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ORIGINAL ARTICLE

Public Health and Microbiological Evaluation of Enhanced Recovery after Surgery (ERAS) Protocols in Hysterectomy Patients: A Clinical Study

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ABSTRACT

Background: Enhanced Recovery After Surgery (ERAS) protocols are evidence-based perioperative pathways designed to optimize surgical outcomes, reduce postoperative complications, and improve recovery. However, limited data exist regarding their impact on microbiological outcomes and infection control among hysterectomy patients in developing healthcare settings.

Objective: To evaluate the public health and microbiological effects of ERAS protocols compared with conventional postoperative care in women undergoing elective hysterectomy.

Methods: This multicenter clinical study was conducted at the Department of Gynaecology, Unit I, SPHQ/BMCH Quetta, and the Department of Obstetrics & Gynaecology, Liaquat National Hospital Karachi from January 2022 to May 2023. A total of 120 patients were enrolled and allocated into ERAS (n=60) and conventional care (n=60) groups. Clinical outcomes included postoperative pain, time to oral intake, mobilization, length of hospital stay, and surgical site infection (SSI) rates. Microbiological evaluation included wound swab cultures, organism identification, and colony-forming unit (CFU) quantification.

Results: ERAS patients demonstrated significantly shorter hospital stays (2.4 ± 1.0 vs. 4.8 ± 1.4 days), lower SSI rates (6.7% vs. 28.3%), earlier oral intake (4.3 ± 2.1 vs. 18.5 ± 6.4 hours), and earlier mobilization (11.2 ± 3.6 vs. 27.3 ± 7.2 hours) compared with conventional care. Pain scores were significantly reduced in the ERAS group (3.0 ± 1.2 vs. 6.1 ± 1.7). Microbiological assessment showed fewer pathogenic isolates, absence of MRSA, and lower mean CFU counts in the ERAS group (2.0×10^3 CFU/mL vs. 7.5×10^3 CFU/mL).

Conclusion: ERAS protocols substantially improve postoperative recovery and infection control in hysterectomy patients. The significant reduction in SSI rates, bacterial load, hospital stay, and antibiotic use underscores ERAS as an effective clinical and public health strategy. Routine integration of ERAS pathways into gynecological surgical care is strongly recommended to enhance patient outcomes and promote antimicrobial stewardship.

Keywords: Enhanced Recovery After Surgery, Hysterectomy, Surgical Site Infection, Microbiological Evaluation, Public Health, ERAS Protocols, Gynecologic Surgery.

INTRODUCTION

Hysterectomy is one of the most commonly performed gynecological surgeries worldwide, indicated for a wide range of benign and malignant conditions including uterine fibroids, abnormal uterine bleeding, endometriosis, chronic pelvic pain, adenomyosis, and early-stage gynecological cancers[1]. Despite improvements in operative techniques particularly the shift toward minimally invasive laparoscopic and vaginal approaches postoperative morbidity remains a significant clinical and public health concern. Surgical site infections (SSI), prolonged hospitalization, delayed mobilization, unnecessary postoperative fasting, excessive opioid use, and inconsistent antibiotic practices continue to contribute to poor recovery outcomes, increased healthcare costs, and increased risk of antimicrobial resistance (AMR), particularly in low- and middle-income countries[2,3].

Enhanced Recovery After Surgery (ERAS) protocols were introduced as an evidence-based, multidisciplinary approach designed to minimize surgical stress, preserve perioperative physiological function, and accelerate postoperative rehabilitation[4]. Key elements such as preoperative counseling, shortened fasting periods, carbohydrate loading, standardized anesthesia and multimodal analgesia, early mobilization, early initiation of oral intake, and optimized fluid management have been shown to significantly improve postoperative outcomes in colorectal, orthopedic, and hepatobiliary surgeries. However, despite strong evidence supporting ERAS in other surgical disciplines, its application in gynecological surgery, specifically hysterectomy, is still evolving, and the literature remains relatively limited in many developing countries[5,6].

One of the critical areas where ERAS may offer substantial benefit is infection control and microbiological outcomes. SSIs contribute significantly to postoperative morbidity after hysterectomy, leading to increased antibiotic consumption, prolonged hospital stay, repeated visits, and higher risk of developing antimicrobial-resistant pathogens[7]. Understanding how ERAS influences microbial burden, SSI rates, pathogen distribution, and antibiotic use is essential for guiding antimicrobial stewardship and improving public health outcomes. Yet, very few studies have evaluated the microbiological impact of ERAS in hysterectomy patients, particularly in resource-constrained healthcare systems where infection control remains challenging[8,9].

The public health implications of ERAS extend beyond individual patient outcomes. By reducing hospital stay, minimizing complications, and lowering antimicrobial exposure, ERAS protocols directly contribute to improved healthcare resource utilization, reduced hospital overcrowding, and decreased burden on surgical wards. Additionally, better infection control reduces the community spread of pathogenic organisms, especially multidrug-resistant strains[10,11].

Given these gaps in the literature and the rising burden of postoperative infections and antimicrobial resistance, there is a strong need to evaluate both the clinical and microbiological effects of ERAS in hysterectomy patients. This study aims to investigate the impact of ERAS protocols on postoperative recovery, infection rates, microbial isolates, antibiotic usage, and overall public health outcomes in women undergoing hysterectomy in a tertiary care setting. The findings will help guide evidence-based integration of ERAS into gynecological surgical practice and support policymaking for improving surgical care standards in developing healthcare systems[12].

MATERIALS AND METHODS

This multicenter clinical study was conducted in the Department of Gynaecology, Unit I, Sandeman Provincial Hospital/ Bolan Medical College Hospital (SPHQ/BMCH), Quetta, Pakistan, and the

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Department of Obstetrics & Gynaecology, Liaquat National Hospital, Karachi, Pakistan. The study period spanned from January 2022 to May 2023. Ethical approval was obtained from the institutional review boards of both participating centers prior to the commencement of data collection, and written informed consent was obtained from every participant.

A total sample of 120 patients scheduled to undergo elective hysterectomy was recruited through consecutive non-probability sampling. Eligible participants were women aged 25 to 65 years who were planned for abdominal, vaginal, or laparoscopic hysterectomy for benign gynecological conditions. Patients with uncontrolled diabetes, chronic immunosuppressive therapy, preexisting pelvic infections, emergency surgical indications, or severe systemic illnesses (ASA class IV and above) were excluded to avoid confounding outcomes related to postoperative recovery and infection risk.

All participants were allocated into two groups based on the perioperative management protocol utilized by the respective surgical teams. The ERAS group received perioperative care aligned with the Enhanced Recovery After Surgery framework, which included structured preoperative counseling, reduced fasting duration, preoperative carbohydrate loading, multimodal non-opioid analgesia, restrictive fluid strategy, avoidance of routine postoperative drains, early initiation of oral intake, and mobilization within the first 24 hours. In contrast, the conventional care group received standard traditional perioperative management involving extended fasting, unrestricted intravenous fluids, opioid-dominant analgesia, routine placement of surgical drains at the surgeon's discretion, delayed feeding, and delayed mobilization.

Preoperative variables including age, BMI, indication for surgery, comorbidities, and type of hysterectomy were documented. Intraoperative factors including duration of surgery, estimated blood loss, anesthesia type, and intraoperative complications were recorded by trained staff. All postoperative outcomes were assessed daily until discharge.

Microbiological evaluation was performed for all patients who developed clinical suspicion of surgical site infection (SSI) or wound discharge. Sterile wound swabs were collected under aseptic technique from the superficial incision site and transported to the microbiology laboratories of the respective hospitals. Swabs were inoculated onto blood agar and MacConkey agar plates and incubated at 37°C for 24–48 hours. Identification of isolates such as Staphylococcus aureus, methicillin-resistant S. aureus (MRSA), Escherichia coli, Klebsiella, Pseudomonas, and other aerobic organisms was carried out using standard biochemical tests. Colony-forming units (CFU/mL) were quantified semi-quantitatively, and antibiotic susceptibility patterns were interpreted using Clinical and Laboratory Standards Institute (CLSI) guidelines.

Primary outcomes included length of hospital stay, incidence of surgical site infection, microbial profile of isolates, postoperative pain scores, antibiotic consumption, and time to return to baseline functionality. Secondary outcomes included time to first oral intake, time to mobilization, postoperative nausea and vomiting, and rate of readmission within 30 days. Pain was assessed using a visual analog scale (VAS) ranging from 0 to 10. Antibiotic use was recorded as total duration of prescribed postoperative therapy.

All data were entered into SPSS version 26 for analysis. Continuous variables such as age, pain scores, CFU counts, and hospital stay were expressed as mean ± standard deviation and compared using the independent sample t-test. Categorical variables including frequency of SSI, type of surgery, and microorganism isolates were compared using the chi-square test or Fisher's exact test where appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics: A total of 120 patients undergoing elective hysterectomy were included in this study, with 60 patients in the ERAS group and 60 patients in the conventional care group. Both groups were comparable in their demographic and preoperative clinical characteristics. The mean age of patients in the ERAS group was 45.9 ± 8.4 years, while the conventional care group had a mean age of 46.7 ± 9.1 years. Body mass index (BMI), ASA classification, type of hysterectomy performed, and presence of major comorbidities did not differ significantly between the groups. These similarities ensured that any differences in postoperative outcomes could be attributed to perioperative care protocols rather than baseline imbalances. The detailed baseline characteristics are provided in Table 1, confirming that both groups were adequately matched for comparative analysis.

Table 1: Baseline Characteristics of Patients in ERAS vs. Conventional Care Groups

Variable	ERAS (n=60)	Conventional (n=60)	p-value
Mean age (years)	45.9 ± 8.4	46.7 ± 9.1	0.63
Mean BMI (kg/m²)	27.3 ± 3.1	27.8 ± 3.4	0.48
ASA Class I/II/III	16/34/10	18/32/10	0.87
Type of Hysterectomy (Abd/Lap/Vag)	21/25/14	22/23/15	0.82
Major Comorbidities (%)	31.6%	33.3%	0.78

Clinical Outcomes: The ERAS group demonstrated significantly superior postoperative outcomes compared to the conventional care group. Patients managed under ERAS protocols had a markedly shorter hospital stay, with a mean duration of 2.4 ± 1.0 days, whereas patients receiving conventional care stayed for an average of 4.8 ± 1.4 days. This difference was statistically significant ($p < 0.001$), indicating the efficiency of ERAS protocols in promoting faster recovery. Surgical site infection (SSI) rates were substantially lower in the ERAS group, with only 6.7% (4/60) developing infection, compared to 28.3% (17/60) in the conventional group ($p = 0.002$). Pain assessment using the visual analog scale (VAS) showed significantly lower postoperative pain levels in patients receiving ERAS-based management, with a mean score of 3.0 ± 1.2 versus 6.1 ± 1.7 in the conventional group ($p < 0.001$). Early mobilization and early oral intake were also significantly improved under ERAS protocols. Patients in the ERAS group ambulated within 11.2 ± 3.6 hours post-surgery and began oral intake within 4.3 ± 2.1 hours, while the corresponding values in the conventional group were 27.3 ± 7.2 hours and 18.5 ± 6.4 hours, respectively. These findings are summarized in Table 2 and highlight the enhanced postoperative recovery associated with ERAS implementation.

Table 2: Postoperative Clinical Outcomes in ERAS vs. Conventional Care Groups

Outcome	ERAS (n=60)	Conventional (n=60)	p-value
Hospital stay (days)	2.4 ± 1.0	4.8 ± 1.4	<0.001
SSI (%)	6.7% (4)	28.3% (17)	0.002
Mean VAS pain score	3.0 ± 1.2	6.1 ± 1.7	<0.001
Time to oral intake (hours)	4.3 ± 2.1	18.5 ± 6.4	<0.001
Time to mobilization (hours)	11.2 ± 3.6	27.3 ± 7.2	<0.001
Antibiotic duration (days)	1.1 ± 0.3	3.5 ± 1.2	<0.001

Table 3: Microorganisms Isolated from SSI Cases

Organism	ERAS (n=4)	Conventional (n=17)
Staphylococcus aureus	1	6
MRSA	0	3
Escherichia coli	2	5
Klebsiella spp.	1	2
Pseudomonas spp.	0	1

Microbiological Outcomes: Microbiological evaluation of wound swabs collected from patients with suspected surgical site infections revealed notable differences between the two groups. The ERAS group had significantly fewer positive cultures, with only four isolates identified compared to seventeen isolates in the conventional care group. The most frequently isolated organisms included Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa. Importantly,

methicillin-resistant Staphylococcus aureus (MRSA) was detected exclusively in the conventional group, further supporting the superior infection control profile of ERAS-based perioperative care. The distribution of microorganisms is shown in Table 3.

Colony-Forming Unit (CFU) Analysis: Quantitative bacterial load assessment further reinforced the clinical findings. The mean CFU count in cultures obtained from ERAS patients was significantly lower at 2.0×10^3 CFU/mL, compared to 7.5×10^3 CFU/mL in the conventional care group ($p < 0.001$). This reduction indicates not only fewer infections but also milder microbial proliferation where infections did occur. These results are presented in Table 4, demonstrating the favorable microbiological impact of ERAS protocols.

Table 4: Mean Colony-Forming Units (CFU/mL) in Culture-Positive Patients

Group	Mean CFU/mL	Range
ERAS	2.0×10^3	$1.1 – 3.3 \times 10^3$
Conventional	7.5×10^3	$4.0 – 12.0 \times 10^3$

Functional Recovery: The overall functional recovery was markedly better in patients managed under ERAS. The time taken to return to routine daily activities averaged 11.0 ± 3.4 days in the ERAS group, while patients in the conventional care group required 18.7 ± 6.2 days to reach comparable levels of recovery. This improvement reflects the cumulative benefit of reduced pain, earlier mobilization, lower infection rates, and shorter hospitalization. Enhanced postoperative function in the ERAS group aligns with all previously reported clinical and microbiological advantages.

DISCUSSION

The findings of this multicenter clinical study demonstrate that the implementation of Enhanced Recovery After Surgery (ERAS) protocols in hysterectomy patients leads to significant improvements in clinical recovery, infection prevention, and microbiological outcomes when compared with conventional postoperative care[11]. The superiority of ERAS was consistent across all measured parameters, reflecting the effectiveness of this evidence-based perioperative approach within the gynecological surgical population in Pakistan[12].

One of the most notable improvements observed in the ERAS group was the significantly shorter hospital stay[13]. Patients managed under ERAS were discharged in nearly half the time required for those receiving conventional care. This reduction is attributable to the central ERAS components early mobilization, early oral intake, multimodal analgesia, and minimization of invasive tubes which collectively decrease physiological stress, enhance gastrointestinal recovery, and promote faster functional stability. These findings align with international literature showing that ERAS protocols can shorten postoperative length of stay without increasing readmission rates or complications. In resource-limited settings such as Pakistan, reduced hospitalization duration has high public health value by decreasing bed occupancy, lowering hospital costs, and enhancing patient turnover in busy surgical units[14,15].

The substantial reduction in postoperative surgical site infections (SSI) among patients in the ERAS group is another significant outcome of this study[16]. ERAS patients experienced fewer SSIs, and the associated microbiological analysis confirmed a lower pathogenic burden, fewer positive wound cultures, and considerably reduced bacterial colony counts[17]. The complete absence of MRSA isolates in the ERAS group further suggests enhanced infection control under ERAS-guided care[18]. These findings may be attributed to several ERAS components, including improved perfusion due to goal-directed fluid management, reduced tissue trauma, minimization of drains and catheters, early mobilization improving immune function, and optimized antibiotic prophylaxis. Together, these practices mitigate the risk factors known to predispose surgical patients to infection. Additionally, reduced postoperative pain and earlier mobilization support the physiological recovery that contributes to improved wound healing and infection resistance[19,20].

From a microbiological standpoint, ERAS demonstrated a clear advantage in reducing bacterial proliferation at the surgical site. Lower CFU counts among ERAS patients indicate not only reduced infection rates but also attenuated severity of infections when they occur. This observation is clinically significant, as it supports the notion that ERAS protocols can reduce the virulence and pathogenicity of surgical site flora. The lower isolation of Gram-negative and Gram-positive pathogens especially Staphylococcus aureus and Escherichia coli highlights improved aseptic integrity and better postoperative wound care under ERAS guidelines[20,21].

Furthermore, antibiotic use was significantly reduced in the ERAS group, supporting antimicrobial stewardship principles. In conventional practices across many hospitals, prolonged postoperative antibiotics are often administered unnecessarily, contributing to rising antimicrobial resistance (AMR)[16]. ERAS protocols emphasize evidence-driven antibiotic prophylaxis and discourage unnecessary postoperative antibiotic use, directly reducing drug exposure and limiting the selection pressures that promote resistant organisms. The public health implications of this observation are substantial: reduced antibiotic consumption enhances AMR control, lowers pharmaceutical costs, and improves long-term patient safety[17,22].

Pain management outcomes further reinforce the benefits of ERAS. Patients reported significantly lower pain scores, resulting in earlier mobilization, increased comfort, reduced opioid use, and faster functional recovery[23]. Reduced postoperative ileus, enhanced ambulation, and rapid return to normal activity observed in ERAS patients support global evidence that multimodal analgesia is more effective and safer than opioid-centered regimens traditionally used in conventional care[11].

Overall, the findings of this study demonstrate that ERAS protocols function not only as a clinical enhancement tool but also as an integrated public health strategy. This is particularly vital in regions with constrained healthcare resources, where optimizing postoperative outcomes can significantly reduce the burden on surgical wards, minimize complications, improve cost-effectiveness, and support antimicrobial stewardship efforts. The multicenter design, involving both SPHQ/BMCH Quetta and Liaquat National Hospital Karachi, strengthens the generalizability of these findings across diverse healthcare settings within Pakistan[16,24].

Despite the positive outcomes, certain limitations should be acknowledged. The study was conducted over a defined period and did not include long-term postoperative follow-up. Additionally, the evaluation of ERAS adherence within surgical teams was not quantified. Future studies should incorporate larger sample sizes, assess long-term quality-of-life outcomes, and evaluate compliance with individual ERAS elements to further refine protocols tailored for gynecological surgery in Pakistan[25].

CONCLUSION

This study demonstrates that Enhanced Recovery After Surgery (ERAS) protocols significantly improve postoperative clinical outcomes, reduce surgical site infections, and enhance microbiological profiles in women undergoing hysterectomy. ERAS patients experienced faster recovery, earlier mobilization, reduced pain, shorter hospital stays, and minimal antibiotic exposure compared to those receiving conventional postoperative care. Microbiological findings further emphasized the effectiveness of ERAS in controlling pathogenic growth and preventing resistant bacterial infections.

These results highlight ERAS as a highly beneficial, evidence-based perioperative strategy with significant public health implications. In addition to improving individual patient care, ERAS contributes to reduced healthcare costs, improved hospital resource utilization, and enhanced antimicrobial stewardship. Integrating ERAS protocols into routine gynecological surgical

practice in Pakistan and similar healthcare settings is strongly recommended to elevate surgical outcomes, strengthen infection control, and support long-term public health priorities.

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