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Improving adherence to early mobilization after laparoscopic total hysterectomy: a type 2 hybrid effectiveness-implementation trial

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Abstract

Background

Early postoperative mobilization is a key component of Enhanced Recovery After Surgery pathways, yet its adherence in gynecological practice remains suboptimal. This study aimed to evaluate the effectiveness and feasibility of a theory-guided, multifaceted implementation strategy for improving early mobilization after laparoscopic total hysterectomy.

Methods

A type 2 hybrid effectiveness-implementation study with interrupted time-series (ITS) design was conducted in a 44-bed gynecology surgical ward of a tertiary hospital in South China. Data were collected over 16 weekly time points (8 pre-implementation, 8 post-implementation). Barriers were identified using the Consolidated Framework for Implementation Research, and targeted strategies were selected via the Expert Recommendations for Implementing Change taxonomy. The intervention bundle comprised staff simulation training, multidisciplinary consensus, weekly audit and feedback, patient educational videos, and a bedside mobilization checklist. Outcomes were evaluated using the RE-AIM framework, including adherence, clinical recovery, implementation fidelity, provider adoption, and 8-week maintenance. Segmented regression was used for ITS analysis.

Results

A total of 121 patients were included (59 pre-implementation, 62 post-implementation). The proportion of patients mobilized within 24 hours increased from 37.3% to 69.4% ($p < 0.001$). Time to first ambulation decreased from 25.98 ± 6.17 hours to 22.22 ± 4.34 hours ($p < 0.001$). Length of stay was reduced from 11.10 ± 4.26 days to 8.92 ± 3.08 days ($p = 0.002$), and total hospital costs decreased from ¥31,688 ± 12,753 to ¥25,244 ± 7,161 ($p = 0.001$). No mobilization-related adverse events occurred. Time-series analysis showed a downward trend in ambulation time post-intervention, although slope and level changes did not reach statistical significance. Improvements were sustained at 8-week follow-up.

Conclusions

The theory-guided, multifaceted implementation strategy significantly and safely improves early mobilization adherence after laparoscopic hysterectomy, with concurrent reductions in length of stay and healthcare costs. These findings support the value of implementation science in bridging the evidence-practice gap in perioperative care.

Trial registration:

Chinese Clinical Trial Registry (ChiCTR), registration number pending (submitted for retrospective registration on 18 May 2026). Retrospectively registered.

1. BACKGROUND

Enhanced Recovery After Surgery (ERAS) programs integrate evidence-based interventions to attenuate surgical stress, reduce complications, and shorten hospital stay without increasing readmission rates(1–3), which have been widely adopted in gynecologic surgery(4–6). The implementation of ERAS in gynecological surgery can significantly reduce postoperative complications by 17.8%, and lower hospitalization costs shorten hospitalization time(7). Early post-operative mobilization (EPM), generally defined as sitting out of bed on the day of surgery and walking ≥ 5 m within 24h, is a cornerstone of ERAS and is strongly endorsed by the ERAS Society gynecological and gynecological-oncology guidelines[4, 5, 8]. Meta-analyses demonstrate that EPM accelerates gastrointestinal recovery, lowers pulmonary morbidity and halves hospital-acquired venous thrombosis[9, 10]. Conversely, delayed ambulation is independently associated with prolonged intestinal obstruction, increased infectious complications and longer length of stay(11–13).

Despite robust evidence, implementation audits consistently reveal large gaps between recommendation and practice. A 2023 European registry reported overall ERAS adherence of only 44% across 12 colorectal centers(14), while an Asian cohort observed that just 9% of patients walked on post-operative day(15). The situation is mirrored in China. A prospective study found that fewer than one-third of laparoscopic patients achieved sustained mobility on the first post-operative day(16). Our 2023 baseline audit also showed that 71% of women undergoing laparoscopic total hysterectomy (LTH) remained on bed rest for the first 24h, although all had received ERAS protocol education. Consequently, facilitating early ambulation within 24h is the priority for health care teams.

At present, there is a significant delay in translating research evidence into practice and policy. Studies have shown that it takes 17 years for scientific evidence to emerge and be promoted in clinical practice(17). Implementation science is a relatively new research method that can promote the transformation and application of evidence and shorten the practice of evidence and practice(18). Unlike efficacy and effectiveness studies that focus on observing whether intervention measures achieve expected changes in health outcomes, implementation studies focus more on exploring whether the procedures for implementation intervention measures are followed, and whether a specific strategy can increase the use of evidence-based practices compared to another strategy(19). Implementation science has been used in various environments such as psychology(20), community(21), and public health(22, 23), which can improve patient outcomes by deepening our understanding of the factors that influence adherence to evidence-based practices aimed at enhancing value and safety(18). ERAS is based on the principles of fast-track surgery and a multimodal perioperative care program aimed at reducing recovery time, hospitalization time, and postoperative complications(7). It includes patient involvement in perioperative interventions (such as giving carbohydrate oral supplements 2 hours before surgery without preoperative medication), anesthesia driven intraoperative interventions (such as fluid

restriction, multimodal pain relief, and prevention of hypothermia), and nursing driven postoperative interventions (such as early mobilization, opioid restriction, early detection and prevention of nausea and vomiting)(5). Research shows that ERAS reduces hospitalization time for colorectal surgery patients by 4.5 times(24). However, the components of ERAS such as early postoperative mobilization, with reported pathway adherence as low as 42.8%(25). Given that pathway adherence is associated with improving patient prognosis, it is important to understand the factors related to ERAS pathway adherence. Implementation science can better support the application of evidence to practice and policy, thereby improving health outcomes for patients, healthcare providers, and the entire healthcare system. It is a very good method to help nursing staff understand why early postoperative bed mobilization compliance is low. At present, most studies mainly focus on the impact of early postoperative mobilization on patients' clinical outcomes, with less attention paid to how to promote early postoperative mobilization. Therefore, this study will explore the effect of the implementation of patients after laparoscopic total hysterectomy from the perspective of implementation science.

2. METHODS

2.1 Study design and setting

This study conducted a type 2 hybrid effectiveness-implementation study using an interrupted time series (ITS) design to evaluate both the clinical effectiveness of early postoperative mobilization (EPM) and the impact of a multifaceted implementation strategy in a 44-bed gynecological surgical ward of a tertiary hospital in Guangzhou, China. The ward has a nurse-to-bed ratio of 0.4 and performs over 2,000 gynecological surgeries annually, with laparoscopic total hysterectomy (LTH) accounting for approximately 40%. This study received ethics evaluation by the ethics committee of the Second Affiliated Hospital of Guangzhou University of Chinese Medicine.

2.2 Participants

The target population included adult women undergoing laparoscopic total hysterectomy (LTH). All consecutive eligible patients during the study period were included. Inclusion criteria were: (1) Age ≥ 18 and < 70 years. (2) First-time laparoscopic surgery. (3) Able to communicate and consent. Exclusion criteria were: (1) contraindications to early mobilization (e.g. hemodynamic instability), and (2) inability to ambulate independently prior to surgery. Healthcare providers involved in perioperative care (including nurses and physicians) participated in the implementation process.

2.3 Intervention: Early postoperative mobilization (EPM)

Consistent with ERAS Society gynecological guidelines, EPM was defined as ambulating within 24 hours after surgery. The EPM protocol consisted of the following standardized progressive mobilization components: **(1) Pre-mobilization readiness assessment**: Prior to first ambulation, nursing staff should informed and assessed patient readiness using a 4-item checklist: hemodynamic stability (systolic blood pressure ≥ 90mmHg, heart rate<100bpm), absence of uncontrolled nausea/vomiting, pain score ≤ 4/10

on numeric rating scale, and patient willingness. Patients meeting ≥ 4 criteria were considered ready for mobilization. **(2) Progressive mobilization protocol**: **Phase 1** (0-6h postoperative): After returning to the ward, patients are allowed to have their head elevated with pillow if they had no nausea or vomiting and are not required to maintain a strict supine position. They were encouraged to turn side-to-side in bed and perform active ankle pump exercises. **Phase 2** (on the morning of postoperative day 1): nursing staff gradually the head of the bed from 30° to 45° and then to 60°. During this process, the patient was assessed for any discomfort, including palpitations, dizziness, nausea, or blurred vision. **Phase 3** (prior to first ambulation): If no discomfort occurred during the above activities, the patient was assisted by a nurse and a family member to sit at the bedside with both legs dangling down for 3–5 minutes. **Phase 4** (within 24 hours): Standing at bedside with nursing assistance and ambulating ≥ 5 meters. First ambulation required one-to-one nursing assistance with immediate termination criteria for dizziness, syncope, wound dehiscence, uncontrolled pain, or patient refusal. This evidence-based practice was already part of routine care prior to the stud. The flow chart of the first postoperative ambulation activity was shown in the Supplementary file Figure S1.

2.4 Implementation strategy

A multifaceted implementation strategy was developed using a barrier-informed approach. Determinants of EPM implementation were identified through pre-implementation qualitative interviews with patients (n = 10) and nurses (n = 5), guided by the Consolidated Framework for Implementation Research (CFIR). Identified barriers were prioritized based on their perceived impact and modifiability, and implementation strategies were selected using the Expert Recommendations for Implementing Change (ERIC) taxonomy. The bundle targeted multiple levels, including healthcare providers, patients, and organizational processes, and consisted of five components: **(1) Educational meetings**: Two 2-hour simulation-based workshops were delivered to nursing staff (n = 18), focusing on early ambulation risk assessment, safety management, and standardized mobilization procedures. **(2) Local consensus discussion**: ERAS recommendations for early mobilization were disseminated through a multidisciplinary WeChat group, facilitating communication and consensus-building among surgeons, nursing staff and nursing caregivers. **(3) Audit and feedback**: Weekly chart audits were conducted to assess adherence to mobilization protocols. Performance data were summarized as running charts and feedback to nurse leaders to support ongoing monitor and improvement. **(4) Patient-facing materials**: A 3-minute instructional video demonstrating safe postoperative ambulation techniques (including sitting up at the bedside, standing with assistance, and walking safely) was displayed on ward televisions to provide visual, real-time guidance and reduce patients' anxiety related to movement. **(5) Addition of bedside assessment form**: A paper-based ambulation assessment checklist was placed at each patient's bedside to facilitate direct bedside evaluation and real-time documentation of mobilization status by nursing staff. The form included items on readiness for mobilization, assistance required, ambulation distance, and patient tolerance, enabling immediate recording without reliance on electronic systems, which was shown in Supplementary file Table S1. All components were implemented concurrently as an integrated strategy throughout the implementation period.

2.5 Outcomes

The outcomes were prospectively defined based on RE-AIM framework and assessed at patient, provider, and system levels. This framework monitors the Reach, Effectiveness, Adoption, Implementation, Maintenance of the EPM. Quantitative and qualitative measures were used to assess these outcomes. The researcher kept a logbook of interesting events or conversations during the implementation process.

2.5.1 Reach

Reach was defined as the proportion and representativeness of eligible patients who participated in the intervention. In this study, Reach was operationalized as the proportion of patients who completed preoperative education and provided informed consent for the early mobilization protocol. Reasons for refusal among eligible patients were documented using structured brief interviews. Demographic and clinical characteristics, including age, educational level, surgical indication, were compared between participants and non-participants to assess potential selection bias. Data were extracted from ward registration logs, preoperative education records, and refusal documentation forms.

2.5.2 Effectiveness

Effectiveness assessed the impact of the implementation strategy on clinical outcomes. Early mobilization adherence rate was defined as primary outcome. The adherence was defined as the proportion of patients who achieved at least one out-of-bed activity (standing or walking) within 24 hours post-surgery. This binary indicator (adherence vs. non-adherence) was measured for each eligible patient and aggregated into weekly adherence proportions for ITS analysis. The 24-hour threshold was selected based on ERAS guidelines and local consensus. The secondary outcomes was included: (1) Time to first mobilization; (2) Postoperative length of hospital stay (days); (3) Composite complication rate (including deep vein thrombosis, intestinal obstruction); (4) Safety events (falls and catheter dislodgements). Data was obtained from bedside assessment forms, nursing records, and the hospital electronic medical record system.

2.5.3 Adoption

Adoption was defined as the acceptance of the intervention by healthcare providers in the target ward. In this study, adoption was measured by training participation rate, intervention protocol utilization rate and the willingness of using intervention protocol. The training participation rate was defined as the proportion of healthcare providers who completed the two simulation-based workshops, derived from training attendance records. The intervention protocol utilization rate was defined as the proportion of healthcare providers who actively used the standardized early mobilization protocol or the bedside assessment form during clinical practice, assessed through direct observation and review of archived bedside assessment forms. The willingness of using intervention protocol was developed a self-designed survey form to understand the willingness of medical staff to participate in early postoperative mobilization programs, a Likert 5-point rating was given from "very willing" to "very unwilling".

2.5.4 Implementation

Implementation refers to the intervention agents' fidelity to the various elements of an intervention's protocol, including consistency of delivery as intended. It also includes adaptations made and the costs in terms of money and time of implementation. In this study, implementation was assessed through fidelity to the core components, adaptations made, and the associated time and financial costs. Fidelity evaluated the consistency between the intervention as delivered and the prespecified protocol, focusing on completion rates of preoperative education completion, catheter securement execution and written activity plan completion. Data was collected through bedside paper-based documentation completed by nursing staff. Nurses recorded the date and time of first ambulation based on direct observation by caregivers during mobilization assistance and patient self-report at the bedside. These data were transcribed from the bedside assessment forms for analysis.

2.5.5 Maintenance

Maintenance is the extent to which behavior is sustained after treatment, and a program becomes institutionalized or part of the routine organization practices and policies. Maintenance was evaluated at 8 weeks post-implementation, including continued the time of postoperative ambulation and proportion of patients mobilized within 24 hours. Additionally, the reasons for maintenance, discontinuance, or adaptation, which were discussed in interviews with representatives of the healthcare professionals involved.

2.6 Data collection

ITS is a robust quasi-experimental design commonly used in implementation research when randomization is not feasible. This design enables assessment of both immediate level change and changes in temporal trends following implementation(26). We collected weekly aggregated data over 16 time points, including 8 pre-implementation and 8 post-implementation observations. Data was extracted from electronic health records, nursing documentation, and hospital administrative systems. Weekly aggregated data were used for ITS analysis. To ensure data quality, records were reviewed by trained researchers, and discrepancies were solved through consultation with clinical staff.

2.7 Statistical analysis

Analyses were performed using IBM SPSS Statistics (version 26.0; IBM Corp., Armonk, NY, USA) and R software (version 4.3.1; R Foundation, Vienna, Austria). Descriptive statistics were presented as mean ± standard deviation (SD), median (IQR), or frequency (%). Baseline comparability between pre- and post-implementation groups was assessed using t-tests, Mann-Whitney U tests, or χ^2 tests as appropriate. Segmented regression analysis of interrupted time series data was used to estimate the effect of the implementation strategy. The model included terms for: baseline level and trend, immediate level change following implementation changes in trend (slope) after implementation. Results were reported as changes in level and slope with corresponding 95% confidence intervals. A two-sided p-value < 0.05 was considered statistically significant.

3. RESULTS

3.1 Participants and baseline demographic and clinical characteristics

A total of 121 patients undergoing laparoscopic total hysterectomy were included, with 59 in the pre-implementation phase and 62 in the post-implementation phase. Baseline demographic and clinical characteristics were comparable between groups, including age, ASA classification, diagnosis, and drain use (Table 1). Operative time and blood loss were modestly lower in the post-implementation group.

Table 1
The baseline demographic and clinical characteristics of patients after LTH

Variable	**Pre-implementation (n = 59)**	**Post-implementation (n = 62)**	**t/χ^2**	***p***
Age	53.78 ± 10.03	51.52 ± 7.52	1.400	0.164
Gynecological Cancer [b]			7.126[a]	0.008
Yes	14(77.8%)	4(22.2%)		
No	45(43.7%)	58(56.3%)		
Operative time (min)	193.88 ± 78.80	167.15 ± 64.20	2.051	0.042
Blood loss (ml)	50.00,70.00	30.00,30.00	-2.509	0.012
ASA	1.98 ± 0.23	2.00 ± 0.18	-0.455	0.650
Drains number			4.770[a]	0.091
0	33(55.9%)	43(69.4%)		
1	18(30.5%)	17(27.4%)		
2	8(13.6%)	2(3.2%)		

Note. ASA: American Society of Anesthesiologists; a: Chi-square test. b: Gynecological cancer disease including cervical cancer, endometrial cancer and ovarian cancer.

3.2 RE-AIM framework outcomes

3.2.1 Reach

Compared to pre-implementation 83.1% (49/59), the proportion of eligible patients who were informed of and agreed to participate in the EPM intervention was 98.4% (61/62).

As shown in Table 2, non-participants were slightly older, but these differences did not reach statistical significance. No differences were observed in level of education or surgery indication distribution. The most common reason for refusal documented via structured brief interviews was “healthcare staff did

not inform" (n = 6), followed by "lack of family support" (n = 3) and "concern about postoperative pain" (n = 1). During post-implementation phase, there was one non-participant who was a 69-year-old woman with a diagnosis of uterine prolapse. Her reason for refusal was "excessive postoperative fatigue" as recorded in the structure interview. Formal statical comparison was not feasible during the post-implementation due to the small number of non-participants.

Table 2
Comparison of demographic and clinical characteristics between participants and non-participants during pre-implementation phase (N = 59)

Variable	**Non-participant (n = 10)**	**Participant (n = 49)**	**t/χ^2**	***p***
Age	59.00 ± 9.65	52.71 ± 9.86	1.844	0.070
Level of education			3.275[a]	0.353
Primary school	4(33.30%)	8(66.70%)		
Middle school	1(7.10%)	13(92.90%)		
High school	2(11.80%)	15(88.20%)		
College or above	3(18.80%)	13(81.30%)		
Gynecological Cancer [b]			0.011[a]	0.917
Yes	3(21.40%)	11(78.60%)		
No	7(15.60%)	38(84.40%)		

Note. a: Chi-square test. b: Gynecological cancer disease including cervical cancer, endometrial cancer and ovarian cancer.

3.2.2 Effectiveness

The proportion of patients who achieved mobilization within 24 hours increased significantly from 37.3% (22/59) pre-implementation to 69.4% (43/62) post-implementation ($\chi^2 = 12.504$, $p < 0.001$). Correspondingly, mean time to first mobilization decreased from 25.98 ± 6.17 hours to 22.22 ± 4.34 hours ($t = 3.891$, $p < 0.001$). In the pre-implementation phase, two patients (3.4%) experienced complications (one lower limb venous thrombosis, one intestinal obstruction). In the post-implementation phase, no patient developed any of the predefined complications (0/62). No falls or catheter dislodgements were recorded in either phase. Other secondary outcomes are shown in Table 3.

Table 3
Post-operative outcomes before and after implementation

Variable	Pre-implementation (n = 59)	Post-implementation (n = 62)	t	*p*
Time to first flatus (h)	26.84 ± 12.63	25.58 ± 10.53	0.597	0.552
Time to first bowel motion (h)	57.20 ± 27.06	47.92 ± 15.16	2.311	0.023
Length of stay (d)	11.10 ± 4.26	8.92 ± 3.08	3.217	0.002
Total hospital cost (CNY)	31 688.00 ± 12 752.69	25 243.75 ± 7 160.85	3.404	0.001

3.2.3 Adoption

All 18-nursing staff in the target ward completed the two simulation-based workshops (training participate rate: 100%). The mean willingness score to deliver the EPM intervention was 4.75 ± 0.44 (out of 5). Direct observation and review of archived bedside assessment forms showed that 17 out of 18 nursing staff (94.4%) actively used the standardized protocol or the bedside assessment form during clinical practice; the bedside assessment form was used by all 18 staff members (100%). Post-implementation interview revealed high acceptability of the bedside assessment forms and patent educational videos. Staff reported that the standardized protocol reduced uncertainty regarding mobilization decisions and enhanced interprofessional communication.

3.2.4 Implementation

In the post-implementation phase, the proportion of pre-education complete rate was 98.4% (61.62). The catheter securement execution was 96.8% (60/62). The writing activity plan completion was 91.9% (57/62). All fidelity indicators met the pre-specified threshold of 90%. The median additional nursing time per patient was 15 minutes (IQR: 12–20 minutes) for completing the beside form and assisting with first mobilization. The cost of environmental decoration, auxiliary tools, and the production of educational materials for mobilization within 24 hours is approximately 500 yuan.

3.2.5 Maintenance

At 8-week follow-up, early mobilization improvements were sustained. Among a consecutive sample of 17 patients during the 8th week, the proportion mobilized within 24 hours was 100%, and mean time to first mobilization was 19.89 ± 2.23 hours. The interrupted time-series analysis was performed using weekly aggregated adherence proportions and the time to first mobilization which was shown in Fig. 1. Although not statistically significant, the trend suggested a reduction in time to first ambulation following implementation and an increase in the proportion of postoperative mobilization within 24 hours. At follow-up, improvements in early mobilization were maintained, with no evidence of decline toward baseline levels. All interviewees confirmed that the early mobilization protocol had become part of daily nursing practice. Reported facilitators of maintenance included the simplicity of the bedside assessment form and positive patient feedback. No participant reported discontinuing use of the

protocol. One nurse mentioned adapting the wording of the activity plan for elderly patients, but this did not alter the core timing criterion.

4. DISCUSSION

This study used a type 2 hybrid effectiveness-implementation study designed with interrupted time series to evaluate the multifaceted, barrier-targeted implementation strategy for improving EPM adherence after LTH. Embedded in a theoretical framework of implementation science, we used CFIR to identify barriers, ERIC to select targeted strategies, and the RE-AIM framework to evaluate outcomes across reach, effectiveness, adoption, implementation fidelity, and maintenance. Our findings demonstrated that the implementation strategy significantly increased the proportion of patients mobilized within 24 hours from 37.3% to 69.4%, accelerated time to first mobilization, reduced hospital length of stay and medical cost, eliminated postoperative complications, achieved high fidelity, provider adoption, and sustained maintenance at 8 weeks. These findings support the value of implementation science in translating ERAS evidence into routine clinical practice, and the theory-driven design distinguishes our work from prior descriptive quality improvement projects.

Our results are consistent with previous ERAS research demonstrating that improved EPM adherence is associated with faster bowel function recovery, shorter hospitalization, and lower healthcare expenditure without compromising safety(24, 25). No falls, catheter dislodgements, or other adverse mobilization-related events were observed, confirming that standardized progressive mobilization with a validated readiness checklist is safe and feasible in patients following LTH. The elimination of postoperative complications such as venous thromboembolism and intestinal obstruction further supports the clinical benefits of consistent early mobilization, which aligns with meta-analytic evidence that EPM reduces pulmonary and thromboembolic morbidity and accelerates gastrointestinal recovery(27, 28).

However, our study makes a distinct contribution by addressing the implementation gap rather than re-establishing clinical efficacy. While prior studies have documented low EPM adherence, few have employed systematic implementation frameworks to identify barriers and select targeted strategies(29). Unlike other studies only focus on patients' education(30, 31), our study developed a multifaceted implementation strategy based on CFIR-ERIC to address multiple interrelated barriers. First, pre-implementation qualitative interviews guided by CFIR identified nurses' uncertainty about patient safety, insufficient staff or time and patients' fear of movement as primary barriers. Through directly targeting these barriers, simulation-based workshops that built nurses' confidence in risk assessment and an instructional video that reduced patient anxiety, the strategy created psychological readiness for behavior change on both sides of the clinical interaction. Second, the bedside assessment form functioned as a cognitive aid that embedded the mobilization decision into routine workflow, reducing reliance on memory in a busy ward environment. This strategy aligns with behavioral science principles that environmental cues and simplified decision-making tools can overcome inertia and promote evidence-based behaviors(32). Third, the weekly audit and feedback cycles fostered collective accountability and normalized the expectation that every eligible patient should attempt ambulation

within 24 hours. This social mechanism, transforming individual behavior into a shared ward norm, is consistent with implementation science evidence that feedback loops sustain behavior change by making performance visible and actionable(33). Finally, the simplicity and low cost of the intervention minimized resource barriers to adoption, facilitating integration into existing workflows without requiring additional personnel or technology infrastructure. Together, these integrated components achieved high implementation fidelity, nurse training participation, and usage of the bedside form, indicating strong acceptability and feasibility in a busy gynecologic surgical ward.

Our ITS design also offers methodological advantages over the pre-post designs commonly used in perioperative implementation studies. While segmented regression revealed non-significant immediate level and slope changes in time to first ambulation, the directionality of effects was consistent with significant pre-post comparisons. The lack of statistical significance in the ITS model likely reflects the limited number of time points relative to the variability in weekly aggregated data, rather than a true absence of effect. Implementation research commonly encounters this tension between clinical significance and statistical significance, particularly in quasi-experimental designs where effect sizes are often modest and heterogeneity is high(34). Importantly, the maintenance of improvements at 8-week follow-up, with no evidence of decay toward baseline, suggests that the implementation strategy achieved durable systems change rather than temporary behavior modification.

Strengths and limitations

This study makes several important contributions to literature. First, to our knowledge, this is the first application of a CFIR-ERIC informed implementation strategy specifically targeting EPM in gynecological surgery within the Chinese healthcare context. While ERAS implementation studies have proliferated in Western settings, evidence from China remains scarce despite the country's large surgical volume and distinct healthcare system characteristics. Second, the type 2 hybrid effectiveness-implementation design simultaneously advances clinical and implementation knowledge, addressing the "implementation gap" that has characterized much of perioperative research. Traditional efficacy trials demonstrate that EPM improves outcomes under ideal conditions, while our study demonstrates how to achieve these benefits in routine clinical practice. Third, comprehensive assessment of implementation outcomes using RE-AIM framework provides a nuanced understanding of implementation success beyond simple adherence metrics. However, several important limitations must be acknowledged. First, the single-center design limits external validity. Our tertiary hospital setting with dedicated gynecological surgical wards and established ERAS infrastructure may not reflect the resource constraints of secondary or rural hospitals. Second, the 16 time points in our ITS analysis provide limited statistical power to detect gradual trends. A longer pre-implementation period would have strengthened causal inference. Third, the multifaceted nature of the EPM bundle precludes attribution of effects to specific components. While this mirrors real-world implementation where strategies are typically deployed as integrated packages, future factorial or sequential designs could disentangle the relative contributions of education, audit-feedback, patient materials, and system changes. Fourth, we relied on nursing documentation for mobilization outcomes, which may be subject to documentation bias particularly if

the implementation strategy increased awareness of EPM and consequently documentation frequency. Objective measures such as accelerometer data would strengthen outcome ascertainment in future studies. Finally, our sample predominantly comprised patients with benign conditions, limiting generalizability to oncologic surgeries requiring extensive lymphadenectomy or prolonged bed rest. Future hybrid trials should test the EPM bundle in diverse surgical populations and hospital settings, ideally using a stepped-wedge or cluster-randomized design to strengthen causal inference.

5. CONCLUSIONS

This study demonstrates that a CFIR-ERIC informed, multifaceted implementation strategy significantly improved adherence to early postoperative mobilization following laparoscopic total hysterectomy, with meaningful improvements in timeliness of mobilization, and clinical outcomes including reduced length of stay and hospitalization costs. High implementation fidelity, strong provider adoption, and sustained improvements at 8-week follow-up indicate that the intervention is feasible, acceptable, and potentially scalable in resource-constrained surgical settings. The findings highlight the value of implementation science in bridging the evidence-practice gap in perioperative care and provide a replicable framework for enhancing ERAS adherence in gynecological surgery and beyond. Future research should focus on long-term sustainability, cost-effectiveness, and adaptation to diverse healthcare contexts.

Abbreviations

ERAS: Enhanced Recovery After Surgery

EPM: Early post-operative mobilization

LTH: Laparoscopic total hysterectomy

ITS: Interrupted time series

CFIR: Consolidated Framework for Implementation Research

ERIC: Expert Recommendations for Implementing Change

Declarations

Ethics approval and consent to participate

The study was reviewed and approved by the Research Ethics Committee of the Second Affiliated Hospital of Guangzhou University of Chinese Medicine (Approval No. ZE2024-224-01). In accordance with national regulations for quality-improvement initiatives embedded in routine clinical care, obtain written consent from all patients as much as possible, and if patients refuse, provide them with verbal consent regarding the project objectives and procedures. The study protocol conformed to the

Declaration of Helsinki, with voluntary participation. Participants were assured that their data would remain confidential and anonymous.

Consent for publication

Not applicable.

Availability of data and material

The data that supports the findings of this study are available on request from the corresponding author on reasonable request.

Competing interest

The authors declare no conflicts of interest.

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Author's contributions

LS: Research design, Conceptualization, Methodology, Validation, Investigation, Writing-original draft. QHH: Conceptualization, Project administration, Supervision, Methodology. ZJZ: Data validation, Data analysis, Data curation, Formal analysis. STL, WFL: Data validation, Data analysis, Data curation. XYZ, LJ, MDL, JC: Clinical intervention, Follow-ups, Outcome evaluation, Data Collection. YC, YZT: Methodology, Resource. HHZ: Methodology, Validation, Supervision. DYH: Conceptualization, Project administration, Supervision, Resources, Writing - review & editing.

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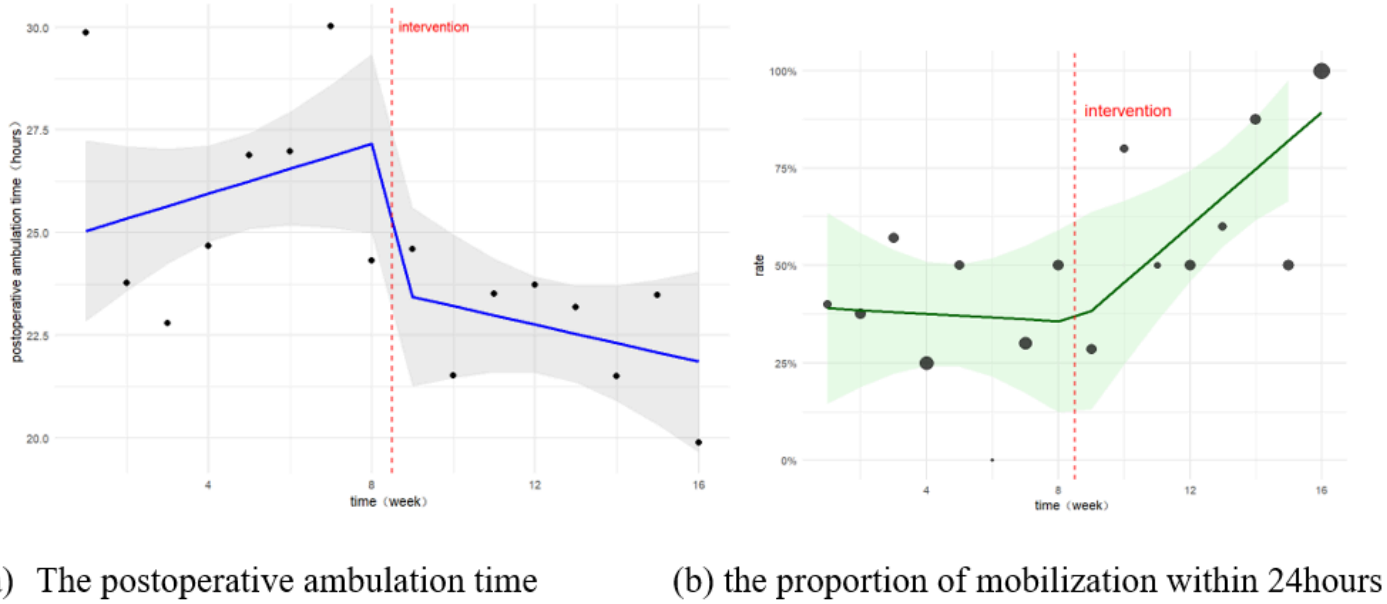
Figures



(a) The postoperative ambulation time (b) the proportion of mobilization within 24hours

Figure 1

The Interrupted time-series analysis of postoperative ambulation time and proportion of patients mobilized within 24 hours.

Supplementary Files

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