Saisong Xiao, Huikai Yang;

Critical revision of the manuscript for important intellectual content: Weidong Mi, Yandong Jiang; Statistical analysis: Yanhong Liu, Saisong Xiao, Huikai Yang, Chongyang Duan; Obtained funding: Weidong Mi, Yanhong Liu; Administrative, technical, or material support: Weidong Mi, Yanhong Liu, Yulong Ma;

Supervision: Weidong Mi, Yanhong Liu.

Data sharing statement

The China Acute Postoperative Pain Study (CAPOPS) is publicly available but need to obtain administrative permission from each investigative hospital.

Declaration of interests

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2023.100822.

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