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Clinical Practice of Evidence-Based PDCA Cycle Management Model in Accelerated Recovery of Lung Cancer Patients

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Abstract

Objective: To explore the nursing effect of evidence-based PDCA cycle management mode in accelerated rehabilitation of patients undergoing thoracoscopic lung cancer radical surgery. **Methods:** 104 patients who underwent thoracoscopic lung cancer radical surgery in our hospital from June 2022 to February 2023 were randomly divided into control group and intervention group, with 52 cases in each group. The control group implemented evidence-based ERAS clinical pathway management, while the intervention group implemented evidence-based PDCA cycle quality management. The postoperative recovery of the two groups of patients was compared. **Results:** The postoperative recovery of the intervention group was significantly better than that of the control group. The first time to get out of bed, the first time to eat, the duration of chest drainage tube placement, and the length of hospital stay were significantly shorter than those of the control group. The incidence of postoperative chest complications and hospitalization costs were significantly lower than those of the control group, and patient satisfaction was significantly higher than that of the control group ($P < 0.05$). **Conclusion:** Evidence-based PDCA cycle quality management mode can effectively improve the implementation quality of accelerated rehabilitation nursing for patients undergoing thoracoscopic lung cancer radical surgery, and it is worthy of clinical promotion.

Keywords

Evidence-Based, PDCA Cycle, Thoracoscopic Lung Cancer Radical Surgery, Accelerated Rehabilitation

1. Introduction

Lung cancer is one of the most common malignant tumors globally. According

to the data from the International Agency for Research on Cancer (IARC) of the World Health Organization in 2020, lung cancer still ranks second in incidence and first in mortality among all malignant tumors [1]. Currently, surgical treatment is still the only clinically proven method supported by evidence-based medicine to cure early-stage lung cancer. With the continuous advancement of neoadjuvant therapy for lung cancer, the role of surgical treatment in the comprehensive treatment of advanced lung cancer is also becoming increasingly prominent. In this regard, thoracoscopic radical surgery for lung cancer has fundamentally changed the clinical situation of traditional open chest surgery, which is characterized by large trauma, long hospital stays, and poor patient acceptance. The concept of Enhanced Recovery after Surgery (ERAS) has also been continuously developing and popularizing with the rise of thoracoscopy and surgical robots [2]. However, minimally invasive surgery may lead to irreversible loss of lung tissue, impaired lung function, and postoperative complications such as atelectasis, air leakage, and lung infections, which can affect recovery and prognosis [3]. At the same time, traditional ERAS currently lacks operational standards, processes, and quality control standards, leading to prominent heterogeneous problems and difficulties in ensuring quality [4]. Therefore, how to implement ERAS measures and pathways, achieve full supervision and feedback, timely rectification, seamless multidisciplinary collaboration, and help patients recover as early as possible is a worthy issue of attention. Based on the evidence-based PDCA cycle management, using the PDCA cycle as a guiding method and integrating the concept of evidence-based practice [5], optimizing workflows has achieved good results in clinical research applications [6]. This study will combine the experience of lung cancer ERAS collaboration in recent years at the Sun Yat-sen University Cancer Center with nursing quality management through PDCA in coordination with ERAS, based on evidence-based medicine, coordinating multidisciplinary team cooperation, promoting standardized and standardized comprehensive management throughout the process to improve patient clinical outcomes, and providing a reference for improving the quality of ERAS implementation in clinical practice.

2. Objects and Methods

2.1. General Information

A total of 104 patients who underwent thoracoscopic lung cancer radical surgery from June 2022 to February 2023 were selected as the research subjects. They were randomly divided into control and intervention groups, with 52 patients in each group, and to avoid contamination, patients were placed in different wards according to their group. In the intervention group, there were 27 male patients and 25 female patients, with an average age of (57.2 ± 5.5) years, including 14 cases of squamous cell carcinoma and 38 cases of adenocarcinoma; in the control group, there were 28 male patients and 24 female patients, with an average age of (56.9 ± 5.8) years, including 12 cases of squamous cell carcinoma and 40

cases of adenocarcinoma. Both groups of patients and their families signed informed consent forms, and there were no statistically significant differences in demographic data such as age, gender, and type of disease between the two groups ($P > 0.05$), indicating comparability.

2.2. Criteria

2.2.1. Inclusion Criteria

① Preoperative diagnosis of lung cancer confirmed by CT, bronchoscopy, or biopsy, with pathological confirmation of primary lung cancer; ② Meeting the surgical indications; ③ Age between 18 and 80 years; ④ Ability to communicate effectively; ⑤ Informed consent from the patient.

2.2.2. Exclusion Criteria

① Patients who underwent thoracotomy or total lung resection during surgery; ② Patients with severe respiratory, cardiovascular, or cerebrovascular diseases, or severe liver or kidney dysfunction before surgery; ③ Non-compliance; ④ Participation in other similar clinical trials concurrently.

2.3. Research Methods

2.3.1. ERAS Nursing Quality Control Management Method

Both groups were managed according to the standardized ERAS nursing clinical pathway established by the department. The department team referred to the Chinese Enhanced Recovery After Surgery (ERAS) Clinical Practice Guidelines (2021) [7], ERAS China Expert Consensus and Pathway Management Guidelines (2018) [8] [9] [10], and other literature on perioperative accelerated recovery nursing care for lung cancer patients from domestic and foreign databases, guideline websites, domestic and foreign thoracic professional association websites, forming the "Best Evidence Summary of Perioperative Nursing Care for Lung Cancer Patients" [11]. After interviewing thoracic medical and nursing staff about existing issues in accelerated recovery practice, the "ERAS Clinical Pathway for Thoracic Lung Cancer Patients" was developed. The pathway included preoperative education, preoperative assessment, smoking and alcohol cessation, nutritional support, preoperative fasting, and other aspects; intraoperative strategies such as prophylactic antibiotic use, optimization of anesthesia, airway management, and lung protection; postoperative pain management, prevention and treatment of postoperative nausea and vomiting, early feeding, early mobilization, discharge guidance (pulmonary rehabilitation), and continuity of care management. Patients and their families were introduced to and implemented the pathway through the distribution of promotional materials and verbal education. The quality control method in the control group involved the responsible nurse implementing the "ERAS Clinical Pathway for Thoracic Lung Cancer Patients," with the nursing team leader randomly checking the implementation of the pathway twice daily and the head nurse focusing on checking the implementation of patients, providing real-time feedback, guidance, and

improvement. The intervention group implemented evidence-based PDCA nursing quality management methods as follows:

2.3.2. Establishment of an Accelerated Recovery PDCA Quality Control Team

The quality control team consisted of 10 members, including 1 thoracic clinical physician, 1 thoracic nursing team leader, 3 specialized nurses, 2 nursing team leaders, 1 research nurse, and 1 ERAS navigation nurse. The nursing team leader was responsible for overall coordination, planning, and coordination of the project; the physician was responsible for formulating and optimizing the plan; the research nurse was responsible for evidence retrieval, updating evidence-based knowledge, and data analysis; specialized nurses were responsible for developing and implementing patient pulmonary rehabilitation exercises and pain management goals, as well as providing psychological and nutritional support; the nursing team leaders provided feedback and guidance to the responsible nurses on the implementation of the pathway; the navigation nurse guided nurses in using evidence-based practices to make effective decisions [12] [13]. The team established an ERAS team WeChat group for coordination and feedback within the team, held regular coordination and quality control meetings, coordinated multidisciplinary consultations based on individual patient needs, monitored the implementation of the pathway throughout, established a continuity of care information platform, developed a continuity of care plan, and addressed non-routine events that were easily overlooked but required timely resolution by medical and nursing staff [14] [15] (**Table 1**).

Table 1. ERAS clinical pathway for patients with lung cancer in the Department of Thoracic Medicine.

Time	project	Specific measures
Preoperatively	Enrollment preparation	1. Confirm enrollment and notify the multidisciplinary team; 2. Preliminary assessment, issue accelerated recovery surgical orders; 3. Education and distribution of accelerated recovery manual, signing of informed consent form.
	Assessment and intervention	1. History of chronic diseases, such as hypertension, diabetes, COPD, etc.; 2. Psychological status screening (using DT psychological distress thermometer); 3. Social support status, such as family members, medical expenses payment, etc.; 4. Nutritional status, screening for malnutrition risk (NRS2002), diet and lifestyle habits; 5. Timely correction of relevant indicators based on assessment results and implementation of corresponding health education, such as psychological care and nutritional support, correction of high blood sugar, high blood pressure, etc.
	Preoperative testing	Assist in improving preoperative examinations, including routine examinations and specialized examinations such as lung function, CT, cardiac color Doppler, etc.
	Bowel preparation	1. Shorten preoperative fasting and drinking time: fasting for 4 hours before surgery, no drinking for 2 hours, oral administration of 10% glucose solution 200 ml or warm water 200 ml 2 hours before surgery, intravenous supplementation of 5% glucose sodium chloride solution 500ml before surgery; 2. No intestinal preparation.

Continued

	Rehabilitation	1. Pulmonary rehabilitation training, deep breathing (exhalation: inhalation time ratio = 2:1, deep breathing 10 times/min, 3 times/day), effective coughing and expectoration (5 min/time, 3 times/day), breath-holding (supine breath-holding for 30 s, relax for 5 s, continuous practice for 5min as one time, 3 times/day), simple breathing training device (10 min/time, 3 times/day); 2. Upper limb activities: finger flexion and extension, fist clenching, shoulder and chest stretching activities, continuous practice for 10min as one time, 3 times/day; 3. Ankle pump activities for lower limbs: flexion and extension, circling movements, continuous practice for 10 min as one time, 3 times/day; 4. Turning training: patients need to turn over every 2 - 3 hours before getting out of bed.
	Pain management	1. Use of pain assessment tools; 2. Pain-related knowledge education.
	Thromboprophylaxis	1. Thrombosis risk assessment (Caprini assessment scale); 2. Thrombosis prevention knowledge education; 3. Training on wearing and removing elastic stockings; 4. Drug prevention.
Intraoperatively	Antibiotic use and fluid management	1. Administer drugs during surgery, prophylactic use of antibiotics during surgery; 2. Record intraoperative fluid volume.
	Temperature control and thromboprophylaxis	1. Avoid intraoperative hypothermia, continuously monitor intraoperative body temperature, provide warming measures: adjust environmental temperature, use warming blankets; 2. Record intraoperative and transfer body temperature, actively raise body temperature after surgery until the patient's temperature is >36°C; 3. Wear elastic stockings according to the situation.
Postoperatively	Diet & Nutrition	1. Inquire about postoperative nausea, vomiting, choking, abdominal distension, etc.; 2. For patients under general anesthesia, start drinking small amounts of water 4 hours after awakening, and if there is no discomfort after 6 hours, they can have a liquid diet. If there is no bloating, nausea, vomiting, etc., they can resume a normal diet within 24 hours after surgery, focusing on high-nutrition and high-protein foods; 3. Nutritional risk screening, implement nutritional supplementation according to medical orders.
	Positioning and early mobility	1. If blood pressure is stable after returning to the ward, elevate the head of the bed to a semi-recumbent position; 2. For patients who are awake after anesthesia, if vital signs are stable, they can perform lung function exercises such as coughing and expectoration in a semi-sitting position; 3. For patients who are not awake after anesthesia, passive activities should be performed, and after awakening from anesthesia, active activities for the upper and lower limbs, turning over, and lifting the buttocks should be performed; 4. Patients should start getting out of bed within 24 hours after surgery; 5. Observe for any discomfort caused by activity.
	Pulmonary rehabilitation management	1. Evaluate before respiratory training 2 hours after surgery, encourage patients to perform low-intensity respiratory function exercises; 2. Forms and frequency of respiratory training: active breathing cycle technique, inspiratory muscle training, diaphragmatic breathing training, effective coughing, abdominal breathing, pursed lip breathing, etc., 3 - 5 times a day, 15 - 20 minutes each time; 3. Observe if the patient experiences chest tightness, shortness of breath, or fatigue during the process, stop the exercise and instruct the patient to rest.
	Airway management	Use glucocorticoids, bronchodilators, and mucolytic nebulization therapy 2 - 3 times a day.

Continued

	Pain management	1. Use pain numerical scoring method, assess pain intensity dynamically on the day of awakening from anesthesia, and provide analgesic measures promptly based on the assessment results; 2. Preemptive analgesia (analgesia given 3 - 30 minutes before a painful operation); 3. Multimodal analgesia, combined analgesia, observe the analgesic effect (evaluate the analgesic effect 3 - 30 minutes after medication); 4. Observe for adverse reactions to analgesic drugs.
	Pipeline management	1. If perioperative urine output monitoring is not needed, do not leave a urinary catheter; if a urinary catheter is present, remove it within 24 hours after surgery; 2. If the chest drainage is <200 ml/day after surgery, the chest X-ray indicates no pneumothorax, the chest tube should be removed immediately; 3. If there is no need for intravenous fluid replacement, promptly remove the central venous catheter; 4. Observe for any discomfort after tube removal.
	Thromboprophylaxis	1. Risk assessment; 2. Drug prevention, pay attention to whether patients have a tendency to bleed when using anticoagulants; 3. Non-drug prevention, lower limb massage (3 times/day), ankle pump exercise (started 6 hours after surgery, dorsiflexion for 10 s, relax for 5 s, then plantar flexion for 10 s, relax for 5 s, 4 min/time, 10 times/day), high-risk patients use elastic stockings, intermittent pneumatic compression devices as needed.
	Preparing for discharge	1. Normal vital signs; 2. Normal diet, free activity, no complications; 3. Patient willing and wishing to go home; 4. Discharge education and data registration.
Outside the hospital	Extended care	Follow-up visits are scheduled for 1 week, 1 month, and 3 months after discharge; follow-up content includes symptoms, diet and rest, medication, pulmonary rehabilitation, psychological status, and reexamination.

2.3.3. Develop Relevant Forms

The PDCA project team members are responsible for developing: ① Further revision based on the "ERAS Clinical Pathway for Thoracic Lung Cancer Patients" in the department, to be used throughout the execution of the patient's ERAS pathway by the responsible nurse. The new content includes: (1) Preoperative: ERAS-related education, cardiopulmonary function (6-minute walk test), physical fitness assessment, nutritional risk (NRS2002), venous thrombosis risk (Caprini), and psychological (DT psychological distress thermometer) assessment. Preoperatively, elderly lung cancer patients with high-risk factors are advised to undergo one week of pulmonary rehabilitation training. Preoperative smoking and alcohol cessation for 2 weeks, multimodal health education (pushing public accounts, audio and video guidance for breathing exercises: focusing on active breathing cycle technology), preoperative fasting and drinking prohibition (shortening preoperative fasting time to 4 hours before surgery, oral intake of clear beverages allowed, including water, cola, sugar water, and coffee without milk, excluding milk, alcoholic beverages), nutritional support (3 + 3 mode oral nutritional supplements as the main source), and psychological relaxation (promoting respiratory mindfulness intervention). (2) Anesthesia: Increase the use of epidural analgesia, minimize the use of opioid analgesics as much as possible based on the patient's actual condition, avoid excessive or insufficient fluid replacement leading to pulmonary edema or renal failure through goal-directed fluid therapy (GDFT). (3) Intraoperative: Choose "non-endotracheal intubation anesthesia for chest surgery" according to the actual situation, wedge resection patients can

choose not to place chest drainage tubes, urinary catheters, and central venous catheters, and patients undergoing lobectomy should have a single chest drainage tube with a diameter not exceeding 24F left in place, avoiding the use of two chest drainage tubes or large drainage tubes with a diameter exceeding 28F. Optimize lymph node sampling or cleaning range based on intraoperative frozen section results (such as infiltration depth, intrapulmonary spread, etc.), avoid excessive cleaning of lymph nodes and damage to the pulmonary plexus nerves, etc. (4) Postoperative: Multimodal analgesia (intravenous patient-controlled analgesia pump, drug therapy, music therapy, etc.), early postoperative feeding (water intake 2 hours postoperatively, liquid diet 4 hours postoperatively), postoperative positioning management (comfortable positions such as semi-sitting or lying down as soon as the patient wakes up postoperatively), early mobilization (ankle pump exercise for limbs when awake postoperatively, active breathing cycle technology exercise). (5) Outpatient: Discharge guidance (personalized pulmonary rehabilitation program), continued nursing management (regular telephone follow-up), use of the hospital's intelligent management platform for patients for outpatient full-cycle management. Introduce and implement the pathway to patients and their families through distribution of promotional materials, public account push, and establishment of health education lectures. ② Develop the "ERAS Implementation Feedback Checklist": The navigation nurse records the effectiveness of the patient's ERAS pathway execution daily, focusing on monitoring key ERAS assessments (preoperative and postoperative pain scores, psychological distress thermometer scores, thrombosis risk scores), preoperative fasting and postoperative early feeding compliance rates, early postoperative exercise, timely postoperative ambulation, extubation status, complications, follow-up feedback issues, patient satisfaction, etc.

Unified Training Navigation nurses provide training on the research purposes and significance, accelerated recovery-related knowledge, and the use and completion requirements of relevant quality control forms to project team members and all responsible nurses.

Inspection and handling stage use a three-level quality control method to control the quality of the ERAS implementation process. Level 1 quality control: Led by the responsible nurse, assess patients jointly with the attending physician and nurse, and implement the ERAS pathway. The responsible nurse summarizes the reasons for inadequate nursing service execution during nursing handover according to the "Clinical Nursing Quality Evaluation Standards of Sun Yat-sen University Cancer Hospital" and promptly writes up the case and checks for any missed ERAS-related assessments, recording all issues on the corresponding nursing service process form and providing feedback to the nursing team leader. Level 2 quality control: Led by the PDCA project team leader, based on self-assessment feedback from nurses, use the "ERAS Nursing Pathway Execution Form" to conduct bedside rounds twice daily with the physician, spot-check during shift handover with the head nurse, provide feedback on the implementation of the ERAS pathway and assessments, attention to high-risk patients,

discharge case checks, and record all issues on the ERAS Nursing Pathway Execution Form for feedback to the navigation nurse. Level 3 quality control: Led by the navigation nurse, based on guidance from the head nurse and feedback from the team leader, use the "ERAS Implementation Feedback Checklist" to analyze patient data, track feedback from level 2 quality control, address issues, coordinate multidisciplinary team follow-up on patient conditions, organize regular nursing quality control meetings monthly, propose optimization strategies, and promote homogenization.

2.3.4. Evaluation Indicators

① ERAS-related indicators: First postoperative meal, ambulation, chest tube retention time, postoperative complications. Evaluated by the navigation nurse and attending physician, recorded by research nurses. ② Length of hospital stay and hospital costs are collected by research nurses from patient hospitalization information. ③ ERAS patient satisfaction: Using the Accelerated Recovery Surgical Inpatient Satisfaction Survey developed by Wang Xiaoxiao *et al*., including health education (6 items), patient care (4 items), clinical nursing (4 items), introduction to accelerated recovery concepts (3 items) in 4 dimensions with a total of 17 items. Each item is scored on a Likert 5-point scale from 1 to 5, with a total score ranging from 17 to 85. A higher score indicates greater patient satisfaction with ERAS-related medical services collected by the navigation nurse on the day of patient discharge.

2.3.5. Statistical Methods

Data analysis was conducted using the statistical software SPSS 26.0. Normally distributed continuous data are presented as mean ± standard deviation, and independent sample t-tests are used for comparison between groups. Count data are presented as percentages, and chi-square tests or Fisher's exact probability tests are used for statistical analysis. A P-value < 0.05 indicates a statistically significant difference.

3. Outcome

3.1. Comparison of ERAS-Related Evaluation Indexes between the Two Groups

See Table 2.

Table 2. Comparison of ERAS-related evaluation indexes between the two groups.

Observe the metrics	Intervention group (n = 52)	Control group (n = 52)	t/χ^2 value	P value
Time to first postoperative feeding (h)	4.72 ± 1.91	7.58 ± 3.78	4.913	<0.05
First Bed Exit Activity (h)	13.75 ± 3.95	17.34 ± 4.32	4.786	<0.05
Chest tube indwelling time (h)	64.5 ± 10.27	76.10 ± 15.83	9.347	<0.05
Postoperative thoracic complications (examples)	5	11	7.365	<0.05
Length of postoperative hospital stay (d)	4.37 ± 1.54	5.43 ± 1.73	3.854	<0.05

Table 3. Comparison of ERAS satisfaction, length of hospital stay, and cost between the two groups.

Observe the metrics	Intervention group (n = 52)	Control group (n = 52)	t value	P value
ERAS Satisfaction (Points)	76.10 ± 8.43	68.72 ± 9.78	4.612	<0.05
Length of postoperative hospital stay (d)	4.37 ± 1.54	5.43 ± 1.73	3.854	<0.05
Hospitalization Expenses (RMB)	54238.37 ± 11346.63	67962.01 ± 13527.84	5.625	<0.05

3.2. Comparison of ERAS Satisfaction, Length of Hospital Stay, and Cost between the Two Groups

See Table 3.

4. Discussion

4.1. Evidence-BASED PDCA Nursing Quality Control Management Can Facilitate the Implementation of the ERAS Process

The current status of Enhanced Recovery after Surgery (ERAS) in thoracic surgery remains more theoretical than practical [16], and the difficulties in evaluation, replication, and standardization are the current challenges [17]. Additionally, there are different ERAS protocols for thoracic surgery, and there is no unified operational standard, leading to significant differences in clinical practice [18]. The lack of a quality control system for ERAS, including process feedback, final quality, and continuous feedback, is the root cause of these issues, hindering the further promotion and application of ERAS [7]. The PDCA cycle method is an important way to improve the quality of nursing work [19]. This study combines the PDCA cycle method in the ERAS process, following the four stages of plan-do-check-act, closely linking each stage. By developing a tailored ERAS clinical pathway for lung cancer patients and focusing on detail management during the check phase, using a three-level quality control approach, the entire process is nurse-led. Through feedback from the pathway table and structured guidance from navigation nurses, all nursing measures are ensured to be completed with high quality, improving the implementation and effectiveness of measures, and facilitating the better implementation and application of the ERAS nursing process.

4.2. Evidence-Based PDCA Nursing Quality Control Management Can Promote Accelerated Recovery of Patients

The results of the study show that the intervention group had significantly shorter time to first ambulation, chest tube duration, and early feeding time compared to the control group ($P < 0.05$), confirming that implementing PDCA nursing quality control management led by navigation nurses can improve the implementation and effectiveness of ERAS. Evidence-based PDCA nursing quality control management can promote patient's accelerated recovery. The study results show that evidence-based PDCA nursing quality control management can significantly reduce the incidence of postoperative chest complications, shorten hospital stay, reduce hospital costs, and improve patient satisfaction

with ERAS. By developing an "ERAS Nursing Pathway Execution Table" and guiding nurses to provide standardized nursing measures, conducting three-level quality control, strengthening the implementation of preoperative multimodal health education, postoperative pain management, and lung rehabilitation management, and coordinating multidisciplinary cooperation based on clinical data, the study ultimately improves patient outcomes and promotes the development of ERAS for lung cancer.

5. Conclusion

Evidence-based PDCA nursing quality control management can promote the quality of accelerated recovery for lung cancer patients. This study is limited to a single center hospital, and future research should expand the sample size and include multiple center hospitals for further exploration.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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