Asia-Pacific Journal of Oncology Nursing 9 (2022) 100054

Contents lists available at ScienceDirect

Asia-Pacific Journal of Oncology Nursing

journal homepage: www.apjon.com

Review

Summary of best evidence for enhanced recovery after surgery for patients undergoing lung cancer operations

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ARTICLE INFO

Keywords:
Lung cancer
Enhanced recovery after surgery
Evidence summary
Evidence-based medicine

ABSTRACT

According to the cancer burden report released by the International Agency for Research on Cancer (IARC) in 2020, the mortality rate of lung cancer is 18%, ranking first in the world, and its morbidity and mortality rates are highest in China. Pneumonectomy is the preferred treatment for lung cancer patients, but surgery carries a significant risk of perioperative complications, which may affect the patient's functional recovery and quality of life. So, the rehabilitation of the large number of lung cancer patients in China requires greater attention. A number of studies have shown that the enhanced recovery after surgery (ERAS) protocol can reduce the risk of death, readmission rate, adjuvant chemotherapy time, postoperative pain level, anesthesia medication amount, length of stay, and hospitalization expenses. Foreign literature has successively issued guidelines to improve recovery among lung cancer patients, but Chinese-specific literature for patients undergoing lung cancer surgery or thoracic surgery remains inadequate. Some Chinese expert consensus have only considered part of the content of ERAS in thoracic surgery. To summary the evidence of the ERAS program for lung cancer surgery patients at home and abroad basing on evidence-based medicine is necessary. Therefore, this study used evidence-based practical thinking as a guide to (1) evaluate, integrate, and summarize relevant evidence guidelines and data resources at home and abroad so as to construct an enhanced recovery program for lung cancer patients suitable for Chinese national conditions and (2) provide a scientific basis for future research and practice in related fields.

Introduction

Lobectomy is the treatment of choice in the early stage (stage I or II) of lung cancer, but even with minimally invasive surgery,[1,2] the resulting surgical incision is still one of the most painful,[3] and there is a significant risk of perioperative complications.[4] Complications not only reduce patient satisfaction, but also may impact patients with a huge associated socioeconomic impact in terms of quality of life, functional recovery, and health-related quality of life.[5] Therefore, the perioperative rehabilitation of lung cancer patients cannot be ignored.

The concept of enhanced recovery after surgery (ERAS) was first proposed by Danish doctor Henrik Kehlet in 1995 and introduced into colorectal surgery.[6] So far, the application effect of ERAS has been fully verified. For different types of research, the main indicators used to evaluate the effectiveness of ERAS programs include the length of stay, complication rates, readmission rates, and hospitalization expenses. To date, ongoing research has focused on the potential impact of ERAS programs on chronic postoperative pain after thoracotomy, new opioid dependence, cancer recurrence, and the impact of enhanced recovery protocols on patient-reported outcomes and quality-of-life indicators.[7] It is likely that the full potential of thoracic enhanced recovery protocols has not yet been realized and that more widespread adoption and study of these methods will lead to further improvements in patient care and outcomes.

The present study aimed to research and evaluate relevant available evidence of ERAS for patients with lung cancer surgery, then create a summary of the best evidence available to use as a reference in clinical practice, so as to construct an enhanced recovery after surgery program more suitable for application to lung cancer patients under Chinese national conditions and provide scientific reference for subsequent research.

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https://doi.org/10.1016/j.apjon.2022.03.006
Received 26 January 2022; Accepted 11 March 2022

Methods

Identification of evidence-based issues

We used the PIPOST method as a guide to identify research questions,[8] where "P" (population) is the target population for the application of evidence, that is, patients undergoing lung cancer surgery; "I" (intervention) is the recommended intervention, that is, enhanced recovery intervention; "P" (professional) is the implementer of the evidence application, that is, clinical management; "O" (outcome) is the outcome indicator(s), that is, the patient's complication rate, postoperative pain, and quality of life, etc.; "S" (setting) is the evidence application site; and "T" (type) is the type of evidence, that is, evidence-based guidelines, evidence summaries, practice recommendations, best-practice information sheets, systematic reviews, and expert consensus.

Evidence retrieval

According to the 6S model,[9] we performed literature searches of Medlive, PubMed, the Web of Science, the Cochrane Library, ClinicalKey, Embase, the Chinese Biomedical Literature Database (Sinomed), the China Academic Journals (CNKI) database, Wanfang Data, Ovid, the Registered Nurses' Association of Ontario database, UpToDate, National Guideline Clearinghouse database, the Guidelines International Network, the National Institute for Health and Care Excellence database, the European Society for Medical Oncology, and other databases. We also conducted manual reviews of the references of relevant studies. The search time was from the January 1995 until May 2021, and each database was searched using the following keyword string: "lung cancer or lung carcinoma or lung neoplasm or lung malignancy or VATS lobectomy or thoracoscopic surgery" and "fast track or enhanced recovery after surgery or enhanced recovery or enhanced recovery pathway or multimodal perioperative care or multimodal perioperative management or perioperative surgical home or FTS or ERAS." Additionally, the guideline used "fast track or enhanced recovery or multimodal perioperative or perioperative surgical home" and "lung cancer or VATS lobectomy or lobectomy or thoracic surgery" as search keywords.

Evidence inclusion and exclusion criteria

For a study to be included, the research object had to be lung cancer surgery patients; the research content had to include ERAS measures; and the research was either a guideline (in the last 10 years), evidence summary, best-practice information sheet, practice recommendation, expert consensus, or systematic review. In contrast, studies were excluded if the research content involved ERAS but the theme was not consistent with the content of the research; the study record was available as an abstract-only or translated version; the retrieved record was a news story, the study was only available behind a paywall/not available open access or other interpretation of a guideline or systematic review; the language of publication was Chinese or English; or the quality of the research was inadequate.

Evidence evaluation standard

To evaluate guidelines, the updated version of the Appraisal of Guidelines for Research and Evaluation Instrument II, which was published in December 2017[10] and is used to assess an article's scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, and editorial independence, was applied, considering six fields, 23 entries, and an additional two comprehensive evaluation items. Each item was scored from one to seven points, and the higher the score, the greater the degree of conformity of the item. Meanwhile, no corresponding quality-evaluation tool exists by which to evaluate evidence summaries, practice recommendations, and best-practice evidence information sheets, so we judged the quality of these types of evidence by tracing the original document of each evidence source and selecting the corresponding evaluation tool for quality evaluation. The 2017 updated version of the AMSTAR 2 evaluation criteria was used to assess systematic reviews.[11] Finally, the 2016 version of the Australian Joanna Briggs Institute (JBI) Evidence-based Health Care Center corresponding evaluation standards for evaluation was used to assess expert opinions/consensuses, quasi-experimental study, randomized controlled trials, and cohort studies.

Evidence description and summary

The 2014 version of the JBI Evidence Pre-grading System was used for the evidence-level classification, and the 2014 version of the JBI Evidence Rank System was used for the recommended-level classification.[12] According to the different research design types, the evidence level was divided into levels 1–5. The more rigorous the research design, the higher the level of evidence, and the recommended level of evidence was set according to the feasibility, suitability, validity, and clinical significance of the evidence, ultimately receiving either a Grade A recommendation (strong recommendation) or a Grade B recommendation (weak recommendation).[13]

Literature evaluation quality process

A team of two main literature reviewers (both with experience in evidence-based nursing learning and related training), one literature search consulting expert, and one evidence-based field consulting expert was established to evaluate the literature quality. In the case of disagreement, third-party experts were consulted. Based on the principles of the latest released or updated high-quality guidelines, the team jointly decided on the process of document inclusion and evaluation.

Results

Literature search results and general information

A total of 14 articles were included, including five clinical practice guidelines,[14–18] three expert consensus,[19–21] four systematic reviews,[22–25] and two evidence summaries.[26,27] Detailed general information of the included studies is shown in Table 1.

Literature quality-evaluation results

The quality-evaluation results of the guidelines are presented in Table 2.

Quality evaluation results of expert consensus

This study included three expert consensus,[19–21] two of them were evaluated as "unclear" for item six[19,21]; in contrast, the rest of the ratings were "yes" and were allowed to be included.

Quality evaluation results of systematic reviews

A total of nine systematic reviews were included in this study.[22–25] The studies by Huang et al,[23] Li et al,[24] and Fiore et al[22] received "yes" ratings, except for item 3 of all three studies, which received a "no" rating. Considering the study by Sebio Garcia et al,[25] except for items 3 and 15, which received "no" ratings, the rest of the items received "yes" ratings and were allowed to be included. In addition, five of the included articles were sourced from the evidence summary by Bibo et al,[25,26,28–31] including one of the aforementioned included systematic reviews.[25] Considering the remaining four articles, among the research items of Li et al,[28] item 3 received a "no" rating, item 4 received an "unclear" rating, and the rest received "yes" ratings, respectively, while research items 3, 10, 15, and 16 received "no" ratings and the rest received "yes" ratings

Table 1
Evidence Source and Content.

Literature Source (institution/database)	Author	Literature Type	Publication/ Update Date	Research Subject
Medlive	Berna et al.[14]	Evidence-based guideline	2021	Patient management for enhancing recovery after surgery of pneumonectomy patients
Medlive	Zhi et al.[15]	Evidence-based guideline	2020	Airway management of patients during the perioperative period of thoracic surgery
ERAS/ESET	Batchelor et al.[16]	Evidence-based guideline	2018	Optimal perioperative management of patients undergoing thoracic surgery
Pubmed/PACTS	Piccioni et al.[17]	Evidence-based guideline	2020	Anesthesia care management during the perioperative period of thoracic surgery (pre-hospitalization and preoperative)
Pubmed/PACTS	Piccioni et al.[18]	Evidence-based guideline	2020	Anesthesia care management during the perioperative period of thoracic surgery (intraoperative and postoperative)
Medlive	Wang et al.[19]	Expert consensus	2019	Perioperative lung protection in thoracic surgery
Medlive	China enhanced recovery after surgery expert group[20]	Expert consensus	2016	The management of enhanced recovery after surgery
Web of Science	Gao et al.[21]	Expert consensus	2019	Enhanced recovery after surgery management strategy
Web of Science	Fiore et al.[22]	Systematic review	2015	The effect of enhanced recovery after lung resection
Embase	Huang et al.[23]	Systematic review	2020	Evaluation of the effect of avoiding the use of a thoracic drainage tube after thoracic surgery
OVID	Li et al.[24]	Systematic review	2017	Management effect of enhanced recovery after lung cancer surgery
OVID	Sebio Garcia et al.[25]	Systematic review	2016	The effect of preoperative exercise for patients with lung cancer
Web of Science	Bibo et al.[26]	Evidence summary	2021	Pulmonary rehabilitation/physiotherapy before lung resection
OVID	Sørensen et al.[27]	Evidence summary	2021	Optimal suction level of digital chest drainage device after lobectomy

when considering the study by Steffens et al.[29] All research items of Cavalheri et al[30] except for items 3 and 4 received "no" ratings, and the rest received "yes" ratings. Finally, the research items of Ni et al,[31] items 3, 5, and 15 received "no" ratings; meanwhile, research items 2 and 4 received "partial yes" ratings, and the rest received "yes" ratings. The upon studies' research design is relatively complete and all these studies are included.

Quality evaluation results of randomized controlled trials

A total of eight randomized controlled studies were included in this study, four of which were sourced from the evidence summary of Sørensen et al[27,32–35] In the two studies of Lijkendijk et al,[34,35] item 3 received an "unclear" rating and items 4, 5, and 6 received "no" ratings, respectively. The research items of Holbek et al[33] received the same ratings as those recorded for Lijkendijk et al,[34,35] although item 9 also received a "no" rating. Research items 1, 2, 4, and 5 of the study by Brunelli et al[32] received an "unclear" rating, and the rest received "yes" ratings. The other four studies were chosen from the report of Bibo et al[26,36–39] Of them, research items 2, 4, 5, 8, and 9 of Bhatia et al[31] received "unclear" ratings and the rest received "yes" ratings; research items 4 and 5 of Liu et al[37] received "no" ratings and the rest received "yes" ratings; research items 4, 5, 6, 8, and 9 of Laurent et al[38] received "no" ratings and the rest received "yes" ratings; and item 2 received an "unclear" rating, item 4 received a "no" rating, and the rest received "yes" ratings when considering the study of Lai et al.[39] The upon studies' research design is relatively complete and all these studies are included.

Evidence summary and analysis

Through the evaluation and integration of the evidence, 84 best-evidence points were summarized for five aspects, including risk assessment, preoperative management, intraoperative management, postoperative management, and discharge follow-up for patients with lung cancer surgery, as shown in Table 3.

Discussion

In this study, we focused on the related measures of enhanced recovery after surgery included in different guidelines, expert consensus, etc. in various databases, and committed to integrating relevant measures to promote a complete ERAS program. In our results, the main content of ERAS for lung cancer surgery patients is divided into five main components, risk assessment, preoperative management, intraoperative management, postoperative management and post-discharge follow-up, but some of our included literature did not cover all the aspects. Regarding the parts of post-discharge follow-up and risk assessment, some literature' content is not focused on these two aspects, but spread out in the article. Based on the results, we found that different literature on enhanced recovery techniques have different emphases. It is necessary to synthesize the evidence, and at regular intervals we need to update the new evidence and adjust the conflicting recommendations between the conclusions of the old and new evidence.

In the guidelines quality evaluation section, most of the included guidelines were rated B, with only one guideline rated A by Berna et al.[14]

Table 2
Methodological Evaluation of the Guidelines Included in This Study.

Study	Standardized Scores in Various Domains (%)						≥ 60%	≤ 30%	Quality Evaluation
	Domain 1: Scope and Purpose	Domain 2: Stakeholder Involvement	Domain 3: Rigor of Development	Domain 4: Clarity of Presentation	Domain 5: Applicability	Domain 6: Editorial Independence			
Berna et al.[14]	69.4	63.9	66.7	88.9	60.4	100.0	6	0	A
Zhi et al.[15]	66.7	58.3	62.5	91.7	41.7	45.8	4	0	B
Batchelor et al.[16]	69.4	36.1	65.6	100.0	54.2	50.0	3	0	B
Piccioni et al.[17]	72.2	50.0	74.0	88.9	52.1	91.7	4	0	B
Piccioni et al.[18]	72.2	50.0	74.0	88.9	52.1	91.7	4	0	B

Y, recommended; YM, recommended after modification

Table 3
Best-evidence Summary for Enhanced Recovery After Surgery Techniques for Patients Undergoing Lung Cancer Surgery.

Subject of Evidence		Evidence Content	Original Resource	Evidence Level	Recommendation
Risk Assessment	Nutritional status	Screen patients for nutritional status and weight loss	Guideline	Level 3	A
		The following indicators were used to determine whether the patient has a severe nutritional risk: (1) weight loss of $\geq$ 10%–15% within six months; (2) the patient's food intake is $<$ 60% of the recommended intake for $>$ 10 days; (3) the body mass index is $<$18.5 kg/m^2; and (4) the albumin level is $<$30 g/L (no liver or kidney dysfunction)	Expect consensus	Level 5	B
	Complications risk	Patients with ASA level $\geq$ 3 are at greater risk of complications	Guideline	Level 3	A
	Anemia	Identify and investigate anemia	Guideline	Level 5	A
	Lung function assessment	Assess the patient's dyspnea, airway inflammation, and smoking; perform a lung function test, and, if necessary, a cardiopulmonary exercise test; finally,	Expect consensus	Level 5	A
		FEV_1 is a must-check item before surgery	Guideline	Level 5	A
		Arterial blood gas analysis as a routine lung-function test	Guideline	Level 2	A
		Preoperative arterial $PaCO_2$ $>$ 45 mmHg should not be used as a routine preoperative risk-assessment index	Guideline	Level 3	A
		Risk factors for preoperative airway complications: age $>$70 years, $>$ 400 cigarettes/year, asthma, airway hyper-responsiveness, chronic obstructive pulmonary disease, obesity or body surface area $>$1.68 m^2, low lung function, peak expiratory flow $<$300 L/min, pathogenic airway colonization bacteria, nutritional and metabolic disorders, past history of radiotherapy and chemotherapy, and history of surgery	Guideline	Level 3	B
	Thrombosis risk assessment	Use the Caprini score to screen moderate- and high-risk patients ($>$ 3 points)	Expect consensus	Level 5	A
	Infection	Elective surgery should be postponed until the acute respiratory infection is cured	Expect consensus	Level 5	A
	Renal function assessment	Abnormal serum creatinine and glomerular filtration are present in high-risk patients, so pay attention to prevent kidney injury	Guideline	Level 3	A
	Heart function assessment	Perform careful preoperative assessment of cardiac function, including clinical scoring	Guideline	Level 1	A
Preoperative management	Preoperative education	Patients regularly receive special preoperative consultations; introduce treatment-related knowledge and various suggestions to promote recovery through oral, written, and multimedia forms	Guideline	Level 1	A
	Nutrition management	Preoperative malnourished patients should take oral nutrition supplements	Guideline	Level 1	A
	Quit smoking	Quit smoking $\geq$ 4 weeks before surgery	Guideline	Level 1	A
	Quit drinking	Stop drinking for $\geq$ 4 weeks before surgery	Guideline	Level 1	A
	Anemia management	Iron therapy is the first-line treatment for iron-deficiency anemia; for non-special cases, blood transfusion or erythropoiesis should not be used for anemia just before surgery	Guideline	Level 1	A
	Pre-rehabilitation	Pre-rehabilitation can improve the patient's exercise capacity and enhance preoperative lung function	Systematic review	Level 1	A
		Perform comprehensive pre-rehabilitation for $\geq$ 1 week before surgery, including instructing patients to perform breathing exercises (e.g., using breathing training equipment), effective coughing, postural drainage, chest and back slaps; encourage patients to take deep breaths and effective coughs as soon as possible, and try to use multimodal rehabilitation (combined with respiratory assessment, smoking cessation, respiratory rehabilitation, application status, and physical exercise)	Guideline	Level 1	A
	Fasting before surgery	Patients are allowed to drink clear liquid before anesthesia and 2 h before surgery, and patients should fast for 6 h before the induction of anesthesia	Guideline	Level 1	A
	Carbohydrate therapy	Regular use of clear liquids to supplement carbohydrates	Guideline	Level 1	A
		If the patient has no history of diabetes, it is recommended to drink 400 mL of a 12.5% carbohydrate beverage 2 h before surgery	Expert consensus	Level 5	B
	Medication before anesthesia	Avoid routine preoperative sedatives to relieve anxiety	Guideline	Level 1	A
	Venous Thrombosis Prevention	Thoracic surgery patients are at high risk of postoperative VTE	Guideline	Level 5	A
		Use mechanical measures (e.g., intermittent pressure air pumps or elastic stockings) and medication to prevent VTE	Guideline	Level 3	A
		High-risk patients should take multiple drugs to prevent VTE	Guideline	Level 3	B
	Preventive use of antibiotics	Routine intravenous antibiotic prophylaxis should be completed within 60 min before the skin incision is made	Guideline	Level 3	A
	Prevent atrial fibrillation	Patients who took β-blockers before surgery should continue to take them after surgery	Guideline	Level 1	A
		Patients with magnesium deficiency may consider supplementing with magnesium	Guideline	Level 5	B
		For patients at high risk of atrial fibrillation, diltiazem or amiodarone can be taken before and after surgery	Guideline	Level 3	B
	Airway management	Patients undergoing thoracic surgery require airway preparation	Guideline	Level 5	B
		Those with more airway secretions can use mucolytics	Guideline	Level 1	A
		Preoperative patients with pathogenic tracheal-colonization bacteria should use antibiotics rationally	Guideline	Level 3	B

(*continued on next page*)

Table 3 (*continued*)

Subject of Evidence		Evidence Content	Original Resource	Evidence Level	Recommendation
		Chlorhexidine oropharyngeal disinfection	Guideline	Level 1	A
	Mode of administration	Use nebulized inhalation for patients who are unable to inhale, such as the elderly, the infirm, infants, and those with very low inspiratory flow rates	Guideline	Level 1	A
	Catheter indwelling	Avoid routine nasogastric tube placement	Guideline	Level 3	A
		Low-risk patients should avoid routine use of urinary catheters and do not need to use urinary catheters for urine output	Guideline	Level 5	B
Intraoperative management	Warm technology	Use a convective active warming device to maintain the patient's body temperature	Guideline	Level 1	A
	temperature monitoring	Monitor the patient's body temperature in real time and maintain the core temperature >36 °C to avoid hypothermia or hyperthermia	Guideline	Level 1	A
	Lung protection	Establish lung isolation with double-lumen tube or bronchial blocker	Guideline	Level 1	A
		Use active lung-protection strategies during single-lung ventilation	Guideline	Level 1	A
		Non-intubation anesthesia is not recommended	Guideline	Level 5	B
		Lung-protection strategy: low tidal volume (4–6 mL/kg), positive end-expiratory pressure ventilation for ventilation measurement, and lung recruitment strategy	Guideline	Level 1	A
	Anesthesia Technique	Use a combination of local anesthesia and general anesthesia to ease recovery from anesthesia and allow extubation as soon as possible	Guideline	Level 5	A
	Anesthesia management	Monitor the depth of inhalation anesthesia and intravenous anesthesia with an EEG bispectral index of 40–60; elderly patients should avoid a prolonged EEG bispectral index of < 45	Expect consensus	Level 5	B
		Avoid $PaCO_2$ of < 35 mmHg for a long time	Expect consensus	Level 5	A
	Preemptive analgesia	Reduce postoperative opioid use	Guideline	Level 1	A
		Intraoperative injection of magnesium sulfate or ketamine to relieve postoperative pain	Guideline	Level 1	B
	Liquid management	As conventional capacity management, avoid very strict or loose liquid solutions, and focus on goal-oriented personalized capacity management	Guideline	Level 2	A
		Use vasopressors and fluid restriction to avoid insufficient intraoperative perfusion, balanced crystalloids solution is preferred	Guideline	Level 1	B
		Doppler-guided blood flow detection and titration for postoperative fluid management	Guideline	Level 1	A
	Blood sugar control	Insulin is used to control blood sugar at < 10 mmol/L during surgery, and attention should be paid to avoid hypoglycemia	Expect consensus	Level 5	B
	Surgical technique: minimally invasive surgery	Use VATS	Guideline	Level 1	A
	Air leakage treatment	Use surgical sealant (glue or patch) for intraoperative air leakage	Guideline	Level 1	A
	Catheter management	Consider the use of central venous catheters according to the specific situation	Guideline	Level 5	A
		Some patients may consider not using a thoracic drainage tube	Systematic review	Level 1	A
Postoperative management	Stay in ICU	Do not enter the ICU ward systematically after surgery	Guideline	Level 3	A
		For patients with comorbidities, intraoperative complications, and a risk of postoperative complications, consider them entering the intermediate care unit after surgery	Guideline	Level 5	A
	Postoperative ventilation	Non-routine use of preventive non-invasive ventilation to reduce postoperative complications or hospital stay	Guideline	Level 1	A
		Unconventional use of high-flow oxygen therapy to reduce postoperative complications or hospital stay	Guideline	Level 1	A
	Non-drug control of PONV	Assess the risk of PONV	Guideline	Level 1	A
	Stay in ICU	All patients undergoing thoracic surgery should take non-pharmacological measures to reduce the baseline risk of PONV	Guideline	Level 1	A
	Pharmacological control of PONV	A multimodal pharmacological approach is combined with other measures to reduce the use of opioids after surgery; this is suitable for patients at moderate or high risk	Guideline	Level 5	A
	Postoperative multimodal analgesia	Paravertebral block and thoracic epidural analgesia have equivalent analgesic effects; epidural analgesia is used in major surgical operations (e.g., thoracotomy, thoracotomy, thoracic wall resection), and paravertebral block is used in VATS	Guideline	Level 1	A
		Dexamethasone can be given to prevent PONV and relieve pain	Guideline	Level 1	A
		For patients with chronic pain who have been taking opioids for a long time, consider ketamine	Guideline	Level 1	A
		Use a visual analog scoring method, digital rating scale, language rating scale, etc. to evaluate the pain of patients in different states	Expect consensus	Level 5	B
		For patients with known or confirmed coagulation dysfunction, use thoracic paravertebral block	Guideline	Level 1	A
		The erector spinae plane block is a kind of multimodal analgesia, which is suitable for VATS	Guideline	Level 4	A
		A fascial pain block, as a kind of multimodal analgesia, is suitable for VATS	Guideline	Level 1	A
	Chest drainage tube management	Avoid conventional application of external negative pressure suction flow	Guideline	Level 1	A
		Use a digital drainage system	Guideline	Level 1	A .

(*continued on next page*)

Table 3 (*continued*)

Subject of Evidence		Evidence Content	Original Resource	Evidence Level	Recommendation
		When air leakage is no longer observed and the drainage tube produces 300 mL/day of non-blood, non-chylous fluid, immediately remove the chest drainage tube	Guideline	Level 1	A
		Drainage using a single chest tube	Guideline	Level 1	A
		Low attractive force reduces total fluid drainage and the duration of possible air leaks	Evidence summary	Level 1	A
	Other pipeline management	Early removal of the catheter	Guideline	Level 1	A
		Early removal of the nasogastric tube	Guideline	Level 3	A
	Early activity	Early activity after 24 h	Guideline	Level 2	A
	Cough after operation	Patients with persistent cough after surgery affecting the quality of life should be assessed using the LCQ-MC scale	Guideline	Level 4	B
		Continuous cough after operation can be treated with inhaled corticosteroids and bronchiectasis	Guideline	Level 1	A
	Incision management	Clean the surgical incision regularly and check the situation	Expect consensus	Level 5	A
	Eating early	Resume oral intake as soon as possible for patients who are malnourished before surgery, they should be placed on oral nutrition preparations after surgery; for those who are still malnourished when discharged from the hospital, they should be encouraged to continue oral nutrition preparations outside the hospital for several weeks	Expect consensus	Level 5	A
	Pulmonary rehabilitation	Encourage patients to cough, breathe deeply, stimulate spirometry, practice oral care, raise the head of the bed (> 30°)	Expect consensus	Level 5	A
Discharge follow-up	Discharge follow-up	Strengthen follow-up and testing after discharge; guide patients' self-care through the telephone or outpatient service	Expect consensus	Level 5	A

ASA, American Society of Anesthesiologists; EEG, electroencephalography; FEV_1, amount of air forced from the lungs in 1 s; ICU, intensive care unit; LCQ-MC, Mandarin Chinese version of the Leicester Cough Questionnaire; $PaCO_2$, partial pressure of carbon dioxide; PONV, postoperative nausea and vomiting; VTE, venous thromboembolism; VATS, video-assisted thoracoscopic surgery

Most guidelines are of good quality, but are not rated as A due to lack of discussion or clear explanation in some domain (such as domains 2 and 5) resulting in low scores in that domain.

In the evaluation of the quality of expert consensus, some expert consensus have discrepancies or discrepancies with previous versions or viewpoints. Because this article believes that some discrepancies with previous viewpoints are updates of evidence or viewpoints, two of expert consensus were evaluated as “unclear” for item 6. Therefore, the quality of all included expert consensus is good. The content of their articles was included in the evidence rating of subsequent enhanced recovery surgery evidence.

In the quality assessment part of systematic reviews, some systematic reviews only included randomized controlled trials, and some included literature of other trial designs except RCTs. The quality of their research designs was all included in the quality rating.

In the RCT quality rating section, most studies did not describe allocation concealment and blinding, and there may be measurement bias. However, all literature showed that ERAS can promote perioperative rehabilitation with consistent research results, so the results are considered to be reliable, and the quality of the research design is considered to be included in the quality rating.

In summary table, we subdivided the five areas into smaller sections for convenience in clinical practice. It is hoped that this summary of evidence will help integrate existing knowledge into practice, align perioperative care and encourage future practice to address existing knowledge gaps. As the recommendation grade for most of the included ERAS elements is strong, the use of a systematic ERAS pathway has the potential to improve outcomes after thoracic surgery.

So far, the concept of enhanced recovery after surgery has been widely disseminated in China, but in practical applications, the extent of dissemination and implementation varies in different regions. In the application of thoracic surgery, the thoracic surgery department of West China Hospital, which is located in the southwest of China, is the first to create single-direction thoracoscopic lobectomy for lung cancer patients. So, West China Hospital has a faster speed and process to introduce and further develop ERAS for lung cancer patients. Hospitals in southwest China that were influenced by West China Hospital, accepted and adopted the concept of ERAS faster, too. Meanwhile, a series of thoracic surgery ERAS training courses led by West China Hospital also indirectly radiated to hospitals across the country. The top 3-A hospitals in the north and east of China have also successively carried out and continued to develop ERAS for thoracic surgery. At present, the process of implementing ERAS technology in a part of 3-A hospitals in China has been relatively mature, but there are individual and regional differences in the standardized application of ERAS by different medical staff in different hospitals. In addition, ERAS pays attention to the patient's sense of recovery experience. China is a large country composed of 56 ethnic groups. Different ethnic groups are distributed in different regions. The customs and cultural differences of patients still have an impact on the implementation of ERAS program. In general, the development of ERAS is inseparable from the continuous program improvement process and more detailed solutions for lung cancer patients. At the same time, the integration of medical care and multidisciplinary cooperation is also very important. Furthermore, it needs to be combined with the standardized application of ERAS clinical programs.

Limitations

Our research systematically searched 16 databases, guideline networks, etc., and manually searched the references of some relevant literature to fully include the relevant literature on enhanced recovery after surgery, but guidelines that are more than ten years old, the guidelines before the update, Consensus and other literature have been excluded, and there may be some bias. In addition, only Chinese and English databases were searched in this study, and some minor language literature were not included.

Conclusions

This article summarized the best evidence of ERAS techniques for patients undergoing lung cancer surgery and provided clinical medical staff with a scientific evidence-based basis for this technique. The literature included in this study were mainly written in English. The included articles report different concepts, attitudes, and understandings of enhancing recovery after surgery technology. There are obvious cultural and regional differences between foreign medical service systems and

domestic medical environments, so the application of ERAS technology in clinical practice should combine the best evidence and fully consider the status quo of the department, clinical experience, and patient conditions in order to develop a personalized and practical plan. In future research, further attention could be paid to the in-depth verification of the in-depth differences between primary and secondary interventions in patients with lung cancer surgery being managed under an ERAS protocol. This will help to provide richer and more reliable evidence resources for the enhanced recovery management of lung cancer patients in China and elsewhere and improve the science and effectiveness of clinical practice.

Authors' contributions

Conceived and designed the analysis: Renhua Xu, Yutong Lu, Zhenwei Yuan, Yuqiang Han, Yanfang Zhang
Collected the data: Yutong Lu
Contributed data or analysis tools: Yutong Lu, Zhenwei Yuan
Performed the analysis: Yutong Lu
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Funding

This work was supported by the Projects of Shandong Provincial Social Science Planning and Management Office (Grant No. 21CGLJ01, RHX), Shandong Province Department of Science and Technology (Grant No. 2018GSF118159, RHX), Shandong Province Natural Science Foundation (Grant No. ZR2016CL08, RHX), and Binzhou Medical University (Grant No. JYKTZD2021012, RHX; HYCX2021-004, YTL).

Declaration of competing interest

None declared.

Acknowledgements

We thank Professor Jun'e Liu from the Capital Medical University School of Nursing for her thesis guidance.

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