Effects of an Early Promoting Mobility Program on Postoperative Recovery Outcomes in People with Critical Illness after Major Abdominal Surgery: A Quasi-experimental Study

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Abstract: Delayed early mobilization after major abdominal surgery in people with critical illness has a considerable impact on recovery outcomes and the incidence of complications. This quasi-experimental study investigated the effects of an early promoting mobility program, grounded in the Enhanced Recovery After Surgery (ERAS) framework, on postoperative recovery outcomes. Forty participants undergoing major abdominal surgery were purposively recruited from a tertiary hospital in Bangkok, Thailand. They were matched by age and the specific type of surgical procedure and then assigned to the experimental group (n = 20), which received the intervention program within the first five to seven days after surgery in addition to usual care. The control group (n = 20) received only usual care. The data collection instruments included the Demographic Form, Bowel Function Recovery Assessment, Pulmonary Function Test, Postoperative Pulmonary Complications Assessment, Postoperative Time Out of Bed, and Quality of Recovery-40 Questionnaire. Data were analyzed using descriptive statistics, independent t-test statistics, Mann-Whitney U, and chi-square tests.

The results showed that, upon completing the program, the experimental group had significantly better pulmonary function than the control group. However, no significant differences were observed in other outcome variables. These findings suggest that while the program effectively enhances lung function, it may have a limited impact on different aspects of recovery. Further investigation is needed to better understand its full impact. An additional study employing randomized controlled trials with larger sample sizes is necessary to evaluate the program's effectiveness across a broader range of outcomes. Additionally, incorporating this program into routine intensive care unit practice and assessing its feasibility in real-world clinical settings by nurses and other healthcare professionals will be crucial for successful implementation.

Keywords: Critical illness, Early mobilization, Enhanced Recovery After Surgery (ERAS) program, Major abdominal surgery

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Introduction

Millions of major surgical procedures are performed globally each year, with 0.4 to 0.8% resulting in death or long-term disability.[1] From a clinical perspective, major surgery involves significant operative intervention, often with life-threatening risks, and is associated with an estimated mortality rate of approximately 1%.[2] Among these, major abdominal surgeries are particularly associated with high postoperative complication rates,[3] and are increasingly performed in high-risk people. In Thailand, the Thai-Surgical Intensive Care Unit study, a multicenter initiative, revealed that 78% of the people were postoperative cases, with 40% diagnosed with gastrointestinal conditions.[4] While intensive care units (ICU) provide essential monitoring to prevent complications, prolonged immobility during ICU stays can contribute to poor outcomes, including functional decline, increased complication rates, decreased quality of life, and extended hospitalizations.[5] These risks are especially pronounced in high-risk patients following major abdominal surgery, reinforcing the importance of structured, early mobilization efforts during recovery.

Early mobilization has emerged as a core component of Enhanced Recovery After Surgery (ERAS) protocols, which aim to accelerate recovery and reduce complications. Prior studies have shown the benefits of early mobilization after abdominal surgeries, including improved pulmonary and gastrointestinal functions[6] and enhanced physical performance.[7] However, most studies focus on general surgical populations and lack standardized mobility protocols, particularly for high-risk, critically ill populations.[8,9]

Recent reviews have emphasized the benefits of early mobilization in people with critical illness, including reduced muscle weakness, shortened duration of mechanical ventilation, and decreased ICU and hospital lengths of stay.[10] However, barriers to implementation persist, such as heavy staff workloads, safety concerns, and inconsistent protocols.[10] Additionally, the absence of standardized definitions and clear implementation strategies remains a significant barrier to widespread adoption.[11] These challenges emphasize the need for structured, replicable protocols designed explicitly for ICU settings.

To address these gaps, this study examined the effects of an early mobility promotion program based on the ERAS framework on recovery outcomes in people with critical illness after major abdominal surgery. It emphasized the importance of adhering to mobilization goals, monitoring safety, and providing a standardized program to improve mobilization efforts and support enhanced recovery following surgical procedures.

Literature Review and Conceptual Framework

The ERAS program was used as a conceptual framework in this study, together with the modification of the mobility protocol of the Society of Critical Care Medicine (SCCM)[12] and the American Association of Critical Care Nurses (AACN).[13] The ERAS framework incorporates multimodal strategies and enhances patient involvement to improve care throughout the preoperative, intraoperative, and postoperative phases.[14] The ERAS framework was initially developed to improve outcomes in people undergoing elective colorectal cancer surgery procedures[15] and has since been adapted for a wide range of major surgeries.[14,16] The key components include patient education, minimally invasive surgical techniques, multimodal analgesia, early mobilization, individualized fluid management, and early initiation of postoperative nutrition to enhance recovery and reduce complications.[17]

Empirical evidence supports the implementation of early mobilization within ERAS protocol across various abdominal procedures. ERAS has shown significant effects in both open colorectal and laparoscopic surgeries.[18] While typically used in elective surgeries, ERAS protocols also yield positive outcomes in emergency settings, including reduced postoperative complications, faster bowel recovery, and shorter hospital stays, without increasing readmissions or reoperations.[19] Cohort studies show that staff-led early mobilization,[20] combined with resistance exercises[21] and preoperative respiratory training[21] enhances functional and pulmonary outcomes.

Early mobilization has proven to be a vital component of recovery, particularly in ICU settings. However, ERAS guidelines often offer broad targets for early mobilization without specific protocols for critically ill populations. Many studies have explored early mobilization within ERAS frameworks but have not addressed the unique challenges of critically ill populations.[8,22] This gap in the literature is a significant barrier to the widespread adoption of early mobilization practices in ICU settings.

In response to these gaps, the SCCM[12] and the AACN[13] provide specific screening criteria and mobility progression levels tailored to ICU populations. The SCCM outlines safety criteria for initiating and ceasing mobilization, taking into account the stability of cardiovascular, respiratory, and neurological conditions.[12] Meanwhile, the AACN has developed an Early Progressive Mobility (EPM) framework,[13] which consists of a series of progressive movements that commence from the patient's current level of mobility. This approach requires that safety screenings are conducted before mobilization.

Recent reviews have synthesized evidence supporting the benefits of early mobilization in critically ill patients. Singam[10] reviewed the efficacy of early mobilization in ICU patients, finding it is associated with reduced muscle weakness, shorter mechanical ventilation durations, and decreased ICU and hospital lengths of stay. However, the review also noted that barriers such as safety concerns, staff limitations, and variability in protocols continue to hinder the adoption of early mobilization practices across ICUs. Similarly, Clarissa et al.[11] identified key barriers to effective early mobilization among people with mechanical ventilation, such as unclear definitions, variability across ICU settings, reliance on collaborative patient-staff negotiation, and contextual challenges. These limitations support the development of standardized, ICU-specific mobilization protocols that clarify goals, ensure safety, and optimize recovery in critically ill populations.

A review reveals that postoperative recovery outcomes serve as key indicators for assessing enhanced recovery after surgery, encompassing five specific measures:[23] biological and physiological variables, symptom status, functional status, general health perceptions, and quality of life (QoL). This study specifically focuses on biological and physiological variables related to restoring bowel and pulmonary function and the incidence of postoperative pulmonary complications (PPCs). Additionally, functional status is defined by the time taken to mobilize out of bed following surgery, while QoL pertains to the overall quality of the recovery process.

This study focused on an early mobility initiative created by the primary investigator (PI) for individuals experiencing critical illness after major abdominal surgery. The program includes preoperative education, initiates early mobilization the day after surgery, and continues through postoperative days 5 to 7. This mobilization involves in-bed mobility, deep breathing exercises, incentive spirometry (IS), effective coughing techniques, and leg exercises. Postoperative recovery outcomes were evaluated following the completion of the intervention program.

Study Aim and Hypotheses

This study examined the effects of an Early Promoting Mobility Program (EPMP) on postoperative recovery outcomes in people with critical illness after major abdominal surgery. Key outcomes included bowel and pulmonary function, postoperative pulmonary complications (PPCs), postoperative time out of bed, and the quality of recovery (QoR). The hypothesis was that participants who participated in the EPMP would demonstrate faster recovery of bowel and pulmonary function, fewer postoperative pulmonary complications, a shorter time spent out of bed, and better overall recovery quality than those receiving only usual care.

Methods

Design: A quasi-experimental study with a two-group posttest design was used. This report followed the Transparent Reporting of Evaluations with Non-randomized Designs (TREND) statement for reporting non-randomized studies.

Sampling and Setting: Purposive sampling was used to recruit individuals with a critical illness after elective major abdominal surgery at a tertiary university hospital in Bangkok, Thailand, from November 2021 to March 2023. The inclusion criteria were: 1) age ≥ 18 years (those over 60 required a cognitive screening test using the Six-Item Cognitive Impairment Test: 6CIT-Thai version[24]; 2) able to communicate in Thai; and 3) willing to participate. Exclusion criteria included: 1) undergoing laparoscopic surgery; 2) being handicapped or bedridden, or at risk for bone fractures; 3) experiencing severe postoperative complications (e.g., stroke, uncontrollable hemorrhaging, and respiratory failure); 4) being unable to be extubated by postoperative day 2; 5) not meeting criteria for mobilization (hemodynamic and oxygenation stability, wound stability, adequate pain control with a numeric rating scale < 4, and no nausea or vomiting); and 6) being unable to complete an early mobility promotion program.

The sample size was determined based on a two-sample independent t-test, with a significance level of 0.05 and a statistical power of 0.80. Effect sizes were calculated based on prior research examining the effect of the ERAS program on postoperative outcomes in people undergoing major abdominal surgery.[25-28] The calculated effect sizes using Cohen's formula based on the mean duration for mobilization completion, time to first flatus, time to first defecation, and time to solid food tolerance were 0.974, 0.872, 0.937, and 1.075, respectively. Subsequently, the G* power program[29] was employed to determine the required sample sizes of 28, 34, 30, and 24, incorporating a 15% attrition rate from the initial 34 to account for potential participant loss. As a result, the total sample size was 40, with 20 participants allocated to each group. Participants who met the inclusion criteria were recruited using purposive sampling. The first 20 participants were assigned to the experimental group and completed the program, while the following 20 participants were placed in the control group. Pair-matching ensured similarity in surgery type and age (within a five-year difference) between groups (**Figure 1**).

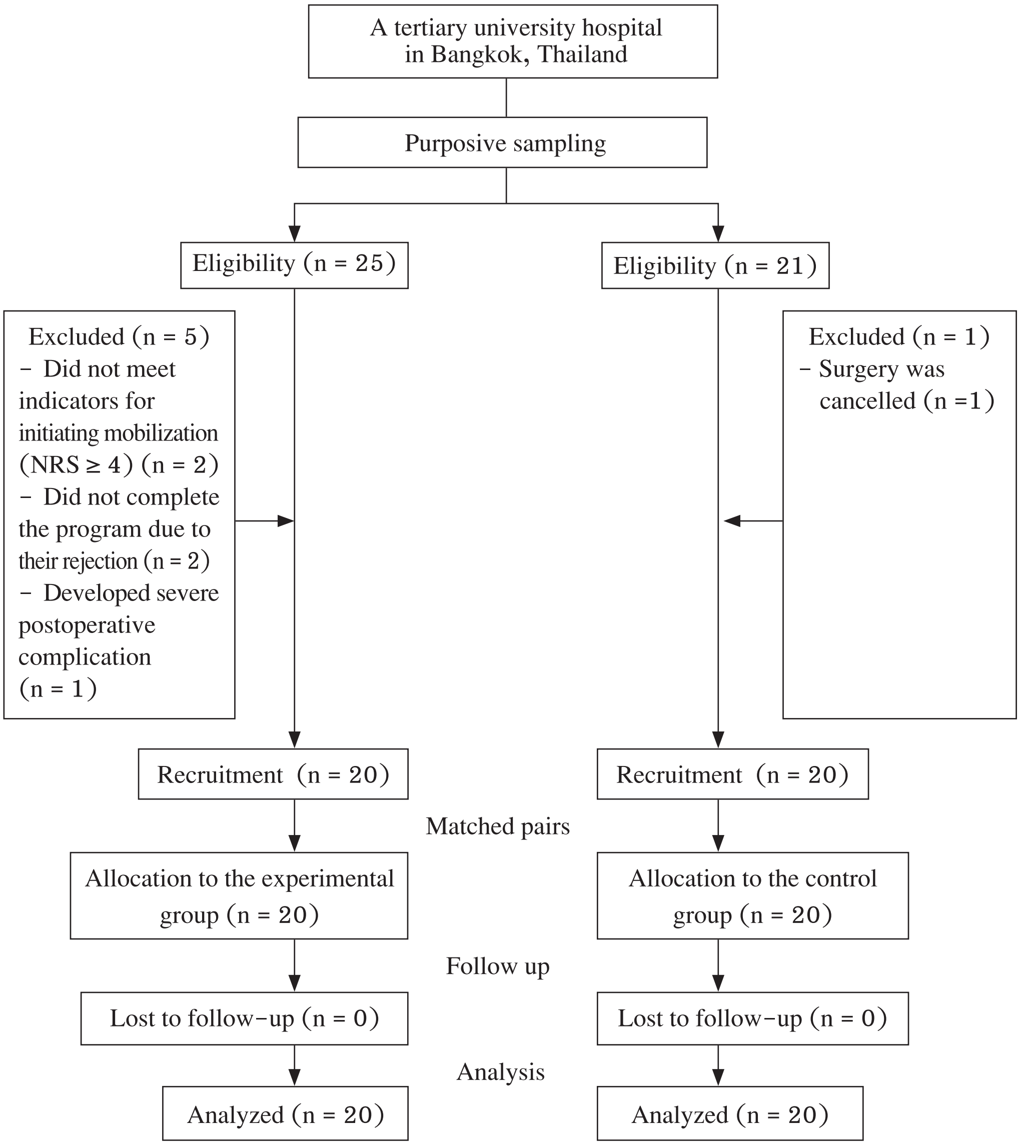

Figure 1. Flow chart of the participants throughout the study

Ethical Considerations: This study received approval from the Institutional Review Board (IRB) for Research Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital, Mahidol University (COA. MURA2021/766). Participants were informed of the study's objectives and procedures and their right to withdraw without affecting the standard of care and provided written consent. Personal identifiers were replaced with codes to maintain confidentiality, and results were presented as aggregated data. All collected information was destroyed at the end of the study.

Research Instruments consisted of 1) the screening instrument, 2) six data collection instruments, and 3) the intervention program. The primary investigator (PI) developed all instruments except the Six-Item Cognitive Impairment Test and the Quality of Recovery-40 (QoR-40) Questionnaire.

The Demographic Data Form consisted of two parts. The first part was about personal information, including gender, age, body mass index (BMI), and educational level. The second part was about the clinical and treatment information composed of 13 items: 1) underlying disease; 2) personal health history; 3) history of surgery; 4) diagnosis; 5) surgical procedure; 6) duration of surgery; 7) estimated blood loss; 8) anesthesia management; 9) postoperative mechanical ventilation; 10) the number of lines/drains; 11) postoperative analgesic management; 12) length of ICU stay; and 13) length of hospital stay.

The Bowel Function Recovery Assessment Form evaluated bowel function recovery post-surgery by measuring the time to first flatus, defecation, and solid food tolerance for at least four hours without nausea or vomiting.[30] Participants reported the timing of these events, and shorter durations indicated quicker recovery of bowel function.

The Pulmonary Function Test was conducted using the Mini-Wright portable peak flow meter, which adheres to the European scale and complies with European standards for measuring peak expiratory flow in liters per minute (L/min) within a range of 60-800 L/min. The PI was trained through the device's user manual and instructional videos provided by the manufacturer. Participants were instructed to exhale forcefully into the peak flow meter, and the PI recorded the highest of three readings as the peak expiratory flow rate (PEFR). The highest PEFR was compared to the standard predicted spirometric values (Siriraj equations). These predicted values were calculated based on the equations established by Dejsomritrutai et al.,[31] which employed regression analyses incorporating sex, height, and age as independent variables. A higher PEFR indicates better pulmonary function. Data were collected at baseline and again on postoperative days 5 to 7 or at discharge.

The Postoperative Pulmonary Complications Assessment Form, developed by Browning et al.,[32] evaluates PPCs in individuals undergoing elective upper abdominal surgery. Diagnosis is confirmed with four or more positive signs and symptoms within 5 to 7 days post-surgery, including 1) chest radiograph report of collapse/consolidation; 2) raised temperature > 38°C on two or more consecutive days; 3) change in sputum color; 4) abnormal breath sounds; 5) unexplained white cell count > 11×10^9/L or antibiotic prescription for a respiratory infection; 6) $SpO_2 < 90\%$ on room air on two consecutive days; 7) infection in sputum culture; and 8) physician diagnosis of chest infection.

The Postoperative Time Out of Bed Form documented the initial mobilization from bed after surgery, with the PI recording the time in hours until the first ambulation. A shorter interval indicated a quicker recovery.

The Quality of Recovery-40 (QoR-40) Questionnaire, developed by Myles et al.[33] and translated into Thai by Damri,[34] assesses health status after anesthesia and surgery. It includes 40 items across five dimensions: emotional state (9 items, e.g., Have you experienced feelings of anxiety?), physical comfort (12 items, e.g., Are you able to breathe easily?), physiological support (7 items, e.g., Can you communicate with family or friends?), physical independence (5 items, e.g., Are you able to wash, brush your teeth, or shave?), and pain (7 items, e.g., Have you experienced severe pain?). Responses range from 1 ('none of the time') to 5 ('all of the time'), with negative statements reversed in scoring. Total scores range from 40 (extremely poor quality of recovery, QoR) to 200 (excellent QoR), with higher scores indicating better QoR.

Validity testing: Three experts, a surgeon, a surgical critical care nursing instructor, and a medical-surgical advanced practice nurse, assessed the validity of the data collection instruments, including the handbook, and the postoperative recovery assessment forms. Following the recommendations from the experts, the content was revised to enhance clarity and improve the logical flow of information. The content validity index (CVI) for the QoR-40 Questionnaire was 0.93.

Reliability testing: The QoR-40 questionnaire was administered to ten pilot people with critical illness undergoing major abdominal surgery. The results indicated Cronbach's alpha coefficients of 0.94 for the pilot study and 0.91 in the actual study.

The Early Promoting Mobility (EPM) Program: This was developed by PI based on the ERAS framework and existing literature and involves two phases (see **Appendix, Table A1**): 1) Preoperative education and counseling focus on creating a shame-free environment, utilizing a teach-back method (return demonstration), and providing a handbook on early mobilization the day before surgery; 2) Postoperative mobilization includes scheduled early mobilization from the day of surgery through postoperative days 5-7 (POD 5-7) with ongoing safety assessments before and during each session. The program includes monitoring vital signs and consciousness; mobilization is halted if adverse events occur. The experimental group received the EPM program from the PI in addition to usual care. Initiation of the activity was recommended within 24 hours post-surgery. The PI conducted a visit the day after surgery. In cases where patients were admitted to the intensive care unit (ICU) after 6 PM, the commencement of the activity was deferred until the subsequent day. The PI subsequently evaluated the patient's readiness for mobilization and encouraged participation in two daily sessions, each lasting approximately 30 minutes. Throughout the program, the PI provided assistance, guidance, and demonstrations of the activities. Vital signs were monitored, and the patient's level of consciousness was assessed to ensure safety during activities. The program would be halted immediately if any symptoms indicate adverse events based on established stopping criteria (see **Appendix, Table A2**). The program's feasibility was trialed on three individuals with critical illnesses who safely engaged in activities without adverse events. However, six participants across the study were unable to follow the mobilization schedule due to pain levels exceeding a numeric rating scale of four after pain management, refusal to participate, or significant postoperative complications.

Usual care: This encompassed both preoperative and postoperative periods. During preoperative phase, nurses provided routine care by assessing pain, changing wound dressings, and aiding ambulation through explanations and video clips. During the postoperative period in the ICU, nurses monitored vital signs, level of consciousness, fluid intake and output, and performed routine laboratory tests. They also checked surgical drains and sites to ensure proper drainage, identify excessive bleeding, and assess pain levels. As for mobilization activities, ICU nurses played a crucial role in facilitating mobilization activities, including repositioning and ambulation. Without established mobility protocols, the staff nurse adapted and tailored these activities to align with each patient's capabilities and tolerances, with adjustments made according to the staff's skill set.

Data Collection: Following IRB approval, Data were collected from November 2021 to March 2023. The PI conducted the intervention and data collection using a sequential allocation method to prevent data contamination. The demographic data form and pulmonary function test were administered as a baseline. In addition to usual care, the experimental group received the intervention program within the first five to seven days after surgery, while the control group received usual care only. Bowel function recovery, PPCs, and postoperative time out of bed were monitored from postoperative days 1 to 7. A repeated pulmonary function test and the QoR-40 questionnaire were collected on postoperative days 5 to 7 or at discharge.

Data Analysis: Statistical analyses were conducted using SPSS software (version 21.0.0) with a statistical significance level of 0.05. After cleaning and coding, descriptive statistics were used to assess sociodemographic data. Demographic and clinical treatment data differences were evaluated using the Chi-square test, independent t-test, and Mann-Whitney U test for non-normally distributed data. The statistical analysis was then performed on the data as follows: 1) the Mann-Whitney U test compared time to first defecation, time to solid food tolerance, and postoperative time out of bed; 2) independent t-test compared the time to first flatus, mean percentage of peak expiratory flow, and mean scores of QoR-40.

Results

This study involved 40 participants, 20 in each group, with an average age of approximately 63 years. The average BMI for the experimental and control groups was 23 kg/m^2 and 24 kg/m^2, respectively. When comparing sociodemographic characteristics, no statistically significant differences were found ($p > 0.05$), as shown in **Table 1.** A comparison of the clinical characteristics across groups reveal no statistically significant differences in clinical characteristics between groups ($p > 0.05$), as shown in **Table 2.**

Table 1. Comparison of the sociodemographic characteristics according to groups (N = 40)

Characteristics	Experimental group (n = 20) Frequency (%)	Control group (n = 20) Frequency (%)	χ^2	p-value
Gender			$\chi^2 = 0.119$	0.730
Male	13 (65)	15 (75)		
Female	7 (35)	5 (25)		
Age (years)			$\chi^2 = 0.119$	0.730
< 60	5 (25)	7 (35)		
60-74	14 (70)	11 (55)		
75-84	1 (5)	2 (10)		
Mean (SD)	63.30 (8.83)	63.55 (9.86)		
Body mass index (kg/m^2)			$\chi^2 = 0.000$	1.000
Normal (18.5-22.9)	6 (30)	7 (35)		
< 18.5 (underweight)	3 (15)	0 (0)		
≥ 23 (overweight)	11 (55)	13 (65)		
Mean (SD)	23.08 (5.00)	24.68 (3.22)		
Education level			$\chi^2 = 4.048$	0.132
Elementary school	7 (35)	5 (25)		
High school/certificate	9 (45)	5 (25)		
Bachelor's degree & higher	4 (20)	10 (50)		

Table 2. Comparison of the clinical characteristics according to groups (N = 40)

Characteristics	Experimental group (n = 20) n (%)	Control group (n = 20) n (%)	Statistics	p-value
Number of underlying diseases			Fisher's exact	0.465
1-2	13 (65)	10 (50)		
> 2	4 (20)	7 (35)		

Table 2. Comparison of the clinical characteristics according to groups (N = 40) (Cont.)

Characteristics	Experimental group (n = 20) n (%)	Control group (n = 20) n (%)	Statistics	p-value
Underlying disease			Fisher's exact	1.000
No	3 (15)	3 (15)		
Yes*	17 (85)	17 (85)		
Hypertension	10 (50)	14 (70)		
Diabetes mellitus	6 (30)	8 (40)		
Dyslipidemia	5 (25)	8 (40)		
Others	13 (65)	10 (50)		
Alcohol/tobacco use			χ^2 = 0.104	0.747
No	11 (55)	13 (65)		
Tobacco use	3 (15)	1 (5)		
Alcohol use	0 (0)	1 (5)		
Tobacco & alcohol use	6 (30)	5 (25)		
History of surgery			χ^2 = .000	1.000
No	9 (45)	10 (50)		
Yes		10 (50)		
Diagnosis			χ^2 = .000	1.000
General	7 (35)	8 (40)		
Stomach cancer	1 (5)	1 (5)		
CRLM	5 (25)	5 (25)		
Colon cancer	1 (5)	0 (0)		
Rectal cancer	0 (0)	1 (5)		
GIST	0 (0)	1 (5)		
Hepatobiliary & pancreas	13 (65)	12 (60)		
HCC	8 (40)	6 (30)		
MCN	1 (5)	0 (0)		
Vascular liver tumor	1 (5)	1 (5)		
Cholangiocarcinoma	1 (5)	2 (10)		
Gallbladder cancer	0 (0)	1 (5)		
Pancreatic cancer	2 (10)	2 (10)		
Surgery procedure			Fisher's exact	1.000
General	3 (15)	3 (15)		
APR	0 (0)	1 (5)		
Right adrenalectomy	1 (5)	0 (0)		
Total/distal gastrectomy	1 (5)	1 (5)		
Subtotal colectomy	1 (5)	0 (0)		
Double bypass	0 (0)	1 (5)		

Table 2. Comparison of the clinical characteristics according to groups (N = 40) (Cont.)

Characteristics	Experimental group (n = 20) n (%)	Control group (n = 20) n (%)	Statistics	p-value
Hepatobiliary & pancreas	17 (85)	17 (85)		
Limited resection	7 (35)	8 (40)		
Right hepatectomy	3 (15)	2 (10)		
Left hepatectomy	2 (10)	1 (5)		
Partial/Wedge resection	1 (5)	1 (5)		
Sectionectomy	1 (5)	2 (10)		
Segmentectomy	1 (5)	1 (5)		
Radical/classic	2 (10)	2 (10)		
PD/Whipple procedure				
Anesthesia management			χ^2 = .000	1.000
GA	14 (70)	15 (75)		
GA and RA	6 (30)	5 (25)		
Postoperative mechanical ventilation			Fisher's exact	1.000
No	18 (90)	19 (95)		
Yes	2 (10)	1 (5)		
Lines/drains			χ^2 = 0.000	1.000
< 5	6 (30)	5 (25)		
≥ 5	14 (70)	15 (75)		
Mean (SD)	4.90 (1.02)	5.55 (1.54)		
Postoperative analgesic management			χ^2 = 0.427	0.514
PCA and opioid IV	6 (30)	9 (45)		
Epidural analgesia	14 (70)	11 (55)		

Note. *Participant could answer more than one, CRLM = Colorectal liver metastasis, GIST = Gastrointestinal stromal tumor, HCC = Hepatocellular carcinoma, MCN = Mucinous cystic neoplasms, APR = Abdominoperineal resection, PD = Pancreaticoduodenectomy, GA = General anesthesia, RA = Regional anesthesia, PCA = Patient -controlled analgesia, IV = Intravenous

Table 2. Comparison of the clinical characteristics according to groups (N = 40) (cont.)

Clinical information	Experimental group (n = 20)		Control group (n = 20)		Z	p-value
	Mean	Mean rank	Mean	Mean rank		
Duration of surgery (hours)	6.51	21.63	6.32	19.38	-0.609	0.542
Estimated blood loss (mL)	622.50	19.60	539.00	21.40	-0.488	0.625
ICU length of stay (days)	2.80	19.08	3.45	21.93	-0.784	0.433
Hospital length of stay (days)	10.30	19.25	12.20	21.75	-0.681	0.496

Bowel function recovery: Assessments included the time to first flatus, defecation, and solid food tolerance. The independent t-test and Mann-Whitney U test indicated no significant differences: time to first flatus (t = -0.974, p = 0.168) (see **Table 4**), time to first defecation (Z = -0.933, p = 0.176), and time to solid food tolerance (Z = -0.162, p = 0.436) (see **Table 3**).

Table 3. Comparison of the postoperative recovery outcomes between the experimental group (n = 20) and control group (n = 20) using the Mann-Whitney U test

Postoperative recovery outcomes	Group	Median (IQR)	Mean rank	Sum of ranks	Z	p-value
Time to first defecation (hours)	Experimental	95.84 (52.35)	18.78	376	-0.933	0.176
	Control	99.13 (24.19)	22.23	445		
Time to solid food tolerance (hours)	Experimental	78.21 (57.73)	20.20	404	-0.162	0.436
	Control	89.38 (108.13)	20.80	416		
Postoperative time out of bed (hours)	Experimental	69.00 (30.85)	19.68	393.50	-0.446	0.328
	Control	74.17 (52.39)	21.33	426.50		

Pulmonary function: Preoperative peak expiratory flow (PEF) was measured for both groups, showing no significant differences (t = 0.31, p = .380). Post-surgery, the experimental group's mean PEF was 66.55% (SD = 11.22), and the control group's was 59.67% (SD = 10.19), indicating a statistically significant difference (t = 2.03, p = 0.025) (see **Table 4**). Importantly, no participants in either group developed any PPCs; therefore, these were not reported in this study.

Postoperative time out of bed: Using the Mann-Whitney U test, the experimental group's median time to get out of bed was 69 minutes, compared to 74.17 minutes for the control group. The analysis revealed no statistically significant difference in the postoperative time out of bed (Z = -0.446, p = 0.328), as shown in **Table 3**.

Quality of recovery: An independent t-test compared the mean QoR-40 scores of the experimental group (174.85, SD = 14.14) and the control group (178.95, SD = 13.39). An analysis of each dimension of QoR-40 revealed similarities between the two groups. The comparison of QoR-40 scores indicated no statistically significant differences (t = -0.942, p = 0.176), as shown in **Table 4**.

Table 4. Comparison of the postoperative recovery outcomes between groups using independent t-test (n=40)

Postoperative recovery outcomes	Maximum possible score	Experimental (n = 20)		Control (n = 20)		t	p-value
		Mean	SD	Mean	SD		
PEF, pre-op (%)		83.19	19.12	81.63	12.20	0.31	0.380
PEF, post-op (%)		66.55	11.22	59.67	10.19	2.03	0.025
Time to first flatus (hours)		48.20	28.04	56.57	26.28	-0.974	0.168
QoR-40 score	200	174.85	14.14	178.95	13.39	-0.942	0.176
QoR-40 dimensions							
Emotional state	45	38.55	4.32	39.75	3.91	-0.921	0.182
Physical comfort	60	51.35	5.18	52.15	5.55	-0.471	0.320
Physiological support	35	33.30	1.90	33.75	1.48	-0.837	0.204
Physical independence	25	21.15	3.13	22.20	2.71	-1.134	0.132
Pain	35	30.50	3.82	31.10	2.94	-0.557	0.291

Note. PEF = Peak expiratory flow, QoR-40 = Quality of recovery-40

Discussion

The findings of this study demonstrated that the EPM program effectively improved pulmonary function. This improvement can be attributed to several key components of the program, including proper deep breathing exercises, correct utilization of IS, and consistent early mobilization. Moreover, the program incorporates various strategies derived from the ERAS protocol, focusing on evidence-based practices to enhance perioperative care and optimize recovery. A crucial aspect of the EPM program is the preoperative education provided through a teach-back approach, ensuring participants comprehensively understand the procedure. The program's structured approach to initiating and ceasing mobilization during scheduled postoperative activities effectively encourages participants to complete their recovery. Previous studies based on the ERAS protocol support these findings. For example, Gu et al.[35] investigated the impact of respiratory function training, including lip and abdominal breathing, effective coughing, and a progressive increase in physical activity from in-bed to out-of-bed tasks. Their results showed that lung function tests after surgery in the ERAS group were significantly higher than those in the control group. Similarly, Zhao et al.[36] utilized diaphragmatic breathing exercises (DBE) and IS to improve pulmonary function. Their findings suggest that regular practice of DBE, along with proper use of IS for 5 minutes, four times daily, both before and after abdominal surgery, serves as an effective intervention for enhancing postoperative pulmonary function, thereby reducing the occurrence of PPCs.

The EPM program did not affect the recovery of bowel function, as the assessment tool used to evaluate bowel function recovery is limited by its subjective nature, relying on the individual's self-reports. This reliance affects the time to first flatus, which is influenced by individual perceptions and contextual factors, as noted by Maffezzini et al.[37] Furthermore, time to first flatus is considered a surrogate marker for overall gut motility recovery. It is frequently assessed alongside time to the first bowel movement.[38] However, the researcher did not auscultate bowel sounds to assess the return of bowel function due to the difficulty of determining precisely and accurately whether frequent auscultation is required.[39]Another consideration is the limited diversity among participants regarding the types of surgical interventions they underwent, including previous exploratory laparotomy and the extent of the abdominal incision.[38] This limitation may serve as a risk factor that affects the gastrointestinal system and contributes to the unusual recovery patterns of bowel function. Variations in the time to first flatus, defecation, and solid food tolerance may be influenced functional gastrointestinal disturbances.

The study found no PPCs within the first week after surgery. A notable incident of this study involved a temperature exceeding 38°C, accompanied by the production of yellow sputum a few days later. These symptoms were effectively managed through early ambulation, timely out-of-bed activities, proper coughing techniques, and appropriate use of an IS. Previous research by Patel et al.[40] reported that 11.9 % of PPCs occurred within the first week after major elective abdominal surgeries, highlighting significant morbidity associated with such complications. The study's brief monitoring period may have missed some PPCs, suggesting that an extended data collection period exceeding two weeks could have potentially revealed the occurrence of PPCs.

The similar postoperative time out of bed observed in both groups may be attributed to the standardized practices implemented in the usual care group, which included preoperative education focused on early mobilization. Although tailored to individual capabilities, the median postoperative time out of bed did not differ significantly between the groups. Importantly, all participants engaged in this program without experiencing adverse events, such as falls, wound dehiscence, syncope, or postural hypotension, indicating that early mobilization after major abdominal surgery in the ICU is both feasible and safe.

The QoR-40 scores did not show significant variation, likely because implementing just one component of the ERAS protocols, specifically the EPM program, may not significantly impact certain aspects and the overall QoR scores. Additionally, the questionnaires' limitations may affect outcomes, as some items focus on assessing early postoperative health in the post-anesthetic care units (PACU).[33]

Notably, only pulmonary function exhibited statistical significance, while other variables deemed non-significant could be influenced by Type II errors due to the small sample size, which limits the power to detect differences. Furthermore, the result reveals a small effect size and a wide confidence interval for non-significant results, suggesting their practical relevance is limited. However, the matched-pairs design is a key strength of the study, ensuring group equivalence and reducing confounding variables. As a result, the EPM program shows potential to positively influence pulmonary function after major abdominal surgery.

In summary, this study suggests that the EPM program, based on the ERAS protocol, significantly enhances pulmonary function. More importantly, adherence to the program is essential for its success, as demonstrated by the absence of PPCs in this study.

Limitations and Recommendations

This study has notable limitations, particularly the potential bias from the sequential allocation method used in clinical trials. Future research should focus on randomized controlled trials to minimize this bias and enhance internal validity. Additionally, the limited sample size raises questions about the generalizability of the findings; larger studies could provide better insights into variations across populations. Furthermore, the researcher used the Mini-Wright portable peak flow meter to measure the pulmonary function. The researcher was trained through the device's user manual and instructional videos provided by the manufacturer. However, this study did not formally assess interrater reliability between the data collector and the expert. Future research could benefit from including a formal evaluation of interrater reliability to ensure the accuracy and consistency of the data collection process. Lastly, while the program constraints did not affect the other outcomes, future program development may reveal specific discrepancies that could be addressed.

Conclusions and Implications for Nursing Practice

This study demonstrated that the ERAS program significantly improves pulmonary function, with the absence of PPCs observed. To optimize recovery, nurses should emphasize preoperative education on the importance of early mobilization. Nurses can develop this program into clinical nursing practice guidelines that focus on optimizing postoperative recovery. Further long-term studies are recommended to assess the program's efficacy and its effects on postoperative outcomes.

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Appendix

Table A1. Description of the content of the EPM program

Session/Goal	Scheduled activities				Duration
	Preoperative phase				
At least one day before surgery	- Establishing a shame-free environment - Provide preoperative education and counseling about the EPM program - Using the teach-back method - Give a handbook for practicing and revising their understanding				45-60 minutes
	Postoperative phase				
	Movement	**Breathing**	**Coughing**	**Leg**	
Day of surgery within 24 hours (In-bed mobility)	- Turn position on the left and right sides - Elevate the head of the bed to 30-45°	Deep breathing for 5-10 breaths	Effective coughing to clear secretion from the airways	Leg exercises repeated 10 times each	20-30 minutes
Postoperative days 1-2 (Sitting on the bed)	- Same as in-bed mobility - Sit on the edge of the bed and dangle feet	- Deep breathing for 5 breaths - Use of incentive spirometry for 10 breaths	Effective coughing	Leg exercises repeated 10 times each	30 minutes
Postoperative days 2-4 (Sitting on a chair at the bedside)	- Same as sitting on the bed - March in place - Sit on a chair at the bedside	- Deep breathing for 5 breaths - Use of incentive spirometry for 10 breaths	Effective coughing	Leg exercises repeated 10 times each	30 minutes
Postoperative days 3-5 (Walking at the bedside)	- Same as sitting on a chair at the bedside - Walk at the bedside or around the bed for a short distance	- Deep breathing for 5 breaths - Use of incentive spirometry for 10 breaths	Effective coughing	Leg exercises repeated 10 times each	30 minutes
Postoperative days 4-7 (Walking down the hallway)	- Sit on a chair with a meal - Walk down the hallway	- Deep breathing for 5 breaths - Use of incentive spirometry for 10 breaths	Effective coughing	Leg exercises repeated 10 times each	30 minutes

Note. * The activity should initiate within 24 hours after surgery and it is to be conducted twice daily, once in the morning and once in the evening.

Appendix

Table A2. Safety indicators for initiating and stopping mobilization

System	Indicators for initiating*	Indicators for stopping**
Myocardial stability	- 130 ≥ HR ≥ 60 bpm - 180 ≥ SBP ≥ 90 mmHg - 110 ≥ MAP ≥ 60 mmHg - No dysrhythmia or chest pain	- HR < 60 or > 130 bpm (≥ 5 mins) - SBP < 90 or >180 mmHg (≥ 5 mins) - MAP < 60 or > 110 mmHg (≥ 5 mins)
Oxygenation stability	- 40 ≥ RR ≥ 10 bpm - SpO_2 ≥ 90 % - FiO_2 < 0.6; PEEP < 10 cmH2O (if required a mechanical ventilator)	- RR < 10 or > 40 bpm (≥ 5 mins) - SpO_2 < 90 % (≥ 5 mins)
Neurologic instability		- Alteration of consciousness - New arrhythmia/chest pain - Distress or ventilator desynchrony
Vasopressor	- No vasopressor use	
Wound stability	- No unstable surgical incision; abnormal bleeding - Pain < 4	- Active bleeding of a surgical incision
Others	- Catheters/lines/drains secured in a manner - No nausea/vomiting	- Fall - Ventilator tube/drain tube/device slips

Note. * The PI assesses and initiates mobility when it meets all required parameters.

** The PI monitors and stops mobility when any of the specified parameters are present.

SpO_2 = Oxygen saturation, FiO_2 = Fraction of inspired oxygen, PEEP = Positive end-expiratory pressure, SBP = Systolic blood pressure, HR = Heart rate, RR = Respiratory rate, MAP = Mean arterial pressure

ผลของโปรแกรมส่งเสริมการเคลื่อนไหวร่างกายโดยเร็วต่อผลลัพธ์การฟื้นสภาพหลังผ่าตัดในผู้ที่มีภาวะวิกฤตภายหลังได้รับการผ่าตัดใหญ่ช่องท้อง : การวิจัยแบบกึ่งทดลอง

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บทคัดย่อ : ความล่าช้าในการเริ่มการเคลื่อนไหวร่างกายโดยเร็วในผู้ป่วยวิกฤตภายหลังผ่าตัดใหญ่ช่องท้องส่งผลกระทบต่อการฟื้นสภาพและการเกิดภาวะแทรกซ้อนหลังผ่าตัด งานวิจัยกึ่งทดลองนี้ มีวัตถุประสงค์เพื่อศึกษาผลของโปรแกรมส่งเสริมการเคลื่อนไหวร่างกายโดยเร็วต่อผลลัพธ์การฟื้นสภาพหลังผ่าตัด โดยใช้โปรแกรมส่งเสริมการฟื้นตัวหลังผ่าตัด Enhanced Recovery After Surgery (ERAS) เป็นกรอบแนวคิดในการวิจัย ผู้เข้าร่วมวิจัยเป็นผู้ป่วยที่เข้ารับการผ่าตัดใหญ่ช่องท้อง ณ โรงพยาบาลระดับตติยภูมิแห่งหนึ่งในจังหวัดกรุงเทพมหานคร ประเทศไทย เลือกกลุ่มตัวอย่างแบบเฉพาะเจาะจงตามคุณสมบัติที่กำหนดจำนวน 40 คน โดยจับคู่กันตามอายุและชนิดของการผ่าตัดที่ใกล้เคียงกัน แบ่งเป็นกลุ่มทดลอง 20 คน ได้รับโปรแกรมส่งเสริมการเคลื่อนไหวร่างกายโดยเร็วใช้ระยะเวลา 5 ถึง 7 วันหลังผ่าตัด ร่วมกับการดูแลตามปกติ และกลุ่มควบคุม 20 คนได้รับการดูแลตามปกติเท่านั้น เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูล ประกอบด้วยแบบบันทึกข้อมูลส่วนบุคคล แบบประเมินการฟื้นตัวด้านการทำหน้าที่ของลำไส้ สมรรถภาพปอด ภาวะแทรกซ้อนระบบทางเดินหายใจ ความสามารถในการเคลื่อนไหวร่างกายโดยเร็ว และแบบสอบถามคุณภาพการฟื้นตัวหลังผ่าตัด วิเคราะห์ข้อมูลโดยใช้สถิติบรรยาย สถิติที สถิติแมนวิทนีย์ และสถิติไคสแควร์

ผลการวิจัยพบว่าภายหลังได้รับโปรแกรมส่งเสริมการเคลื่อนไหวร่างกายโดยเร็ว กลุ่มทดลองมีสมรรถภาพปอดดีกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ขณะที่ตัวแปรอื่น ๆ พบว่าไม่แตกต่างกัน การศึกษาครั้งนี้ชี้ให้เห็นว่า อาจมีข้อจำกัดที่ทำให้ผลของตัวแปรอื่น ๆ ไม่แตกต่างกัน ควรมีการศึกษาเพิ่มเติมในงานวิจัยการทดลองแบบสุ่มในกลุ่มตัวอย่างที่มีขนาดใหญ่ขึ้น เพื่อใช้เป็นข้อมูลในการประเมินประสิทธิภาพของโปรแกรมต่อผลลัพธ์อย่างครอบคลุม นอกจากนี้ การนำโปรแกรมนี้ไปใช้ร่วมกับการดูแลผู้ป่วยวิกฤติตามปกติและการประเมินความเป็นไปได้ในสถานการณ์ทางคลินิกจริงโดยพยาบาลและบุคลากรด้านสุขภาพอื่น ๆ ถือเป็นสิ่งสำคัญสำหรับการปฏิบัติอย่างประสบความสำเร็จ

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คำสำคัญ: ภาวะเจ็บป่วยวิกฤต การเคลื่อนไหวร่างกายโดยเร็ว โปรแกรมส่งเสริมการฟื้นตัวหลังผ่าตัด การผ่าตัดใหญ่ช่องท้อง

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