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Application of PDCA Cycle Combined with Predictive Nursing in Pain Management after Video-Assisted Thoracoscopic Lobectomy

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Abstract: *Objective:* To explore the application effect of the PDCA cycle combined with predictive nursing in pain management after video-assisted thoracoscopic lobectomy. *Methods*: A total of 156 patients who underwent video-assisted thoracoscopic lobectomy in our hospital from January 2024 to December 2025 were selected and divided into a control group and an intervention group according to the nursing protocol, with 78 cases in each group. The Visual Analog Scale (VAS) scores at 6 h, 24 h, and 48 h after surgery, the number of effective presses on the analgesic pump, the rate of rescue analgesia, and the incidence of adverse reactions were compared between the two groups. *Results:* The VAS scores at each time point after surgery in the intervention group were lower than those in the control group ($p < 0.05$). The number of effective presses on the analgesic pump and the rate of rescue analgesia were significantly reduced in the intervention group ($p < 0.05$), and the incidence of adverse reactions such as nausea and vomiting was lower than that in the control group ($p < 0.05$). *Conclusion*: The PDCA cycle combined with predictive nursing can effectively relieve pain after video-assisted thoracoscopic lobectomy, improve the quality of analgesia, and reduce adverse reactions, which is worthy of clinical promotion and application.

Keywords: PDCA cycle; Predictive nursing; Video-assisted thoracoscopic lobectomy; Postoperative pain management

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1. Introduction

Video-assisted thoracoscopic lobectomy is the main minimally invasive surgical procedure for early-stage lung cancer and benign pulmonary lesions. Although it has advantages such as minimal trauma and rapid recovery, the incidence of moderate-to-severe postoperative pain remains high, seriously affecting patients' early ambulation, coughing and sputum expectoration, and overall rehabilitation process [1]. How to implement systematic and precise postoperative pain management has become a core issue in improving the quality of nursing care in thoracic surgery. Traditional postoperative analgesia mostly relies on passive execution of medical orders, lacking a forward-looking assessment and dynamic adjustment mechanism,

which easily leads to inadequate analgesia or excessive medication [2]. The PDCA cycle, as a continuous quality improvement tool, has been gradually introduced into perioperative nursing management and has shown significant advantages in standardizing nursing procedures and improving execution standardization [3]. Predictive nursing emphasizes proactive risk assessment and early intervention, which has a positive effect on reducing agitation during recovery and acute pain [4]. The PDCA cycle focuses on achieving standardization and continuous improvement from the perspective of management procedures, while predictive nursing focuses on achieving proactive intervention from the perspective of individual risks. The two are complementary in concept, and their combined application is expected to synergistically improve the quality of perioperative pain management from the two dimensions of "process optimization" and "risk prepositioning". Currently, there are few reports on the combined application of the two in pain management after video-assisted thoracoscopic lobectomy. This study aims to explore its actual effect to provide a reference for clinical nursing care.

2. Materials and methods

2.1. General information

A retrospective selection was made of 156 patients who underwent video-assisted thoracoscopic lobectomy under general anesthesia in our hospital from January 2024 to December 2025.

2.1.1. Inclusion criteria

(1) Age ≥ 18 years
(2) ASA classification grades I–III
(3) Elective unilateral surgery, no long-term use of opioid drugs before surgery, and clear consciousness to cooperate with the assessment.

2.1.2. Exclusion criteria

(1) Severe cardiocerebrovascular diseases or liver and kidney dysfunction before surgery
(2) Conversion to thoracotomy during surgery, postoperative transfer to the ICU with a tube for more than 24 h
(3) The need for a second surgery due to severe complications.

2.1.3. Study design

The patients were divided into a control group and an intervention group according to the nursing protocol, with 78 cases in each group. There were no statistically significant differences in general information such as gender, age, BMI, surgical site, surgical time, and ASA classification between the two groups ($p > 0.05$). This study was a retrospective analysis and was exempted from informed consent after approval by the hospital ethics committee.

2.2. Nursing methods

2.2.1. Control group

The control group received conventional postoperative pain management: After surgery, a patient-controlled intravenous analgesia pump (PCIA, using an electronic microinfusion pump) was administered according to

the doctor's orders. The drug formulation was morphine (10 mg diluted with 0.9% sodium chloride injection to 50 mL, with a concentration of 0.2 mg/mL). The background infusion rate was set at 1 mL/h, the single PCA press dose was 2 mL, and the lockout time was 8 min. Nurses assessed pain during each shift. If the VAS score was ≥ 4 points, the doctor was notified to adjust the protocol, or an intravenous drip of tramadol (e.g., 100 mg) was administered for rescue analgesia. At the same time, routine health education was provided, but the education content did not undergo systematic pre-assessment.

2.2.2. Intervention group

The intervention group received interventions based on the conventional analgesic protocol of the control group, with the same baseline medication. The PDCA cycle combined with predictive nursing was implemented as follows.

(1) Planning stage (Plan)

Team members identified three major improvement directions by retrospectively analyzing the weak links in pain management after video-assisted thoracoscopic lobectomy in our department: Lack of preoperative pain risk stratification assessment; Passive delay in postoperative assessment and intervention; Inconsistent implementation of prevention of analgesic adverse reactions. In response to the above problems, an improvement plan was formulated with reference to the ERAS concept [5,6]. Before surgery, the Pain Catastrophizing Scale (PCS) was used to screen high-risk patients (PCS ≥ 30 points), and multimodal analgesia strategies were communicated in advance with the anesthesiologist [7,8]. The assessment frequency within 24 h after surgery was increased to once every 2 h, and a lower threshold of VAS ≥ 3 points for intervention was set.

(2) Implementation stage (Do)

① Predictive nursing prepositioning: Before surgery, through predictive visits, patients were informed about the pattern of postoperative pain, the use of the analgesic pump, and techniques for protecting the incision during coughing and sputum expectoration. High-risk patients with PCS ≥ 30 points received additional psychological counseling and pain expectation management to reduce preoperative anxiety and fear. ② Postoperative standardized execution: After returning to the ward after surgery, patients completed the first pain assessment immediately. High-risk events were predicted at 4 h after surgery, and reassessment was performed once every 2 h within 24 h after surgery. If the VAS score was ≥ 3 points, the doctor was notified immediately, and assistance was provided. Each shift used a standardized handover form for pain management handover to ensure the continuity of assessment and intervention.

(3) Checking stage (Check)

Quality control nurses checked the timeliness of assessment, the execution rate of intervention within 15 min, and the consistency of PCA records every day. A pain management quality discussion meeting was held once a week, focusing on analyzing cases of pain control failure (VAS ≥ 6 points) and identifying deviations in process execution.

(4) Action stage (Act)

The problems identified in the checking stage were incorporated into the next round of the PDCA cycle, and targeted corrective measures were formulated and implemented. Each cycle lasted 2 weeks and continued until the patient was discharged from the hospital, ensuring that each patient experienced at least 2 complete cycles to achieve continuous improvement in the quality of pain management [9].

2.3. Observation indicators

(1) Pain intensity

The pain intensity of the two groups of patients at rest at 6 h, 24 h, and 48 h after surgery was assessed using the Visual Analog Scale.

(2) Analgesic effect indicators

The number of effective presses on the analgesic pump and the rate of rescue analgesia within 48 h after surgery were recorded [10].

(3) Adverse reactions

The number of cases of nausea and vomiting (PONV), dizziness, and excessive sedation within 48 h after surgery was counted. The criteria for judging adverse reactions referred to the drug adverse reaction monitoring norms in the literature.

2.4. Statistical methods

SPSS 25.0 software was used for data analysis. Measurement data were expressed as the mean ± standard deviation ($\overline{x} \pm s$), and independent sample *t*-tests were used for comparison between the two groups. Count data were expressed as the number of cases (%), and χ^2 tests or Fisher's exact tests were used. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of general information between the two groups

There were no statistically significant differences between the two groups in terms of gender composition, age, BMI, surgical site, operation duration, and ASA classification ($p > 0.05$), indicating comparability. See **Table 1** for details.

Table 1. Comparison of general information between the two groups (n = 156)

Variable	Control group (n = 78)	Intervention group (n = 78)	t/χ^2 value	p value
Sex (male/female, n)	44/34	46/32	0.104	0.747
Age (years, $\overline{x} \pm s$)	58.44 ± 10.23	57.13 ± 11.47	0.754	0.452
BMI (kg/m², $\overline{x} \pm s$)	23.55 ± 3.07	24.03 ± 3.38	-0.768	0.444
Surgical site (left/right, n)	35/43	38/40	0.207	0.649
Operative time (min, $\overline{x} \pm s$)	142.45 ± 28.74	138.92 ± 31.19	0.759	0.449
ASA grade (I/II/III, n)	12/48/18	14/50/14	0.511	0.774

Note: There were no statistically significant differences in the aforementioned indicators between the two groups ($p > 0.05$).

3.2. Comparison of VAS scores between the two groups at different time points after surgery

The VAS scores of the intervention group at 6 hours, 24 hours, and 48 hours after surgery were all lower than those of the control group, with statistically significant differences ($p < 0.05$). Moreover, the intervention group exhibited a more pronounced decreasing trend in pain after 24 hours, as shown in **Table 2**.

Table 2. Comparison of VAS scores between the two groups at different time points after surgery (points, $\overline{x} \pm s$)

Group	Number of cases	6h postoperatively	24h postoperatively	48h postoperatively
Control group	78	4.27 ± 1.38	3.86 ± 1.34	3.06 ± 1.19
Intervention group	78	3.48 ± 1.53	2.77 ± 1.36	2.24 ± 1.12
t value	-	3.58	5.31	4.95
p value	-	0.001	< 0.001	< 0.001

3.3. Comparison of postoperative analgesic effects and adverse reactions between the two groups

The number of effective presses on the analgesic pump within 48 hours after surgery in the intervention group was significantly lower than that in the control group ($p < 0.001$), and the rate of rescue analgesia was also lower in the intervention group ($p = 0.015$), as shown in **Table 3**.

Table 3. Comparison of postoperative analgesic effects within 48 hours between the two groups

Indicator	Control group (n = 78)	Intervention group (n = 78)	Statistic	*p* value
Effective compressions (times, $\overline{x} \pm s$)	12.60 ± 5.31	8.41 ± 4.73	$t = 5.267$	< 0.001
Rescue analgesia [cases (%)]	21 (26.92)	9 (11.54)	$\chi^2 = 5.912$	0.015

In terms of adverse reactions, the incidence of nausea and vomiting in the intervention group was significantly lower than that in the control group ($p = 0.036$). There was no statistically significant difference in the incidence of dizziness and excessive sedation between the two groups ($p > 0.05$), although the absolute values were lower in the intervention group compared to the control group, as shown in **Table 4**.

Table 4. Comparison of adverse reactions within 48 hours after surgery between the two groups

Indicator	Control group (n = 78)	Intervention group (n = 78)	Statistic	*p* value
Nausea and vomiting [n (%)]	24 (30.77)	13 (16.67)	$\chi^2 = 4.396$	0.036
Dizziness [n (%)]	10 (12.82)	6 (7.69)	$\chi^2 = 1.099$	0.294
Excessive sedation [n (%)]	5 (6.41)	2 (2.56)	$\chi^2 = 1.334$	0.248

4. Discussion

Thoracoscopic lobectomy is the mainstream surgical approach for early-stage lung cancer and benign pulmonary lesions. Although it significantly reduces surgical trauma compared to traditional thoracotomy, moderate to severe postoperative pain remains a core obstacle to early patient recovery. Conventional postoperative pain management often relies on passive execution of medical orders, with nurses conducting rounds and assessments according to shifts and notifying physicians for intervention only when the Visual Analog Scale (VAS) score reaches ≥ 4. This approach lacks proactive prediction and stratified management of individual patient pain risks, often leading to delayed or inadequate analgesic interventions.

The PDCA (Plan-Do-Check-Act) cycle, as a standardized quality management tool, enables continuous optimization and improvement of nursing processes through iterative cycles of planning, implementation, inspection, and handling. In this study, it was applied to postoperative pain management following thoracoscopic lobectomy. During the planning phase, three key weaknesses were identified through

retrospective analysis: the absence of preoperative risk stratification, passive and delayed assessment and intervention, and inconsistent implementation of adverse reaction prevention measures. Based on these findings, a stratified and proactive improvement plan was developed. During the implementation phase, the plan was put into practice through measures such as standardized handover forms, increased assessment frequency, and setting a lower intervention threshold. The inspection and handling phases ensured the sustainability of improvements through quality control checks and iterative cycles, addressing the lack of a systematic closed-loop in conventional management.

The core of proactive nursing lies in shifting interventions upstream by actively identifying and intervening before risk events occur. In this study, proactive nursing was manifested at two levels: First, the Pain Catastrophizing Scale (PCS) was used preoperatively to screen patients at high risk for pain catastrophizing. Early communication with anesthesiologists regarding multimodal analgesia strategies was established, and proactive visits were conducted to educate patients on postoperative pain patterns, analgesic pump usage, and techniques for protecting incisions during coughing and sputum expectoration, thereby alleviating fear and anxiety about postoperative pain. Research indicates that preoperative pain catastrophizing is a significant predictor of postoperative acute pain intensity, and preoperative psychological counseling and pain expectation management can effectively reduce central sensitization and postoperative pain perception. Second, the first postoperative pain assessment was completed immediately, followed by reassessments every 2 hours within the first 24 hours postoperatively. Intervention was initiated at a VAS score of ≥ 3, representing a lower threshold and faster response compared to the control group's threshold of ≥ 4, thereby transforming passive post-event handling into proactive pre-event prevention and in-event control.

The results of this study showed that VAS scores at 6, 24, and 48 hours postoperatively in the intervention group were lower than those in the control group ($p < 0.05$). The number of effective analgesic pump presses decreased by approximately 33% compared to the control group, and the rescue analgesia rate dropped from 26.9% to 11.5% ($p < 0.05$), consistent with findings from previous studies on the application of the PDCA cycle in postoperative pain management. These results suggest that the PDCA cycle combined with proactive nursing can synergistically enhance analgesic quality from two dimensions: process optimization and risk proactivity. The PDCA cycle ensures standardized and sustained nursing behaviors, while proactive nursing preemptively addresses some pain triggers at the individual patient level, forming a complementary dynamic closed-loop management system.

5. Conclusion

The combination of the PDCA cycle and proactive nursing, acting synergistically through process-oriented quality improvement and proactive risk avoidance, significantly reduces acute pain intensity, decreases the number of analgesic pump presses and the need for rescue analgesia, and lowers the incidence of drug-related adverse reactions such as nausea and vomiting in patients following thoracoscopic lobectomy. This integrated model transforms post-event handling into a dynamic management system encompassing pre-event prevention, in-event control, and continuous optimization. It is operationally feasible, demonstrates clear effects, and can serve as a preferred option for postoperative pain management in accelerated rehabilitation surgery nursing within thoracic surgery, holding high clinical application value.

Disclosure statement

The author declares no conflict of interest.

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