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Review Article

Enhanced recovery after breast surgery: a review of international evidence and nursing challenges in China

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Abstract: Enhanced recovery after surgery (ERAS) has recently gained widespread global adoption in surgical rehabilitation. In breast surgery, ERAS has shown impressive clinical benefits and has become an important strategy for improving postoperative recovery and reducing complications. This review summarizes the current application of ERAS in breast surgery and compares its implementation in domestic and international settings across the preoperative, intraoperative, and postoperative phases. It further analyzes the key factors influencing ERAS promotion and implementation. It focuses on the fundamental functions of nursing practice and the challenges encountered. The purpose of this review is to provide evidence to support the optimization of recovery protocols for patients undergoing breast surgery.

Keywords: Enhanced recovery after surgery, breast surgery, nursing practice, postoperative recovery, application status

Introduction

Breast cancer is the most prevalent non-skin malignancy among women and the second most frequently diagnosed cancer worldwide. Its incidence and mortality rates are continuously rising. In 2022, breast cancer accounted for more than 2.3 million new cases and approximately 666,000 deaths worldwide [1, 2]. By 2040, the global incidence is projected to increase by more than 40%, reaching an estimated 3 million new cases per year, while mortality is expected to rise by about 50% to nearly 1 million per year [3]. Breast cancer also represents a major public health concern in China. About 357,000 new cases were reported in 2022, accounting for 15.6% of all female cancer cases and ranking second among malignancies in women [2, 4]. Management of breast cancer requires a comprehensive strategy, among which surgery, chemotherapy, radiotherapy, endocrine treatment, and targeted treatment constitute the core therapeutic modalities [5, 6]. For patients with early-stage breast cancer, breast-conserving surgery is the most commonly adopted approach. While effectively removing the tumor, this surgical method preserves breast appearance and function to the greatest extent [7-9].

Surgery is of great significance in the treatment of breast cancer. It not only enables direct removal of the elision but also provides essential pathologic information for the formulation of subsequent treatment plans. However, surgery may cause various side effects, including postoperative pain, wound infection, lymphedema, and psychological distress [10-12]. Therefore, postoperative rehabilitation and perioperative management are critical. Enhanced recovery after surgery (ERAS), first proposed by Henrik Kechlet in the early 1990s [13], is an evidence-based perioperative care strategy designed to optimize surgical recovery through multidisciplinary collaboration. ERAS aims to reduce surgical stress, minimize postoperative complications, shorten hospital stay, and enhance functional recovery by integrating opti-

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mized perioperative nursing and medical management. This model replaces the traditional single-modality care approach with a coordinated, multidisciplinary framework.

ERAS has been widely adopted across multiple surgical specialties, particularly in gynecologic, orthopedic, and abdominal surgery [14-16]. In gynecologic oncology, ERAS was first introduced in 2016, marking the beginning of systematic implementation in this field [17]. Subsequent updates in 2019 and 2023 further refined these recommendations based on emerging clinical evidence [18, 19]. Continuous updates of ERAS guidelines highlight their importance in improving recovery outcome and reducing medical costs [20].

Currently, ERAS has become an established standard of perioperative management in many surgical fields. ERAS involves a series of coordinated interventions, including optimization of preoperative medical conditions, standardized anesthesia protocols, reasonable fluid management, effective analgesia, and early mobilization [21, 22]. These comprehensive interventions work synergistically to promote postoperative recovery.

Following breast cancer surgery, recovery outcomes are influenced by patient's physical condition, psychological burden, and potential complications. ERAS plays a crucial role in regulating these key factors. It can not only improve patients' satisfaction, and reduce complication rates, but also effectively shorten the hospitalization time [23, 24]. The advantages of ERAS are not only reflected in promoting the recovery of patients' physical function, but also in providing necessary psychological support for patients. ERAS also provides psychological support, helping patients cope with postoperative challenges such as body image changes and mood fluctuations.

This study conducted a comparative analysis of the current implementation of ERAS in breast surgery, focusing on the differences in perioperative management, nursing practice, and multidisciplinary collaboration both domestically and internationally. The aim of this study was to identify major barriers to ERAS implementation, including limited policy support, insufficient technological innovation, and inadequate professional training for nursing staff. By integrating existing research evidence and clinical data, this study proposes strategies to optimize nursing care, strengthen multidisciplinary collaboration, and improve postoperative recovery outcomes. Ultimately, this study aims to provide a reliable theoretical basis and practical guidance for the broader implementation and localization of ERAS in breast surgery.

Problem statement and application scenario in domestic and international contexts

Fundamental concept and evolution of ERAS

As a core component of ERAS, evidence-based medicine provides solid theoretical support for its implementation. ERAS optimizes perioperative care through a series of interventions based on high-quality clinical evidence. Its primary objectives are to reduce postoperative complications, enhance overall treatment outcomes, and improve patients' quality of life (QoL) [25, 26]. Reducing postoperative complications represents one of the key goals of ERAS. This is achieved through a variety of strategies, including optimization of preoperative nutritional status, precise intraoperative fluid management, rational anesthesia selection, and promotion of minimally invasive surgery. These measures effectively decrease the incidence of postoperative infection, pain and other complications, thus facilitating faster postoperative functional recovery [27-29].

Beyond physiological recovery, ERAS also attaches great importance to psychological support. Structured counseling, emotional support, and patient education can significantly alleviate anxiety, depression, and other negative emotional responses. By improving patients' understanding of their condition, ERAS helps reduce surgery-induced psychological distress. In breast surgery, ERAS-guided personalized nursing demonstrates significant advantages. It promotes the development of tailored rehabilitation plans based on surgical type and patient-specific conditions, thereby addressing diverse recovery needs [30, 31]. For example, patients undergoing mastectomy often require enhanced psychological support and functional rehabilitation due to greater surgical trauma, while patients receiving breast-conserving surgery may pay more attention to cosmetic outcomes and body image recovery.

Overall, ERAS plays a crucial role in improving postoperative recovery after breast surgery. It mitigates both physical and psychological challenges during rehabilitation, promotes comprehensive recovery, and ultimately enhances patients' QoL. With the continuous accumulation of clinical evidence and refinement of practice protocols, ERAS is expected to become a routine management model in breast cancer surgery, offering safer and more efficient rehabilitation.

International progress and current status of ERAS in breast surgery

The application of ERAS in breast surgery started relatively late. However, with the evolution of perioperative care concepts, it has become an important part of modern breast cancer management. Early ERAS practice in breast surgery was largely adapted from the success obtained from of gastrointestinal surgery, where initial evidence demonstrated that optimized perioperative management could significantly accelerate postoperative recovery [32]. Globally, ERAS has gained wide recognition and promotion. Europe and North America have led the way in promoting its standardized development through systematic academic research [33, 34]. Currently, many large medical institutions have adopted ERAS model and confirmed its clinical effectiveness through multi-center clinical trials [35, 36]. The International ERAS Association, established in 2010, further promoted the international standardization process of ERAS protocols [37]. In 2017, the association released dedicated guidelines for perioperative optimization in breast cancer surgery [38]. These suggestions emphasize fundamental practices such minimally invasive surgery, early mobilization, nutritional optimization, and multimodal analgesia, all aimed at reducing complications and promoting recovery. For instance, Stone et al. showed that implementation of ERAS in minimally invasive breast reconstruction greatly reduced complications, shortened hospital stay, and improved patients' quality of life, while offering targeted solutions to address implementation barriers [39].

More recently, ERAS has expanded beyond large tertiary centers into regional medical institutions with comparatively fewer resources. Mui et al. reported that the majority of patients could be safely discharged within 24 hours, and the average hospital stay following mastectomy decreased from 2.26 days to 1.42 days [40]. These findings suggest that ERAS not only maintains medical safety but also reduces treatment costs and improves resource use. In recent years, digital health technologies are increasingly being integrated into ERAS practice, such as mobile applications, remote monitoring, and online rehabilitation platforms [41, 42]. For example, the online platform *RecoverEsupport* developed by Sansalon et al. provides personalized rehabilitation guidance based on patient condition, and preliminary data indicate that such digital interventions can effectively improve patient engagement and improve rehabilitation outcomes [43].

Overall, in healthcare systems with well-established infrastructure, ERAS has evolved to be the standard postoperative management model for breast surgery. Its maturity is mainly reflected in broad clinical application, strong evidence-based support, standardized guidelines from professional associations, and the ongoing integration of digital health technologies to provide personalized and optimized rehabilitation pathways.

Development of ERAS in breast surgery in China and current challenges

In China, the application of ERAS in breast surgery started relatively late. However, with improvements in medical care and the expansion of early screening programs, ERAS has become an important strategy for promoting postoperative recovery. In 2016, the release of the Chinese Expert Consensus on Accelerated Postoperative Rehabilitation marked an important milestone [44]. This consensus systematically introduced ERAS principles and promoted their application in general surgery and gynecology. Although breast surgery was not the focus at the time, the consensus laid the foundation for its subsequent expansion in the field.

The successful application of ERAS in other surgical fields and the unique clinical need of breast cancer treatment have promoted domestic clinical practice to gradually explore and adapt ERAS principles. In 2017, the ERAS Association released the Guidelines for the

Perioperative Management of Breast Reconstruction [38]. The guide clearly emphasized measures such as preoperative education, precision anesthesia, and early mobilization. Subsequent clinical studies have provided further supporting evidence. For example, Li et al. demonstrated that ERAS-based postoperative care effectively shortened hospitalization time, reduced complications, and improved pain control and early oral intake in patients with breast cancer [45]. Similarly, Ma et al. reported that ERAS alleviated preoperative discomfort, reduced intraoperative blood loss, and promoted recovery following breast reconstruction [46]. These findings, together with other evidence [47-50], support the wide application of ERAS in China. Currently, many tertiary hospitals and research institutions in China have systematically incorporated ERAS into the standard perioperative management for breast surgery.

Despite the remarkable progress, widespread implementation of ERAS in China still faces several challenges. First, clinical awareness and system-level implementation is still in the initial stage, especially in professional fields such as discharge planning and transitional care for breast cancer patients [51]. The absence of unified national nursing guidelines and standardized operating procedures leads to significant variability across institutions. In addition, most existing studies focus primarily on short-term postoperative outcomes, while comprehensive long-term management throughout the recovery remains limited. Discharge guidance often fails to fully account for individual patient factors, such as cultural background, psychological state, and disease trajectory, resulting in suboptimal alignment with patients' actual needs.

In addition to awareness and personalization, the technology gap is another obstacle. Although some leading hospitals have introduced ERAS pathways, advanced tools such as intelligent decision support systems and remote postoperative monitoring platforms are not yet widely available nationwide. Furthermore, methodologic limitations persist in current research: most studies rely on cross-sectional design, and long-term follow-up data evaluating sustained ERAS benefits remain scarce.

Therefore, within the context of ongoing healthcare reform in China, addressing these challenges will be essential for future implementation of ERAS. Key priorities include reducing regional resource gap, strengthening technological integration, and conducting more comprehensive research on individualized care and long-term effects.

Core elements of the ERAS program in breast surgery

The ERAS program is a comprehensive perioperative care strategy that has been adopted across various surgical specialties in recent years. ERAS aims to shorten postoperative recovery time, reduce complications, and improve postoperative QoL through multidisciplinary collaboration and standardized interventions [52, 53]. In breast surgery, the coordinated perioperative measures involved in ERAS application are summarized in **Figure 1**.

Preoperative stage

The preoperative stage is crucial to successful ERAS implementation, as it lays a solid foundation for both surgical safety and postoperative recovery. Its primary goal is to comprehensively evaluate and optimize patients' general condition in order to reduce perioperative risks and improve outcome. ERAS-based preoperative management encompasses multiple components, including nutrition assessment, psychosocial intervention, and health education. These elements collectively reduce preoperative anxiety, improve physiological readiness, and enhance surgical preparedness. Evidence supports the effectiveness of such preparatory interventions. For example, a study by Genmini et al. demonstrated that patients undergoing breast reconstruction who received an ERAS-based preoperative program (e.g., counseling, carbohydrate loading, multimodal analgesia, and antiemetic prophylaxis), experienced faster postoperative recovery, as evidenced by a 19.4% reduction in postoperative nausea and an average decrease in hospitalization time of 0.28 days [24].

Preoperative education represents a core element of ERAS and is widely used in clinical practice. Before operation, structured communication helps patients understand the operative procedure, expected recovery trajectory,

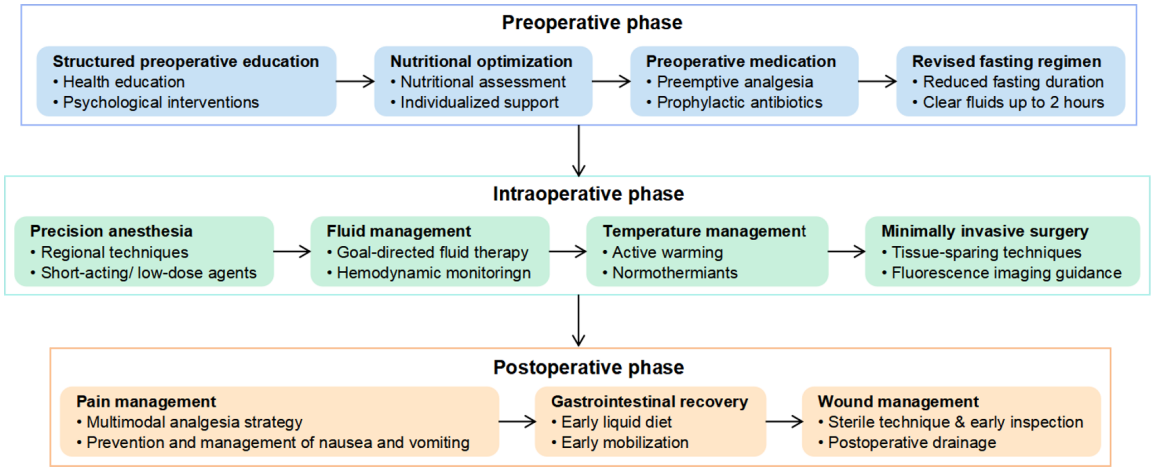

Figure 1. Enhanced recovery after surgery pathway in breast surgery.

and treatment goals [54, 55]. This kind of education improves psychological preparedness, reduces postoperative complications, and improves treatment compliance. In addition, digital and multimedia educational tools are being used to improve patient understanding of surgical process and alleviate anxiety [56, 57]. Bailey et al. reported that preoperative education was associated with improved compliance with ERAS measures and shorter hospitalization [58]. Educated patients showed higher adherence to measures such as shortened fasting time, regional nerve blocks, multimodal analgesia, and thrombosis prophylaxis (21.2% vs. 8.9%).

The ERAS program attaches great importance to nutritional optimization, especially in breast cancer patients who frequently experience reduced appetite or impaired nutrient absorption during treatment [59]. Preoperative malnutrition is associated with higher infection risk, prolonged hospitalization, and delayed recovery [60]. Therefore, ERAS protocols recommend nutritional assessment 1-2 weeks before surgery, followed by personalized nutritional support as needed [61]. For patients who have undergone chemotherapy, adequate supplementation of protein, vitamins, and micronutrients may enhance immune function and improve postoperative recovery. Supporting evidence from colorectal ERAS studies also indicates that higher perioperative protein intake is associated with shorter hospitalization and fewer complications [62].

Preoperative medication is also crucial. Multimodal preventive analgesia, including acetaminophen, celecoxib, meloxicam, and gabapentin, combined with spinal or local anesthesia can effectively reduce perioperative stress and opioid requirements [63]. Such strategies help prevent central sensitization, reduce inflammatory mediator release, and improve postoperative pain control. In addition, preventive antiemetics, such as ondansetron, aprepitant, and dexamethasone, are commonly used to prevent postoperative nausea and vomiting, particularly when combined with opioid-sparing analgesic protocols and reduced fasting duration [64, 65].

In breast surgery, especially with wide-range tissue resections, infection prevention is another important preoperative component. ERAS protocols typically include prophylactic antibiotics, standardized skin preparation, and antiseptic cleansing before surgery to reduce the risk of postoperative infection. Evidence suggests that multimodal perioperative optimization strategies may significantly shorten hospital stay and improve pain outcomes [66, 67].

Traditional surgical practice often required fasting for more than 12 hours before surgery [68]. However, ERAS guidelines recommend allowing clear liquids up to 2 hours before surgery. This approach reduces hypoglycemia and dehydration, and improves preoperative comfort, without increasing aspiration risk. A Dutch quality-improvement study including 451 patients confirmed that shortened fasting time effec-

tively reduced thirst and postoperative nausea without significantly increasing the risk of accidental aspiration [69].

Patient-specific optimization is also emphasized within ERAS. Although the number of younger women undergoing breast surgery is increasing, most patients remain middle-aged or elderly [70]. Personalized preoperative preparation is therefore essential. For example, given that elderly patients often present with comorbidities such as diabetes or hypertension, necessitating more comprehensive preoperative evaluation and optimization. In general, ERAS protocols advocate tailored perioperative strategies to achieve optimal outcomes.

Intraoperative phase

The intraoperative phase represents a key component of the ERAS pathway. Through precise intraoperative management, the risk of postoperative complications can be minimized, thereby facilitating early recovery. The primary objective during this stage is to attenuate the physiological stress response to surgical trauma while ensuring procedural efficiency and safety. Key intraoperative elements include anesthesia strategy, multimodal analgesia, fluid management, and body temperature control, collectively contributing to maintaining optimal physiologic stability throughout the procedure.

Local and regional anesthesia has been widely used in breast surgery. It can effectively reduce postoperative pain and limit systemic side effects of general anesthesia, thus improving patient comfort. Selection of anesthetics is crucial. ERAS recommends short-acting drugs with rapid metabolism and minimal residual effects to facilitate early awakening and mobilization. Commonly used drugs include short-acting sedatives, opioids, and muscle relaxants [71]. Studies show that, compared to conventional general anesthesia, ultrasound-guided paravertebral block provides superior postoperative pain control, while improving patient satisfaction and accelerating rehabilitation [72, 73]. For example, ERAS was associated with lower postoperative pain scores, reduced opioid use, shorter hospital stay, and improved patient satisfaction [74, 75]. These findings support the broader principle that multimodal anesthesia and opioid-sparing strategies are central to enhanced recovery pathways.

Accurate fluid management plays a crucial role in reducing the risk of adverse events such as tissue ischemia, poor wound healing, and infection of the surgical site [76]. Goal-directed fluid therapy (GDFT) advocated by ERAS enables individualized fluid administration with the help of real-time monitoring of hemodynamic indicators, so as to maximize the level of tissue perfusion, effectively control intraoperative bleeding, and reduce the occurrence of postoperative complications [77]. Wang et al. reported that patients managed with GDFT had higher postoperative QoL scores, shorter hospitalization time, and reduced crystalloid infusion compared with standard fluid management [78]. Adequate fluid management maintains the perioperative stability of the circulatory system, facilitating postoperative recovery.

Maintenance of normothermia is equally essential. In breast surgery, warming devices and heated intravenous fluids are commonly used to prevent intraoperative hypothermia. Intraoperative hypothermia has been associated with impaired immune function, increased bleeding, and delayed postoperative recovery [79]. Routine temperature management has therefore become standard practice in many institutions to reduce postoperative infection and risk of cardiovascular events.

Minimally invasive techniques also align closely with ERAS principles. Among them, laparoscopic-assisted surgery, as well as fluorescence-guided imaging contribute to reduced surgical trauma, less blood loss, and fewer wound complications [80]. These techniques facilitate earlier mobilization, reduce postoperative opioid requirements, and shorten hospital stay.

In summary, the intraoperative stage of ERAS plays a crucial role in minimizing postoperative outcomes. Through refined anesthetic management, individualized fluid therapy, strict temperature control, and advanced minimally invasive surgical technology, ERAS improves patient comfort, enhances recovery, and provides a solid foundation for subsequent postoperative rehabilitation.

Postoperative phase

As a critical component of ERAS protocol, postoperative stage directly influences recovery speed, complication risk, and patients' QoL. Through a series of structured interventions, ERAS aims to accelerate functional recovery, reduce the risk of complications, and improve the patient satisfaction. Effective pain control is central to postoperative rehabilitation. ERAS protocols advocate multi-modal analgesia combining oral, intravenous, and regional techniques to minimize opioid use while ensuring adequate pain relief [81]. Proper analgesia facilitates early mobilization and functional recovery. Another key aspect is the prevention of postoperative nausea and vomiting. Appropriate pharmacological prophylaxis and early nutritional support can significantly improve patient comfort and recovery experience.

ERAS also recommends avoiding prolonged postoperative fasting. Early oral intake promotes gastrointestinal motility and may reduce complications of intestinal obstruction. Early mobilization is now regarded as a core ERAS principle and a standard practice in postoperative care [82]. Evidence indicates that early activity can significantly reduce complication risk, improve both physical and psychological outcomes, and accelerate overall recovery [83].

Wound management is crucial in postoperative care for breast surgery. According to global statistics, about 30% of patients experience wound infection, hematoma, or seroma [84]. ERAS protocols emphasize strict aseptic technique, early wound assessment, and timely intervention to promote healing. Drainage management is another key nursing responsibility. Appropriate use of drainage devices, close monitoring of output, and timely removal can successfully reduce fluid accumulation, lower infection risk, and accelerate wound healing. Recent studies suggest that minimizing or optimizing drainage use may improve postoperative outcomes in selected patients [85-87]. In addition, discharge criteria within ERAS program are based on functional recovery rather than fixed time points. Patients who meet recovery targets may be discharged within 48 hours, and in selected cases, same-day discharge following breast surgery is feasible and safe [40, 88]. Such approaches greatly reduce healthcare costs while maintaining clinical safety.

In general, ERAS program extend throughout the entire stages in breast surgery. By integrating standardized management across preoperative, intraoperative, and postoperative stages, ERAS optimizes recovery trajectories, reduces complications, shortens hospitalization, thus improving patients' rehabilitation experience and QoL.

Core role of nursing practice and the challenges it faces

The core role of nurses within the ERAS multidisciplinary team

With the progress in medical technology, perioperative management has undergone major transformation. In surgical practice, ERAS has evolved into an advanced clinical care model. Within this framework, nurses, an indispensable part of the team, play a crucial role [89, 90]. Successful ERAS implementation relies on close multidisciplinary collaboration, and nurses assume numerous key responsibilities [90-92]. Given that nurses maintain the closest and sustained patient contact, their acceptance and mastery of the ERAS protocols directly influence effectiveness of clinical implementation.

From preoperative preparation to postoperative rehabilitation, nurses participate throughout the entire perioperative continuum. As shown in **Figure 2**, the nursing coordinator plays a key role in the implementation of the ERAS principle. During the preoperative stage, nurses conduct comprehensive patient assessment, including psychological state, general health, and preoperative preparation. Through effective communication, nurses can help alleviate preoperative anxiety while providing education on ERAS principles to patients and their families. During surgery, nursing staff is responsible for monitoring anesthesia, maintaining hemodynamic stability, and preparing instruments and medications as needed. Postoperatively, nurses continue to play a crucial role by delivering both routine care and ERAS-guided interventions. These measures facilitate early mobilization, support gastrointe-

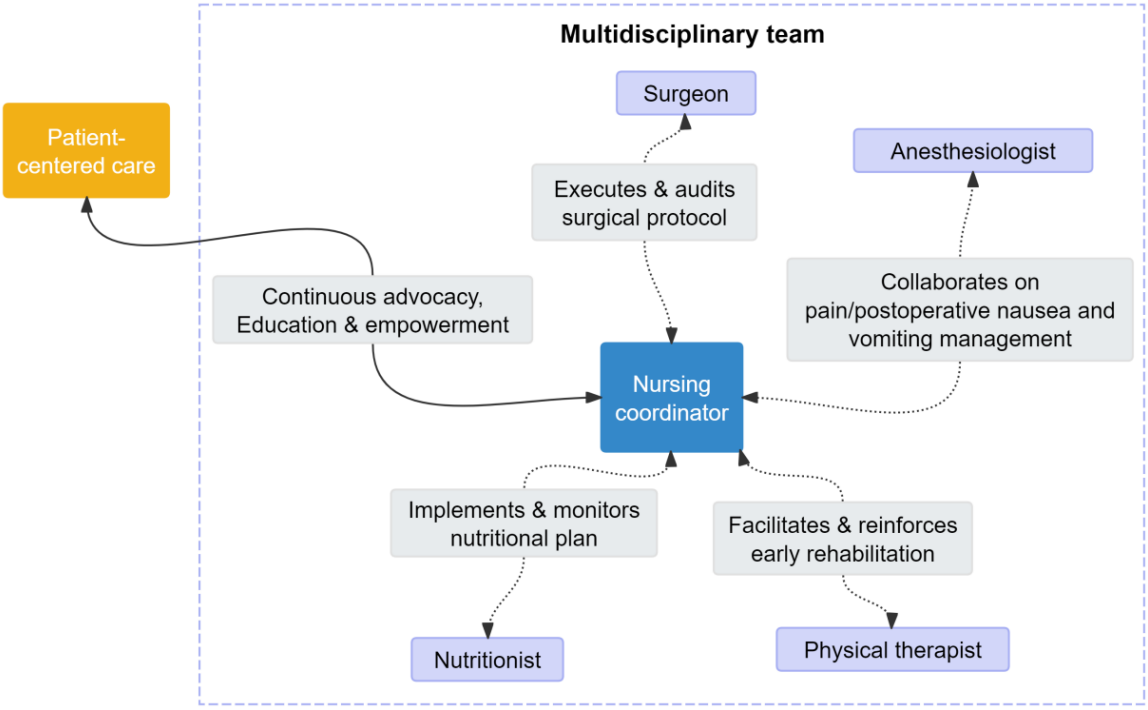

Figure 2. Central role of nursing in enhanced recovery after surgery multidisciplinary team.

stinal recovery, and promote early postoperative oral intake.

The fundamental concept of ERAS is to reduce unnecessary surgical trauma and delays in recovery, thereby accelerating functional recovery [93]. For example, to stimulate bowel motility and prevent constipation, nurses encourage early mobilization, typically within 24 hours after surgery, while also providing necessary nutritional support and monitoring wound healing.

Within the ERAS framework, nurses also assume the responsibility for patient education [94, 95]. Beyond providing perioperative information, they guide patients in lifestyle modification, dietary optimization, and the adoption of appropriate physical activity to facilitate recovery. Particular attention is paid to complication prevention such as lung infections and deep vein thrombosis in high-risk patients.

Therefore, continuous education and professional training are essential to ensure successful ERAS implementation. Regular training helps nurses update knowledge, enhance clinical skills, so improve overall care quality.

Major challenges faced by nursing practice in China

Although the ERAS concept has been widely promoted globally and has achieved certain results in the field of breast surgery, its implementation in China still faces several challenges. As shown in **Figure 3**, these challenges can be mainly classified into four aspects, closely related to the characteristics of the Chinese healthcare system.

First, limitations in the foundational capacity of nursing practice remain a major issue. Although some Chinese hospitals have introduced the ERAS protocols, gaps persist in evidence-based medicine and precise health management. ERAS requires nursing staff to possess solid medical knowledge and the ability to assess individual patient variability to deliver personalized care [96]. However, insufficient training in these areas may compromise the effectiveness of ERAS implementation and limit its potential.

Second, the application of advanced technologies in clinical nursing remains limited. Successful implementation of ERAS relies on

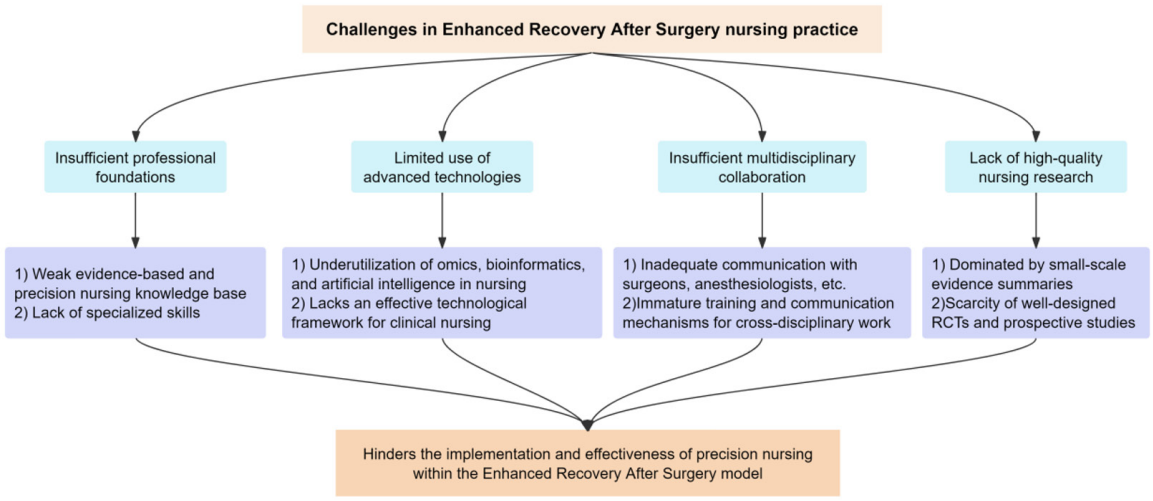

Figure 3. Conceptual framework of key challenges in enhanced recovery after surgery nursing practice in China.

technologies such as omics analysis, bioinformatics, Internet-of-Things-based monitoring, and artificial intelligence [97]. However, the clinical application of these technologies in Chinese nursing practice is still in its infancy. Limited access to technical tools limits the ability of nurses to enhance care quality and efficiency under the ERAS framework.

Third, multi-disciplinary collaboration mechanism remain insufficiently developed. ERAS model emphasizes coordinated teamwork among surgeons, anesthesiologists, nutritionists, and nurses. However, in practice, communication and collaboration between nurses and other departments are sometimes suboptimal. For instance, inadequate alignment between nursing protocols and surgical or anesthetic plans may weaken the continuity of perioperative management. Moreover, the training and communication platforms for interdisciplinary collaboration remain incomplete, posing practical barriers to ERAS implementation.

Finally, ERAS-related nursing research in China remains limited in both scale and methodologic rigor. Most of the current literature focuses on evidence summarization, while high-quality clinical studies are relatively scarce, and sample sizes are often small [90]. This limits the clinical translation of ERAS principles and the development of standardized guidance. In particular, well-designed randomized controlled trials and prospective studies are relatively scarce, which restricts the integration of precision nursing concepts into routine clinical practice.

Discussion

Analysis of fundamental reasons for differences in ERAS implementation

Global practice has demonstrated that ERAS can effectively promote postoperative recovery and reduce patient discomfort. However, in breast surgery, significant differences remain between China and many western countries in the promotion and implementation of ERAS. In-depth analysis shows that these differences stem from systemic factors, many of which are closely related to medical architecture and development stage of China's healthcare system. The key determinants can be summarized as follows.

First of all, ERAS implementation is highly dependent on medical resources and infrastructure support [98]. In most Western medical systems, resource distribution is relatively balanced, facilitating standardized ERAS implementation. In contrast, China's tiered healthcare system and pronounced regional disparities present significant challenges. High-quality medical resources remain concentrated in major urban tertiary hospitals, whereas primary and secondary institutions-particularly in less-developed regions-often lack adequate equipment and infrastructure. This imbalance restricts the equitable dissemination of ERAS

nationwide and limits its standardized application.

Second, ERAS effectiveness depends on well-trained and experienced multidisciplinary teams [99]. In western countries, breast surgery teams typically receive earlier exposure to structured ERAS training and protocols. In China, although some leading tertiary centers are accumulating experience, the dissemination of professional knowledge is limited by the uneven access to graded medical system and continuing education. Consequently, hospitals at various levels and in different regions vary substantially in their understanding and implementation of ERAS principles.

Third, hospital management systems and policy support are critical drivers of ERAS adoption. In many western countries, ERAS programs benefit from dedicated policy endorsement, reimbursement mechanisms, and targeted funding. Although China's current national health policies increasingly emphasize improving the efficiency and quality of health care services, challenges remain in effectively transforming policy goals into operational ERAS programs with high coordination and financial support. In addition, rigid administrative structures in some hospitals may slow the adoption of innovative perioperative care models, thereby comprising overall implementation efficiency.

Fourth, technological capacity represents another important determinant. Western healthcare systems have established mature infrastructures capable of supporting real-time monitoring, data integration, and personalized care. In China, despite rapid advances in medical informatization, substantial technological disparities persist across hospital tiers. Many institutions still lack integrated data platforms and intelligent monitoring systems, limiting the optimization and sustainability of ERAS pathways.

Finally, both public awareness and professional acceptance influence ERAS implementation. Patients' understanding of breast cancer and ERAS concepts affects participation and adherence. In western society, public awareness and social acceptance are generally higher. In China, awareness of ERAS remains relatively limited among both the public and some healthcare providers, particularly in non-tertiary institutions. Strengthening education for both patients and professionals is therefore essential for broader implementation.

Impact and suggestions on nursing practice in China

To address these challenges and accelerate the implementation of ERAS in breast surgery, nursing practice in China should focus on several improvement strategies. First of all, professional education and training should be vigorously strengthened. The competencies of nursing staff in ERAS must be enhanced beyond basic knowledge to include evidence-based practice, precise health concepts, and related supporting technologies. Hospitals and nursing administration departments should develop systematic, tiered training programs ranging from foundational ERAS concepts of general nurses to advanced competencies for ERAS nursing coordinators. Participation in domestic and international academic exchange programs should also be encouraged to promote knowledge dissemination and professional development.

Second, greater emphasis should be placed on the adoption of appropriate clinical technologies. Reducing the technological gap remains a priority. Funds should be invested to introduce practical and scalable tools, such as mobile health platforms for real-time monitoring and health education, and basic data management software. Even in resource-limited settings, gradual deployment of these technologies should be pursued. At the same time, relevant policies should be formulated and financial support should be provided to ensure that medical institutions at all levels can obtain technical resources fairly, thus providing strong support for data-based personalized nursing services.

Moreover, it is necessary to build a standardized multidisciplinary collaboration mechanism. Effective ERAS implementation relies on close collaboration among surgeons, anesthesiologists, nutritionists, and nursing teams. Hospitals should formalize collaborative model, clarify communication pathways, and organize regular multidisciplinary team meetings that include nursing participation in decision-making. Clearly defining the specific roles and

responsibilities of nurses in the team is conducive to transition from task-oriented caregivers to proactive coordinators of perioperative care, ultimately improving patient outcomes and safety.

Fourth, practice-based nursing research should be strengthened. The formulation of locally applicable evidence-based guidelines depends on high-quality nursing research. Nursing research should prioritize real-world clinical issues, such as evaluation of ERAS-related nursing interventions in Chinese hospitals and the development of context-appropriate outcome indicators. Encouraging nurse participation in quality improvement projects and clinical research can enhance research capacity and provide valuable insights for clinical practice.

Finally, patient and public participation should be further improved. In order to help patients better understand ERAS, nurses can take the lead in patient education by delivering culturally appropriate, easy-to-understand educational materials and disseminating them through both offline channels and online digital platforms. Collaboration with community organizations can expand health education beyond hospitals, thereby improving public awareness, acceptance, and adherence to ERAS principles.

Future research directions

Future scholarly efforts should focus on bridging the existing knowledge gaps and providing a theoretical framework for continued advancement of ERAS. A key area is precision nursing science, which can combine biomarkers, patient-reported outcomes, and predictive models to stratify recovery risks of breast cancer patients and formulate personalized perioperative care plans accordingly. In particular, research should target the unique characteristics of Chinese patients and the availability of local medical resources to establish and validate a precise nursing pathway tailored to this population.

The interdisciplinary cooperation model also warrants further exploration. Future research could assess the practical effects of various multidisciplinary collaboration models in Chinese hospitals, such as comparing on-site and remote collaboration. Additionally, it is crucial to examine the obstacles to effective team communication and shared decision-making, aiming to establish a more efficient cooperation framework that enhances treatment adherence and patient rehabilitation outcomes.

Equally important is the systematical evaluation and implementation of scientific research. An ERAS nursing quality evaluation system should be developed, covering multiple dimensions such as clinical outcomes, patient experience, and economic considerations. Such research will help identify the best practices for promoting and sustaining ERAS nursing across diverse medical setting.

Finally, attention should be paid to health equity and the local adaptability of the ERAS model. Relevant research should explore the potential impact of ERAS promotion on healthcare fairness. At the same time, it is necessary to explore how to make appropriate adjustments to the ERAS principle according to the characteristics of different patient groups (such as rural residents and the elderly) and the actual situation of hospitals at different levels. The purpose is to ensure that the ERAS benefits are accessible and applicable to all segments of the population.

Conclusion

The application of ERAS in breast surgery has become an important part of modern surgical treatment. It plays a critical role in promoting early recovery and reducing postoperative complications. A comparative analysis of ERAS development in China and abroad highlights some challenges faced by China, yet significant positive changes are taking place. Professional training for nursing staff has been continuously strengthened, multidisciplinary collaboration mechanisms are being strengthened, and patient education systems are continuously improving. These advancements have created extremely favorable conditions for the widespread adoption and implementation of ERAS principles.

Looking forward, China needs to focus on developing personalized and precision management within the ERAS framework. By aligning ERAS implementation with the country's specific healthcare context, efforts should be made to optimize key components of the protocol, ensuring its broader application in breast

cancer surgery. In addition, leveraging interdisciplinary cooperation and continuous technological innovation will further enhance the effectiveness of ERAS, to improving treatment outcomes and QoL of breast cancer patients, thus bringing substantial benefits to patients.

Disclosure of conflict of interest

None.

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