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Barriers and facilitators to prehabilitation of elderly patients with early lung cancer from the perspective of different clinical professionals: a qualitative study

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Abstract

Background Understanding the barriers and facilitators of prehabilitation in elderly patients with early-stage lung cancer is of significant importance. This study aimed to elucidate these barriers and facilitators from the perspectives of different clinical professionals.

Methods A qualitative descriptive study was undertaken. Semi-structured interviews with clinical professionals, using purposive sampling and content analysis were conducted in March to May 2023 to summarize and refine the key themes.

Results From the perspective of clinical professionals, the facilitators of prehabilitation have been categorized into five major themes. These include the recognized importance of prehabilitation, the positive attitude of clinical professionals, the support of leadership, the willingness of the majority of patients to accept prehabilitation, and the initial implementation of an enhanced recovery after surgery - multidisciplinary team (ERAS-MDT) approach. Conversely, clinical professionals identify several barriers to prehabilitation, which are grouped into seven themes. These impediments encompass a lack of knowledge regarding clinical practice, insufficient preoperative preparation time, the absence of an aging-friendly clinical practice scheme, an immature multidisciplinary cooperation mechanism, a lack of explicit regulations, inadequate emergency safeguards, and a shortage of specialized professionals. Practice strategies for promoting prehabilitation in elderly patients with early lung cancer include development of evidence summaries, develop healthcare training materials, develop patient health education brochures, clarify the division of labor of ERAS-MDT, improve patient safety and monitoring measures, optimize practice flow and obtain funding support.

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Conclusion To enhance the feasibility and clinical relevance of prehabilitation, clinical professionals should consider establishing a multidisciplinary information consulting team, developing a comprehensive prehabilitation program, and reinforcing the support system prior to surgery.

Keywords Elderly, Lung neoplasm, Prehabilitation, Qualitative research, Barrier, Facilitator, Practice strategy

Introduction

Lung cancer is a tumor that ranks high in morbidity and mortality [1]. According to the latest epidemiological data [2, 3], an estimated 19.965 million new cancer cases were diagnosed globally. Among these, lung cancer accounted for 2.48 million new cases, representing 12.4% of all new cancer cases. The total number of cancer-related deaths worldwide reached 9.737 million, with lung cancer contributing to 1.817 million deaths, equivalent to 18.7% of all cancer-related fatalities. In China, approximately 4.825 million new cancer cases were reported, of which lung cancer constituted 1.061 million new cases. This figure represents approximately 40% of the global incidence of lung cancer, positioning it as the most prevalent cancer type in the country [4]. The total number of cancer deaths in China was 2.574 million, of which 733,300 were due to lung cancer, representing over 30% of all cancer deaths [5]. Overall, lung cancer remains one of the most prevalent and deadly cancers globally and in China. Its high incidence and mortality rates pose a significant challenge to public health [6].

Age is an important risk factor for lung cancer [7]. Around 2.3 million incidences of cancer were diagnosed among elderly adults worldwide, accounting for 13% of all cancers [8]. Lung cancer is the predominant malignancy among the elderly population [9, 10]. In recent years, the incidence of lung cancer in elderly individuals has shown an upward trend, correlating with the progressive aging of the global population [11]. Surgery remains a primary therapeutic modality for patients with lung cancer, serving as an essential and critical component in the management of this disease [12]. The frequency of lung resections performed is increasing due to the growing incidence of lung cancer in elderly patients [13].

The advancements in early screening for lung cancer, coupled with the continuous refinement of surgical techniques, have significantly increased the likelihood of curative treatment for elderly patients [14, 15], but the surgical trauma still leads to various stress reactions, which in serious cases can cause a variety of postoperative diseases and affect normal physiological functions [16, 17]. Compared with traditional open surgery, thoracoscopic pneumonectomy is a minimally invasive procedure that offers several clinical advantages [18]. It is associated with a shorter recovery time and reduced postoperative complications. This surgical approach has the potential to attenuate the metabolic response and pain-related stress in elderly lung cancer patients [19]. Additionally, it may contribute to improved survival rates and enhanced cardiorespiratory function following surgery [20].

Nevertheless, surgical treatment may still exert an impact on the postoperative respiratory function and mobility of elderly patients with lung cancer. Owing to diminished preoperative functional capacity and reduced tolerance to surgical stress, elderly patients are at an elevated risk of postoperative complications. Therefore, it is imperative to optimize their preoperative condition to enhance surgical preparedness [21, 22]. Although there is increasing evidence highlighting the benefits of prehabilitation, its integration into routine clinical practice remains limited.

Prehabilitation, which encompasses a multimodal approach involving preoperative assessment and personalized interventions such as exercise, dietary optimization, and psychosocial support, has been demonstrated to improve surgical outcomes, reduce perioperative morbidity, and enhance overall patient prognosis [23–26]. While several quantitative studies have validated its effectiveness [27, 28], the translation of these findings into routine clinical practice is often hindered by real-world challenges [29]. The Ottawa Model of Research Use (OMRU) provides a framework for translating research evidence into clinical practice by emphasizing the importance of evaluating potential adopters during the implementation process [30, 31]. As present, a substantial gap persists in comprehending the barriers and facilitators that influence the implementation of prehabilitation programs, particularly among clinical professionals who care for elderly patients with early-stage lung cancer.

The objective of this study was to evaluate the awareness, attitudes, knowledge, concerns, and current practices of clinical professionals regarding prehabilitation. Specifically, we aimed to identify the perceived barriers and facilitators to implementing prehabilitation programs for elderly patients with early-stage lung cancer, as reported by various healthcare professionals involved in their care, including clinicians, ward nurses, rehabilitators, psychologists, dietitians, and clinical administrators. Our findings may provide novel insights into the practical challenges and opportunities associated with prehabilitation, offering valuable implications for healthcare providers and policymakers.

Methods

Study design and setting

This was a qualitative descriptive study, and was documented in accordance with the Standards for Reporting Qualitative Research [32] to improve the methodological quality of this inquiry. This qualitative study with in-depth interviews and thematic analysis [33] was conducted at Huadong Hospital Affiliated to Fudan University from March to July 2023. The hospital is a tertiary general hospital located in Shanghai, with a focus on geriatric medicine. It is equipped with advanced diagnostic and therapeutic devices and features specialized clinical departments. The hospital has 1,500 open beds and 44 clinical and medical technology departments.

Participants and sampling

In this study, purposive sampling was used to identify potential adopters of prehabilitation for elderly patients with early lung cancer under the ERAS concept, using the maximum differentiation principle: clinical administrators, clinicians, ward nurses, rehabilitators, psychologists, and dietitians. Purposive sampling is a non-probability sampling technique used in qualitative research to select participants based on specific criteria relevant to the study's objectives [34]. This approach ensures that participants are information-rich cases, possessing detailed knowledge and experience with the phenomenon of interest, thereby enhancing the depth and relevance of the data collected [35]. The sample size was determined using the "saturation principle," which states that no new themes arose from the interview data [36].

For clinical professionals, the inclusion criteria were as follows: (1) have necessary licenses; (2)10 years or above of work experience; (3) a bachelor's degree or higher; (4) voluntary involvement in the study and active collaboration during the interviews.

Prehabilitation program

The prehabilitation program implemented in our study was specifically designed to enhance the functional capacity and overall health of patients undergoing lung cancer surgery, with the goal of improving postoperative outcomes. This multimodal intervention integrated exercise training, breathing exercises, nutritional support, psychological support, and education on self-management. Patients participated in a supervised regimen that combined aerobic exercises, such as walking and cycling, to boost cardiovascular endurance, along with resistance training to strengthen major muscle groups. Given the respiratory challenges associated with lung cancer and surgery, patients were also instructed in specific breathing exercises to enhance pulmonary capacity and reduce the risk of postoperative respiratory complications. Nutritional counseling was provided to ensure adequate caloric and protein intake, addressing the critical need for nutritional optimization to mitigate malnutrition and improve overall resilience. Cognitive-behavioral techniques were employed to address anxiety and stress related to the diagnosis and upcoming surgery, particularly important for older adults who may face unique challenges related to frailty and age-related functional impairments.

Additionally, patients received education on the importance of prehabilitation and were provided with resources to support self-management strategies, including information on the surgical process, recovery expectations, and the benefits of maintaining an active lifestyle during the preoperative period. The program was delivered in an outpatient setting over 2–4 weeks prior to surgery, depending on the patient's clinical status and surgical schedule. Compliance was monitored through regular follow-up visits, with adjustments made to the program as needed to accommodate individual patient needs.

Interviews procedures and data collection

In our study, we have collaborated closely with experienced researchers and clinical professionals throughout the research process. Their expertise and guidance have been instrumental in shaping the study design, data collection, and analysis. A descriptive qualitative research approach [37] was employed to conduct semi-structured interviews in a face-to-face format. The interviews were held in a demonstration room within the thoracic surgery ward. To prepare for the interviews, the interviewer attended relevant training sessions and reviewed established methodologies and strategies for qualitative interviewing. The interviews were conducted in a quiet and comfortable setting to minimize potential disruptions. Participants were given the opportunity to select their preferred time slot, with each interview scheduled to last between 20 and 30 min. After obtaining informed consent from the participants, the interview content was captured through a combination of detailed note-taking and audio recordings. All information collected was maintained with strict confidentiality.

The interview process consisted of three distinct phases. In the initial phase, a warm and professional introduction was conducted. The interviewer explained the purpose of the study and the collaborative nature of the research process, established a welcoming and comfortable environment, and introduced the topic of discussion to foster a positive and trusting relationship with the participants [38]. In the second phase, the interviewer closely monitored the emotional state of the interviewees, ensuring that the conversation remained focused and relevant. Participants were encouraged to engage in in-depth discussions, and support was provided to facilitate the expression of their personal insights and experiences

Table 1 Semi-structured outline

Aspect	Questions
Awareness	1. Are you familiar with prehabilitation? Know precisely what's included in it?
	2. Do you consider prehabilitation to be significant from a professional standpoint? Why?
Attitudes	3. Do you believe it is appropriate to carry out prehabilitation to your department? Why?
Knowledge / skills	4. What do you consider to be your department's weak points in the prehabilitation implementation process? What should be made better?
	5. Why, in your opinion, is prehabilitation valuable?
Concerns	6. In your opinion, how should the department proceed if prehabilitation is implemented without adding to the workload?
Current practice	7. What do you think of the current status of prehabilitation implement? Could you cite an instance?

[39]. In the final phase, the interviewer reviewed the key findings with the interviewees and provided timely feedback at the conclusion of the session [40]. Following the interview, participants received prompt feedback that included a summary of the topics and key points discussed, as well as an acknowledgment of their contributions and cooperation.

An interview outline was developed based on the five key aspects of the assessment of potential adopts in the clinical evidence as presented in the OMRU [41]. Before the formal interviews, two clinical professionals were chosen for pre-interviews, and members of the research team carefully revised the content of the interview outline based on the interviews and interviewees' feedback to optimize and improve the final interview outline. Table 1 shows the specific interview outline.

Data analysis

Two researchers organized the interview materials based on the audio recordings of the interviews within 24 h and returned them to the interviewees to confirm their validity. The information was grouped and polished sentence by sentence, then summarized to construct themes using the content analysis method [42].

The research process involved the following steps: (i) The interview data were carefully and thoughtfully reviewed multiple times by the researcher until a thorough understanding of the material and its overall content was achieved. (ii) A line-by-line analysis was conducted, followed by the identification and open coding of significant statements. (iii) Similar or related codes were compared and categorized, leading to the gradual formation of themes. (iv) The researcher defined the themes, and codes, and selected several representative examples from the data. Data collection and analysis were conducted using Microsoft Excel and Word software.

Table 2 Characteristics of participants ($n=12$)

No.	Professional title	Education Degree	Working Experience Year
N1	Thoracic Surgery Rehabilitation Specialist Nurse	Master	10y
N2	Thoracic Surgery Nurse Manager	Master	15y
N3	Head Nurse of Surgical Unit	Bachelor	26y
N4	Associate Chief Thoracic Surgeon	Master	10y
N5	Chief Thoracic Surgeon	Master	19y
N6	Deputy Director of the Ministry of Social Work	Master	10y
N7	Chief Physician of Neurology	Doctor	20y
N8	Nutrition Chief Physician	Master	33y
N9	Dietitian of Nutrition Section	Bachelor	27y
N10	Chief Physician of Rehabilitation Department	Bachelor	29y
N11	Cardiopulmonary Rehabilitation Therapist of Rehabilitation Department	Master	10y
N12	Deputy Director of Medical Services Department	Doctor	10y

Ethical approval and Rigor

This study was conducted in strict accordance with the principles of the Declaration of Helsinki. Prior to the commencement of this investigation, clearance and approval were acquired by the Huadong Hospital affiliated to Fudan University Medical Ethics Committee at Fudan University (20230021). Prior to participating in the interviews, all research subjects were thoroughly briefed on the aim of the study, the specific methodology employed, and the safety measures in place to protect their well-being. Additionally, they were informed about the confidentiality policies governing their personal information and the voluntary nature of their participation. Written informed consent was obtained from each participant after ensuring they had a clear understanding of the study procedures and their rights. Participants were also informed that they could withdraw from the study at any time without penalty or loss of benefits. The names of the study participants were replaced with codes during the investigation, and the study data were appropriately preserved to guarantee that the participants' private information was kept private.

Results

Twelve clinical professionals including clinical administrators, clinicians, ward nurses, rehabilitators, psychologists, and dietitians—numbered N1 through N12—were selected as interview subjects. There were five males and seven females among them, with ages ranging from 32 to 53 and years of job experience from 10 to 33. Table 2 displays the characteristics of participants.

In Table 3, there were five themes for the facilitators of prehabilitation, and barrier themes for the facilitators of

Table 3 An overview of the themes

Themes	
Facilitators	Recognized importance
	Clinical professionals' positive attitude
	Leadership support
	Most patients willing to accept
	Initial ERAS-MDT
Barriers	Lack of clinical practice knowledge
	Insufficient preoperative preparation time
	Lack of aging-friendly clinical practice scheme
	Immature multidisciplinary cooperation mechanism
	Lack of explicit regulatory
	Lack of emergency safeguards
	Lack of professionals
Practice Strategies	Development of evidence summaries
	Develop healthcare training materials
	Develop patient health education brochures
	Clarify the division of labor of ERAS-MDT
	Improve patient safety and monitoring measures
	Optimize practice flow
	Obtain funding support

prehabilitation. In addition, 7 practice strategies for prehabilitation were identified.

Facilitators

Recognized importance

Every interviewee acknowledged the significance of prehabilitation for elderly individuals diagnosed with early lung cancer.

> *Since I am a Cardiopulmonary Rehabilitation Therapist, I feel that prehabilitation is very important for improving patients' tolerance to surgery, reducing postoperative complications, and recovering cardiopulmonary function after surgery. (N11)*

> *I think that for the patient, prehabilitation can draw attention to his own health as well as that of his family, and from that point of view, this is also an important thing. (N5)*

> *From a practical point of view, the implementation of prehabilitation will have a positive influence on bed turnover and readmission rates in the later wards, and I believe it is valuable to do prehabilitation. (N12)*

Clinical professionals' positive attitude

According to this study, the medical professionals surveyed expressed a strong willingness to carry out prehabilitation. They were aware that there would be challenges to overcome, but due to prehabilitation can improve the prognosis of patients, they hoped it could be implemented as soon as possible.

> *Prehabilitation can help patients adjust to life following surgery, so I am an advocate of it. (N2)*

Leadership support

Some interviewees believe that changes in prehabilitation must be actively supported by hospital and departmental leadership, which, when combined with adequate policy support, can expedite prehabilitation program implementation.

> *First and foremost, I feel that the most important contributing aspect is leadership. Our hospital's leadership support is still very much recognized in terms of speed, so that our numerous associated departments in the business of communication and collaboration will be more fluent. (N4)*

Most patients willing to accept

Several interviewees stated that they had discussed prehabilitation with their patients. The majority of the patients had a favorable attitude regarding prehabilitation and were eager to participate since they believed it would aid them throughout their recovery journey.

> *My previous patient's daughter came to see me because her mother was having psychological issues in preparation for a lung resection. Her mother successfully completed the surgery with the support of psychological counseling. They feel that prior to surgery, prehabilitation is required. (N7)*

> *I have an experienced patient who has undergone some procedures. He believed that the better he felt physically before surgery, the better he would be able to fight the anesthetic, therefore prehabilitation was essential. (N3)*

Initial enhanced recovery after surgery - multidisciplinary team (ERAS-MDT)

ERAS-MDT is a comprehensive and collaborative approach designed to optimize patient outcomes by integrating the principles of Enhanced Recovery After Surgery (ERAS) with the expertise of a multidisciplinary team [43]. This team-based approach ensures that each aspect of patient care is optimized, from preoperative preparation to postoperative recovery [44]. According to certain interviewees, since the department was creating an expedited rehabilitation surgical demonstration

unit, it already had an initial ERAS-MDT that was a key facilitator.

Currently, our hospital is one of the best in doing rapid rehabilitation in thoracic surgery. Although prehabilitation is not fully developed, the conditions for its implementation are adequate because we have an initial multidisciplinary team. (N5)

Barriers

Lack of clinical practice knowledge

According to interviewees, they indicated that they were aware of the concept of prehabilitation, but when it came to specific connotations, they frequently interpreted it based on superficial definitions, and there was confusion with the concept of preoperative preparation.

Prehabilitation, as I understand it, most importantly embodies the concept of 'in advance' and the need to take some of the work that was originally done in the late perioperative period and accomplish it up front. (N10)

Prehabilitation is the time that follows the decision to have lung cancer surgery. This process, yet necessitates a multidisciplinary approach. (N1)

Prehabilitation, which we provide in the nutrition department, is providing patients with oral nutritional supplements ten hours before surgery to alleviate gastrointestinal discomfort and anxiety. (N9)

Because previously in my understanding, perioperative rehabilitation for lung cancer included both preoperative and postoperative rehabilitation, and now prehabilitation ought to equate preoperative rehabilitation. (N11)

Insufficient preoperative preparation time

The main issue with the current prehabilitation implementation, which might affect both adherence and the efficacy of prehabilitation procedures, is the lack of preoperative preparation time, as reported by interviewees. A significant obstacle to regularizing prehabilitation is the short preoperative time. Variable hospital bed booking cycles and uncertainty regarding the timing of patients' surgical decisions result in varying patient wait times different, which affect prehabilitation implement.

Given the current circumstances, a large number of patients are admitted to the hospital for a very brief amount of time—between one and three days prior to surgery. There is not much time left for prehabilitation, which can have a big effect on how compliant patients are. (N2)

Lack of aging-friendly clinical practice scheme

Participants in the interviews mentioned that elderly patients would choose basic, easy-to-perform kinds of exercise, but now lack aging-friendly prehabilitation programs which take the patient's physical condition as well as exercise preferences into account.

During an outpatient visit, one of my patients expressed to me how they would like to be able to fit in the necessary exercise into their daily routines. Examples of this include walking, attending morning exercise programs on TV, and doing chores. The current clinical recommendations for exercise are not customized to the patient's preferences. (N10)

It is excellent to provide information in written form, but it needs to be presented in a more detailed and closer manner, and the font size needs to be larger, so that the older patients can read it more easily. (N3)

Immature multidisciplinary cooperation mechanism

The development of the ERAS-MDT is critical across the entire range of prehabilitation, and clinical professionals visited noted the existing lack of a defined team division of labor and adequate incentives.

There are no particular operational methods in the three domains of cooperation, estimation, and responsibility in the interdisciplinary teams that now exist. For instance, there isn't a precise and defined division of work among the several specialties. Additionally, the present information system is imperfect. It's also unclear how referrals to different specialties are made during prehabilitation assessment. (N6)

Lack of explicit regulatory

Interviewees stated that there is no appropriate mechanism in place to surveillance how prehabilitation is carried out. Even after informing the patient, it is unclear whether or not the patient followed through on the recommendation.

The success of prehabilitation is greatly influenced by monitoring, but there is no enough supervision to draw from. While it could be feasible to give the family instructions on how to participate in the process, oversight cannot be completely delegated to the family. (N5)

Lack of emergency safeguards

The requirement for emergency precautions to guarantee patient safety when elderly patients with early lung cancer are unable to finish prehabilitation procedures or when accidents occur during prehabilitation is one issue that interviewees stated that is commonly disregarded.

> *The issue that we sometimes overlook is that the target group is elderly patients, which is a very specific group that needs to be protected during the prehabilitation process. The patient can be seen as being prepared to get emergency care at any time if they are in a hospital setting. In the instance of home, the patient must be informed of the potential risks and the best ways to manage them. (N8)*

Lack of professionals

According to interviewees, the successful execution of prehabilitation is also dependent on the well-coordinated efforts of a lung cancer specialist nurse. Unfortunately, the hospital does not currently have such a position, nor does it have enough specialized staff.

> *Nursing staff has a fusion of perspectives, psychological care, nutritional care, rehabilitation care. When we promote prehabilitation, nursing staff can play a significant role in the management. (N12)*

> *We currently do not have a highly trained nurse specializing in lung cancer in our hospital. Nurses are essential in the implementation of prehabilitation, and they could be contacted by a nurse specializing in the health management of elderly adults with early lung cancer to facilitate this process. (N1)*

Develop healthcare training materials

Interviewees underlined the necessity to continually enhance clinical professionals' conceptions through the creation of training materials and the optimization of training programs in order to support the continued deployment of prehabilitation.

> *The most important component in the application of prehabilitation is that healthcare workers, particularly clinical doctors, must understand the concept of prehabilitation. Their active encouragement of the patient to do so is the most effective. Adequate practical knowledge on the side of healthcare providers is required before they can help patients comprehend that prehabilitation is beneficial to their condition and recovery, and patients will be more likely to cooperate. (N11)*

Develop patient health education brochures

Although patients currently have a positive attitude toward prehabilitation, according to the interviewees, before they can more effectively develop a prehabilitation program, they need access to sufficient health promotion materials to help them learn more about the program's contents.

> *There is a need to continually reinforce the health education of prehabilitation for patients, either in the form of paper brochures or by utilizing video scrolling. (N9)*

> *It would be nice if there were relevant videos for patients to follow along with, just like watching TV to help them accept the training methods more easily. (N6)*

Practice strategies

Development of evidence summaries

In the research of prehabilitation for lung cancer, there is currently no standard for intervention time, modality, or evaluation of intervention effect. Prehabilitation is primarily provided as a single prehabilitation session that emphasizes respiratory training or exercise therapy. There is a need to comprehensively summarize the evidence from relevant guidelines for elder patients with early lung cancer in order to synthesize protocols that will benefit clinical practice.

> *We have been doing prehabilitation related therapy in our department, which mainly involves initial exercise training and respiratory training. We hope to have a summary of all guidelines to help our practice. (N4)*

Clarify the division of labor of ERAS-MDT

According to interviewees, the department now has only a preliminary multidisciplinary team, which is not stable enough, and the corresponding operational procedures must be developed as quickly as feasible. More importantly, there is a need to specify the content of performance evaluation following interdisciplinary collaboration, which will aid in improving the accuracy and efficiency of health care personnel executing prehabilitation.

> *If we want ERAS-MDT to be a function in the long run, a multidisciplinary building mechanism must be developed. This mechanism must specify how multidisciplinary teamwork will be conducted, whether it will take the form of an integrated outpa-*

tient clinic, and how each discipline will be paid in advance and have its performance evaluated. (N12)

Improve patient safety and monitoring measures

A number of the interviewees placed a high value on oversight of the prehabilitation program's implementation and the safety precautions for senior patients. They believed that the first and most important stage in conducting prehabilitation was setting up safeguards.

The program must take patient safety concerns and monitoring into account while implementing home-based prehabilitation. (N3)

Optimize practice flow

The majority of the interviewees brought up the issue of inadequate preoperative preparation time, to which the administrators among them offered solutions. They felt that in order to learn more about the features of patients' preoperative physical conditions, they had to evaluate the characteristics of their preoperative physical dysfunction. From there, the issue of inadequate preoperative preparation time can be resolved by streamlining the prehabilitation method and content.

Hospitalization days and postoperative pulmonary function changes may not accurately reflect the impact of brief prior treatments. Next, by evaluating additional areas of patient benefit, such as inpatient experience, patient-reported outcomes following surgery, and patient cognition, the efficacy of prehabilitation can be confirmed. For the purpose of implementing prehabilitation, even a tiny change matters, so it can be addressed by optimizing prehabilitation practice processes. (N8)

Obtain funding support

A few interviewees brought up the necessity of actively pursuing funding sources that could facilitate the initiation of prehabilitation.

I believe there are still certain things on which one can rely. For example, with funding, we can deploy wearable gadgets to supervise patient execution and check patients' vital signs. Just as you are doing now, accelerating new clinical interventions in a scientific way. It's very easy to do in this way, and it's easy to succeed. (N5)

Discussion

Our findings suggest that while clinical professionals generally maintain a positive attitude towards prehabilitation, there is still a need for additional training to enhance their cognitive understanding and practical skills in this area. To improve patient comprehension of prehabilitation, it is essential to strengthen the multidisciplinary collaboration mechanism and reinforce preoperative informational counseling. A study conducted by Ferreira et al. [45]. demonstrated the feasibility of a multimodal prehabilitation strategy for patients with lung cancer awaiting surgery. The findings revealed that patients undergoing thoracoscopic lobectomies for lung cancer could achieve clinically meaningful improvements in perioperative functioning through a 2-week home-based multimodal rehabilitation program [46]. Nevertheless, a substantial gap persists in the availability of effective, age-friendly prehabilitation programs specifically tailored for elderly patients. To address this deficiency, it is crucial to synthesize the existing evidence recommended by current guidelines. This synthesis will facilitate the development of a systematic prehabilitation intervention program for elderly patients with early-stage lung cancer. The program should incorporate specific elements, including optimal timing of intervention, structured intervention protocols, and defined intervention durations, to ensure its clinical relevance and effectiveness. To enhance the practicality of prehabilitation, it is essential to carefully consider the unique conditions and specific needs of elderly patients. The prehabilitation program aims to provide patients with comprehensive, targeted, and structured interventions and rehabilitation prior to surgery, with the goals of reducing postoperative complications, alleviating pain, improving quality of life, and ensuring clinical appropriateness [47].

Recent evidence highlights the critical role of integrating prehabilitation into the continuum of cancer care to improve long-term patient health outcomes [48]. As clinical research increasingly supports the benefits of multimodal prehabilitation, including enhanced perioperative functional status and accelerated postoperative recovery, many domestic and international ERAS guidelines have updated their recommendations to more strongly endorse prehabilitation-related strategies or elevate their level of evidence [49, 50]. The expanding corpus of evidence-based resources has significantly bolstered clinical professionals' comprehension and application of prehabilitation practices. This progress is further propelled by the prevailing consensus among clinicians that evidence-based therapies and care protocols consistently lead to enhanced patient outcomes. Moreover, hospital administrators have demonstrated a growing interest in promoting prehabilitation, driven by both the benefits to patients and the potential financial advantages for healthcare institutions. However, despite increasing recognition of the value of prehabilitation among healthcare providers, there remains a need to further enhance their clinical expertise in this domain. Therefore, the development of standardized training manuals and the implementation

of regular training sessions for healthcare staff are crucial steps to ensure the effective integration of prehabilitation principles into routine clinical practice.

Among elderly patients with early-stage lung cancer, there is a notable increase in the acceptance of prehabilitation. However, a substantial gap persists between awareness and actual implementation [51]. Effective preoperative management hinges critically on the provision of comprehensive medical information [23] Tailored prehabilitation counseling and detailed, multimodal preoperative information for patients and their families can enhance patient preparedness, satisfaction, and adherence to prehabilitation protocols [52]. The successful implementation of prehabilitation relies heavily on comprehensive informational support provided to patients before its commencement. Utilizing an integrated information technology platform that offers both offline and online consultation and support channels can effectively address patients' informational needs. This approach not only enhances patient compliance with prehabilitation protocols but also has the potential to improve postoperative outcomes.

According to ERS, interdisciplinary cooperation needs to be enhanced all the way through the lung cancer treatment procedure [53]. Creating an effective ERAS-MDT team contributes to better patient outcomes, lower treatment costs, shorter hospital stays, and higher-quality care overall [54]. The National Institute for Health and Care Excellence (NICE) [55] recommends the involvement of clinical lung cancer nursing specialists to provide information and support, thereby enhancing the quality of care for individuals with lung cancer. Specialists within the multidisciplinary team are essential for patient assessment, care planning, and coordination across the entire treatment continuum. However, to address the escalating demands of lung cancer care, continuous optimization of human resource allocation, nursing administrative functions, and the development of specialized educational nursing roles is necessary [56].

Prehabilitation can be categorized into two primary types: home-based and hospital-based. Home-based prehabilitation offers the advantage of convenience and can be sustained over a longer duration. However, hospital-based prehabilitation is generally considered to be more effective [57]. Wearable technology and telemedicine can be used in home-based prehabilitation IOT devices for effective patient safety monitoring [58]. In the current clinical practice of prehabilitation for elderly patients with early-stage lung cancer, a significant challenge is the limited preoperative preparation time. This limitation can be more effectively addressed by incorporating the principles of precision care and precision medicine into prehabilitation protocols. To achieve this, a comprehensive latent analysis of each patient's clinical, functional, and psychosocial profiles is essential. By thoroughly understanding the unique circumstances of individual patients, the implementation process can be restructured to deliver targeted and personalized interventions and therapies. This approach may not only enhance patient outcomes but also optimize the utilization of medical resources.

We recognize several limitations that may affect the interpretation and generalizability of our findings. One significant limitation is the involvement of a diverse group of clinical professionals, each with varying levels of knowledge and backgrounds. Although this multidisciplinary approach provides a comprehensive perspective, it also introduces variability in the implementation and interpretation of interventions. This heterogeneity may limit the generalizability of our results to specific populations and settings, as the effectiveness of targeted interventions could be influenced by the unique expertise and experiences of the healthcare providers involved. Additionally, our study's findings are primarily derived from a specific patient population, which may not be representative of broader clinical contexts. This restricts the direct applicability of our results to other populations or healthcare environments without further validation. Future research should address these limitations by incorporating standardized protocols for intervention delivery and by conducting studies across diverse populations to enhance the robustness and generalizability of findings.

Conclusion

In summary, our study has identified three critical insights with direct relevance to clinical practice: First, clinicians generally hold positive attitudes toward prehabilitation; however, significant gaps exist in their conceptual understanding and practical implementation skills. This highlights the urgent need for systematic training programs to enhance their competencies. Second, the current implementation of prehabilitation is hampered by challenges in multidisciplinary coordination and preoperative patient education. This suggests the necessity of strengthening interdisciplinary collaboration mechanisms and developing standardized patient education materials. Third, safety concerns and compliance issues have emerged as critical barriers to effective prehabilitation, indicating the importance of implementing enhanced safety protocols, emergency response systems, and robust supervision mechanisms. These findings collectively underscore the need for comprehensive training programs for healthcare providers, improved patient education strategies, and robust safety measures. Such initiatives are essential to optimize the implementation of prehabilitation for elderly patients with early-stage lung cancer, thereby enhancing postoperative recovery outcomes.

Supplementary Information

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Supplementary Material 1

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Author contributions
R Z, L X designed research; R Z, M W, Y C, L Z, Y X, L X conducted research; R Z, M W, Y C analyzed data; R Z, M W wrote the first draft of manuscript; Y X, L X had primary responsibility for final content. All authors read and approved the final manuscript. All authors contributed to the conception or design of the study or to the acquisition, analysis, or interpretation of the data. All authors drafted the manuscript, or critically revised the manuscript, and gave final approval of the version that was submitted for publication. All authors agree to be accountable for all aspects of the work, ensuring integrity and accuracy.

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Data availability
The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
In this study, all methods were performed in accordance with the relevant guidelines and regulations. The study has been reviewed and approved by the ethics committee of Huadong Hospital affiliated to Fudan University (approval number: 20230021). And written informed consents had been obtained from all the participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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