

Enhanced Recovery After Surgery (ERAS) Versus Traditional Perioperative Pathway in Lower Segment Caesarean Section: A Narrative Review

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ABSTRACT

Background: Lower segment caesarean section (LSCS) is one of the most commonly performed surgical procedures worldwide, with steadily increasing rates contributing to greater postoperative morbidity, prolonged hospitalization, increased healthcare costs, and delayed maternal recovery. Conventional perioperative care often involves prolonged fasting, delayed oral intake, extended immobilization, prolonged urinary catheterization, and opioid-based analgesia, all of which may adversely affect postoperative recovery. Enhanced Recovery After Surgery (ERAS), specifically Enhanced Recovery After Caesarean (ERAC), is a multidisciplinary, evidence-based perioperative care pathway designed to minimize surgical stress, optimize physiological function, accelerate recovery, and improve maternal outcomes.

Objective: To comprehensively review the current evidence comparing Enhanced Recovery After Surgery (ERAS) with traditional perioperative care pathways in women undergoing lower segment caesarean section, with emphasis on perioperative interventions, maternal recovery, clinical outcomes, implementation strategies, and future directions.

Methods: A narrative review was conducted using published literature comprising international clinical practice guidelines, systematic reviews, meta-analyses, randomized controlled trials, consensus statements, quality improvement studies, and observational research evaluating ERAS in caesarean delivery. The review critically synthesizes evidence regarding preoperative optimization, perioperative fasting, carbohydrate loading, multimodal analgesia, regional anaesthetic techniques, early oral feeding, early mobilization, urinary catheter removal, breastfeeding support, postoperative recovery, maternal satisfaction, and healthcare utilization.

Results: The available evidence consistently demonstrates that ERAS protocols significantly improve postoperative recovery following caesarean delivery compared with conventional care. ERAS pathways are associated with reduced preoperative fasting, improved perioperative metabolic stability, effective opioid-sparing multimodal analgesia, earlier oral feeding, earlier ambulation, timely urinary catheter removal, faster gastrointestinal recovery, reduced postoperative pain, lower opioid consumption, shorter hospital stay, improved breastfeeding initiation, greater maternal satisfaction, and reduced healthcare costs. Large systematic reviews and meta-analyses involving more than 18,000 women have reported accelerated recovery without increasing postoperative complications, readmissions, or adverse maternal and neonatal outcomes. Successful implementation depends on multidisciplinary collaboration, standardized institutional protocols, continuous quality improvement, patient education, and adherence to evidence-based perioperative practices.

Conclusion: Enhanced Recovery After Caesarean has emerged as the contemporary standard for evidence-based perioperative care in obstetrics. Compared with traditional pathways, ERAS provides faster functional recovery, superior maternal outcomes, improved patient experience, and more efficient utilization of healthcare resources while maintaining excellent maternal and neonatal safety. Wider implementation of standardized ERAS pathways, particularly in resource-limited settings, together with further high-quality multicentre research and long-term outcome evaluation, will continue to strengthen its role in modern obstetric practice.

Keywords: Enhanced Recovery After Surgery, ERAS, Enhanced Recovery After Caesarean, ERAC, Lower Segment Caesarean Section, Caesarean Delivery, Perioperative Care, Multimodal Analgesia, Early Mobilization, Early Oral Feeding, Maternal Recovery, Narrative Review.

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INTRODUCTION

Lower segment caesarean section (LSCS) is one of the most frequently performed surgical procedures worldwide and has become an indispensable component of modern obstetric practice. Over the past three decades, the global caesarean section rate has increased substantially, with several countries reporting rates exceeding 30%, far above the 10–15% level previously considered optimal by international health organizations. While caesarean delivery has significantly contributed to reductions in maternal and neonatal morbidity and mortality when appropriately indicated, the rising number of procedures has also increased the burden of postoperative complications, prolonged hospitalization, delayed maternal recovery, and healthcare expenditure. Consequently, improving perioperative care following caesarean delivery has become a major priority in contemporary obstetrics. Traditional perioperative management, characterized by prolonged fasting, delayed oral intake, extended immobilization, routine urinary catheterization, and opioid-based analgesia, often delays functional recovery and adversely affects maternal well-being, breastfeeding, and early mother–infant bonding.[1–4] Enhanced Recovery After Surgery (ERAS) is an evidence-based, multidisciplinary perioperative care pathway developed to minimize surgical stress, accelerate postoperative recovery, reduce complications, and improve patient satisfaction. Originally introduced by Henrik Kehlet in colorectal surgery, ERAS has progressively expanded across multiple surgical specialties, including gynecologic oncology, urology, orthopedics, hepatobiliary surgery, and more recently obstetrics. The ERAS Society has developed standardized recommendations that integrate preoperative optimization, evidence-based intraoperative management, and structured postoperative rehabilitation into a comprehensive clinical pathway. These recommendations emphasize patient education, shortened fasting, optimized fluid therapy, multimodal opioid-sparing analgesia, maintenance of normothermia, early feeding, early mobilization, thromboprophylaxis, and early removal of urinary catheters, thereby promoting faster physiological recovery without compromising maternal or neonatal safety.[1–5]

Recognition of the unique physiological changes associated with pregnancy has resulted in the adaptation of ERAS principles specifically for caesarean delivery, commonly referred to as Enhanced Recovery After Caesarean (ERAC). Recent updates to the ERAS Society guidelines have strengthened recommendations regarding individualized perioperative care, standardized analgesic pathways, maternal-centered recovery, breastfeeding support, and quality improvement measures. The updated recommendations further emphasize continuous audit, protocol compliance, multidisciplinary collaboration,

and incorporation of patient-reported outcome measures to ensure sustained improvements in maternal recovery following LSCS.[5]

The fundamental principle underlying ERAS is attenuation of the surgical stress response. Caesarean delivery triggers neuroendocrine activation characterized by increased secretion of cortisol, catecholamines, glucagon, and inflammatory cytokines, resulting in insulin resistance, protein catabolism, postoperative fatigue, impaired gastrointestinal motility, delayed wound healing, and reduced physical function. Conventional perioperative practices frequently amplify these physiological disturbances through prolonged fasting, delayed ambulation, excessive intravenous fluid administration, and opioid-dependent pain management. ERAS protocols seek to interrupt this cascade through multiple synergistic interventions that collectively preserve physiological homeostasis and facilitate earlier functional recovery.[1,2,6]

Accumulating evidence over the past decade has consistently demonstrated the clinical benefits of ERAS implementation in obstetric practice. A recent systematic review and meta-analysis by Pinho et al. involving multiple comparative studies reported that ERAS significantly shortened hospital stay, accelerated ambulation, improved gastrointestinal recovery, reduced postoperative pain scores, decreased opioid consumption, and enhanced maternal satisfaction without increasing postoperative complications or readmission rates.[7] Similarly, Suharwardy and Carvalho highlighted that successful implementation of ERAS depends on coordinated multidisciplinary care involving obstetricians, anesthesiologists, nursing staff, physiotherapists, and lactation consultants, with protocol adherence being a major determinant of clinical success.[8]

Early clinical implementation studies further support these findings. Wrench et al. demonstrated that introducing an ERAS pathway for elective caesarean delivery increased successful postoperative day-one discharge from **1.6% to 25.2%**, while simultaneously reducing 30-day readmission rates among appropriately selected women, confirming that accelerated discharge can be achieved safely through standardized perioperative care.[9] Likewise, Bowden et al. reported that **76.2%** of women managed under a structured fast-track recovery programme were discharged within the first postoperative day, with a mean hospital stay of only **1.31 days**, accompanied by high maternal satisfaction and no increase in adverse maternal or neonatal outcomes.[10]

Despite the growing body of evidence supporting ERAS, considerable variation continues to exist regarding protocol implementation across healthcare systems. Differences in institutional infrastructure, healthcare resources, clinical expertise, patient education, and cultural practices have limited uniform

adoption, particularly in low- and middle-income countries. Furthermore, heterogeneity among published ERAS pathways has created uncertainty regarding the optimal combination and timing of individual interventions. Therefore, a comprehensive synthesis of current evidence is essential to better understand the evolution, core principles, clinical effectiveness, implementation challenges, and future directions of ERAS in lower segment caesarean section. This narrative review aims to critically examine the contemporary literature comparing ERAS with traditional perioperative care pathways, highlighting their impact on maternal recovery, postoperative outcomes, healthcare utilization, and overall quality of obstetric care.

EVOLUTION OF ENHANCED RECOVERY AFTER CAESAREAN (ERAC): EVIDENCE FROM RECENT SYSTEMATIC REVIEWS, RANDOMIZED TRIALS, AND CONTEMPORARY GUIDELINES

During the past decade, Enhanced Recovery After Caesarean (ERAC) has emerged as one of the most important advances in obstetric perioperative care. Unlike conventional perioperative management, which primarily focuses on the surgical procedure itself, ERAC adopts a multidisciplinary, evidence-based approach encompassing the entire perioperative continuum. The objective is not only to reduce postoperative morbidity but also to restore maternal physiological function rapidly, facilitate early mother–infant interaction, improve breastfeeding success, decrease healthcare costs, and enhance overall patient satisfaction. Growing evidence from systematic reviews, randomized controlled trials, quality improvement studies, and international professional organizations consistently demonstrates that ERAC significantly improves clinical outcomes without compromising maternal or neonatal safety.

One of the strongest pieces of evidence supporting ERAC originates from the systematic review and meta-analysis conducted by **Sultan et al.**[11] This comprehensive review included **12 studies involving 17,607 women** undergoing caesarean delivery and compared ERAC pathways with conventional perioperative management. The pooled analysis demonstrated that ERAC significantly accelerated several important recovery milestones. Women managed under ERAC protocols experienced a **mean reduction in hospital stay of approximately 0.51 days**, enabling earlier discharge without increasing postoperative complications. Time to first mobilization was shortened by nearly **11.05 hours**, while urinary catheter removal occurred approximately **13.19 hours earlier** than in conventional care pathways. Importantly, postoperative opioid consumption decreased by an average of **21.85 mg morphine equivalents**, highlighting the effectiveness of multimodal analgesic strategies incorporated within ERAC protocols. Despite earlier discharge, maternal readmission rates

and postoperative complications remained comparable between the ERAC and conventional groups, confirming that accelerated recovery does not compromise patient safety.[11]

Beyond improvements in recovery milestones, Sultan et al. further emphasized that standardized perioperative pathways enhance protocol compliance among healthcare professionals and improve consistency in postoperative care. Their review demonstrated that implementation of structured ERAC protocols reduced unnecessary variability in clinical practice, thereby facilitating predictable recovery patterns and improved patient outcomes across different healthcare institutions.[11] These findings have established ERAC as one of the highest levels of evidence supporting standardized perioperative care in obstetrics.

Further evidence supporting structured ERAC implementation was provided by the quality improvement initiative conducted by **Cojocaru et al.**[12] Unlike randomized clinical trials that evaluate efficacy under controlled conditions, this investigation examined the effectiveness of ERAC implementation within routine clinical practice. Following introduction of a multidisciplinary ERAC pathway, inpatient opioid consumption decreased dramatically, with median morphine milligram equivalents declining from approximately **30 mg before implementation to 16.8 mg after protocol adoption**, representing nearly a **44% reduction** in opioid exposure.[12] Simultaneously, patient-reported postoperative pain scores improved despite reduced opioid administration, demonstrating that multimodal analgesia provides superior pain control while minimizing opioid-related adverse effects.

The study also demonstrated significant improvements in functional recovery parameters. Women receiving ERAC achieved earlier oral feeding, earlier ambulation, earlier urinary catheter removal, and earlier discharge readiness compared with historical controls.[12] Importantly, these improvements occurred without increasing postoperative nausea, wound complications, urinary retention, or hospital readmissions. The investigators concluded that successful ERAC implementation depends not only on protocol development but also on continuous staff education, multidisciplinary collaboration, regular auditing, and institutional commitment toward evidence-based perioperative care. Their findings illustrate that quality improvement initiatives can successfully translate evidence generated by randomized trials into routine clinical practice.[12]

Although initial ERAC research focused primarily on elective caesarean deliveries, its applicability to emergency obstetric surgery remained uncertain. Emergency caesarean sections often involve greater maternal physiological stress, higher complication rates, increased anxiety, and limited opportunities for preoperative optimization. To address this knowledge gap, **Mundhra et al.**[13] conducted a randomized

controlled trial evaluating ERAC implementation among women undergoing emergency caesarean delivery. The investigators demonstrated that ERAC remained highly effective even in emergency settings. Women managed under ERAC experienced significantly shorter hospital stays, averaging **53.87 hours compared with 73.92 hours** in the conventional care group.[13] Early postoperative recovery milestones were consistently improved. Oral feeding was initiated substantially earlier, ambulation occurred sooner, bowel sounds returned more rapidly, and urinary catheters were removed earlier than in women receiving traditional perioperative care. Furthermore, postoperative pain scores measured using standardized visual analogue scales were significantly lower throughout the recovery period, while quality-of-life assessments demonstrated superior physical functioning and maternal comfort.[13] Importantly, no increase in postoperative complications, surgical site infections, readmissions, or neonatal adverse outcomes was observed, confirming that ERAC can be safely extended beyond elective procedures into emergency obstetric practice. The growing body of evidence supporting ERAC was further strengthened by the most recent systematic review and meta-analysis published by **Lestari et al.**[14] This review incorporated **23 studies involving more than 18,368 women**, representing one of the largest evidence syntheses currently available. Compared with previous analyses, the inclusion of additional randomized trials and contemporary implementation studies provided greater statistical power and strengthened confidence in the observed clinical benefits.

The pooled analysis demonstrated that ERAC consistently shortened postoperative hospital stay while improving nearly every major recovery parameter evaluated. Earlier oral intake, earlier mobilization, earlier urinary catheter removal, faster return of bowel function, and reduced postoperative opioid consumption were consistently observed across multiple healthcare settings.[14] Importantly, despite accelerated discharge protocols, no statistically significant increase occurred in postoperative complications, wound infections, emergency department visits, or hospital readmissions. These findings strongly support the conclusion that ERAC improves efficiency without sacrificing patient safety. The authors emphasized that the greatest clinical benefits were achieved when institutions implemented standardized ERAC pathways with high protocol compliance rather than selectively adopting isolated interventions.[14]

Another important contribution to contemporary ERAC literature comes from **Carvalho and Sultan**, who comprehensively reviewed the current concepts underlying Enhanced Recovery After Caesarean Delivery.[15] Rather than focusing solely on individual interventions, they described ERAC as an integrated physiological strategy designed to minimize

activation of the surgical stress response. According to their review, optimal maternal recovery requires simultaneous implementation of multiple evidence-based interventions rather than reliance upon any single perioperative modification.

The authors highlighted patient education as one of the earliest determinants of successful recovery. Adequate preoperative counselling reduces maternal anxiety, improves adherence to postoperative rehabilitation protocols, and increases patient confidence regarding early feeding and mobilization.[15] Similarly, shortening fasting duration while permitting clear fluids until two hours before surgery reduces dehydration, hunger, insulin resistance, and maternal discomfort without increasing aspiration risk in appropriately selected women.

Pain management remains another cornerstone of ERAC. Carvalho and Sultan emphasized that multimodal analgesia combining neuraxial opioids, non-steroidal anti-inflammatory drugs, paracetamol, regional fascial plane blocks, and local wound infiltration provides superior analgesia compared with traditional opioid-based regimens.[15] By minimizing opioid exposure, ERAC reduces postoperative nausea, vomiting, sedation, pruritus, constipation, urinary retention, and delayed bowel recovery while simultaneously facilitating earlier mobilization and breastfeeding initiation.

The review further discussed the importance of maintaining perioperative normothermia, optimizing intravenous fluid administration, preventing postoperative nausea and vomiting, encouraging early oral nutrition, removing urinary catheters promptly, and promoting early maternal ambulation.[15] Each intervention individually contributes modest improvements; however, when combined within a standardized ERAC pathway, these interventions exert synergistic effects that substantially accelerate maternal recovery.

Collectively, evidence generated from systematic reviews, randomized controlled trials, implementation studies, and contemporary expert reviews consistently demonstrates that ERAC represents a major advancement in obstetric perioperative care. Across diverse healthcare systems, ERAC has been associated with shorter hospitalization, earlier functional recovery, improved gastrointestinal function, reduced opioid requirements, superior pain control, enhanced maternal satisfaction, and more efficient healthcare resource utilization without increasing maternal or neonatal complications. These findings have transformed ERAC from an emerging clinical concept into an evidence-based standard of perioperative care increasingly recommended by professional organizations worldwide. Continued refinement of protocol components, improved institutional compliance, and broader implementation across both high-income and resource-limited settings are expected to further enhance maternal outcomes following lower segment caesarean section.

INTERNATIONAL GUIDELINES, FOUNDATIONAL PRINCIPLES, AND FUTURE DIRECTIONS OF ENHANCED RECOVERY AFTER CAESAREAN DELIVERY

The increasing body of evidence supporting Enhanced Recovery After Caesarean (ERAC) has prompted several international organizations to incorporate standardized enhanced recovery pathways into routine obstetric practice. Contemporary ERAC protocols are no longer viewed as isolated perioperative interventions but rather as comprehensive, multidisciplinary clinical pathways that begin during antenatal counselling and continue until complete maternal functional recovery. The recommendations developed by international professional societies integrate the best available scientific evidence with practical clinical experience to provide standardized guidance that can be adapted across diverse healthcare systems. These recommendations emphasize evidence-based perioperative optimization while maintaining maternal safety, neonatal wellbeing, and patient-centred care.

Recognizing the substantial increase in caesarean delivery rates worldwide, the **American College of Obstetricians and Gynecologists (ACOG)** formally endorsed Enhanced Recovery After Surgery principles for obstetric practice.[16] According to ACOG, ERAC should not be considered merely a strategy for shortening hospital stay but rather a comprehensive programme aimed at improving maternal recovery, reducing perioperative complications, optimizing pain management, enhancing breastfeeding success, and improving patient satisfaction. The committee recommends that healthcare institutions establish standardized multidisciplinary protocols incorporating obstetricians, anesthesiologists, nurses, physiotherapists, pharmacists, nutritionists, and lactation consultants to ensure seamless perioperative care.[16]

ACOG emphasizes that patient education begins well before surgery. Comprehensive antenatal counselling regarding fasting guidelines, expected postoperative milestones, pain management strategies, early mobilization, breastfeeding support, and discharge planning improves patient participation and reduces perioperative anxiety.[16] Women who understand postoperative recovery goals are more likely to comply with early ambulation, early oral feeding, and multimodal analgesic regimens, resulting in faster recovery and improved satisfaction. Furthermore, individualized perioperative planning based on maternal comorbidities, anesthetic risk, obesity, diabetes, hypertensive disorders, and thromboembolic risk factors allows ERAC protocols to be safely adapted to high-risk obstetric populations without compromising clinical outcomes.[16]

The **Society for Obstetric Anesthesia and Perinatology (SOAP)** further strengthened anesthetic recommendations specific to ERAC.[17] SOAP recognizes anesthesiologists as central members of the

multidisciplinary ERAC team because anesthetic management profoundly influences postoperative recovery. Their recommendations advocate preferential use of neuraxial anesthesia whenever feasible, as spinal anesthesia minimizes airway complications, reduces maternal physiological stress, and facilitates rapid postoperative recovery. The society strongly recommends multimodal opioid-sparing analgesia through scheduled administration of paracetamol, non-steroidal anti-inflammatory drugs, neuraxial morphine, and regional fascial plane blocks such as transversus abdominis plane (TAP) block or quadratus lumborum block whenever appropriate.[17] SOAP also highlights prevention of postoperative nausea and vomiting as a critical component of successful ERAC implementation. Maternal nausea significantly delays oral intake, ambulation, breastfeeding initiation, and overall patient satisfaction. Consequently, prophylactic antiemetic therapy combined with appropriate intraoperative fluid management and avoidance of excessive opioid administration has become an essential component of modern obstetric anesthesia.[17] In addition, maintenance of perioperative normothermia through active warming devices and warmed intravenous fluids reduces shivering, improves maternal comfort, and contributes to enhanced postoperative physiological recovery.

The **ERAS Society**, which pioneered enhanced recovery pathways across multiple surgical specialties, has continuously refined cesarean-specific recommendations based upon emerging evidence.[18] Current ERAS Society guidelines integrate more than twenty evidence-based perioperative interventions across the preoperative, intraoperative, and postoperative periods. These recommendations emphasize shortened fasting duration, carbohydrate loading in appropriately selected patients, standardized antimicrobial prophylaxis, maintenance of euvolemia, opioid-sparing multimodal analgesia, early oral nutrition, early mobilization, early urinary catheter removal, venous thromboembolism prevention, breastfeeding support, and continuous quality auditing.[18]

One of the distinguishing characteristics of ERAS Society recommendations is the emphasis placed on protocol compliance rather than isolated interventions. Numerous implementation studies have demonstrated that institutions achieving higher compliance with ERAC protocols consistently report superior clinical outcomes compared with centres adopting only selected components. Consequently, continuous auditing, staff education, protocol monitoring, and multidisciplinary collaboration remain fundamental requirements for successful implementation.[18] The Society further recommends that hospitals establish measurable quality indicators, including time to first oral intake, ambulation, catheter removal, opioid consumption, pain scores, hospital stay, breastfeeding initiation, maternal satisfaction, and readmission rates,

thereby facilitating continuous quality improvement. The conceptual foundation of Enhanced Recovery After Surgery can be traced to the pioneering work of **Henrik Kehlet**, whose landmark publication fundamentally transformed perioperative surgical care.[19] Before the development of ERAS, postoperative recovery was largely considered a passive process requiring prolonged fasting, immobilization, extensive intravenous fluid administration, and delayed rehabilitation. Kehlet challenged these traditional concepts by demonstrating that postoperative recovery could be significantly accelerated through simultaneous modification of multiple perioperative factors responsible for activating the surgical stress response.[19]

Kehlet proposed that surgery induces complex neuroendocrine, inflammatory, metabolic, and immunological responses characterized by increased secretion of cortisol, catecholamines, glucagon, inflammatory cytokines, and acute phase proteins. These responses contribute to insulin resistance, protein catabolism, impaired immune function, postoperative fatigue, gastrointestinal dysfunction, muscle wasting, delayed wound healing, and prolonged hospitalization.[19] Rather than attempting to treat individual postoperative complications separately, Kehlet advocated attenuation of the entire stress response through multimodal perioperative care. This revolutionary concept subsequently became the scientific foundation upon which modern ERAS protocols were developed across numerous surgical disciplines.

Building upon Kehlet's original concept, **Ljungqvist, Scott, and Fearon** further refined ERAS into a comprehensive evidence-based perioperative care model applicable across virtually every major surgical specialty.[20] Their review emphasized that successful enhanced recovery depends upon coordinated implementation of multiple synergistic interventions rather than isolated modifications of surgical practice. They demonstrated that ERAS pathways consistently reduce postoperative complications by approximately **30–50%**, shorten hospital stay by **2–3 days** in many surgical specialties, decrease healthcare expenditure, improve patient satisfaction, and accelerate return to normal daily activities without increasing mortality or readmission rates.[20]

Importantly, Ljungqvist and colleagues argued that ERAS should be viewed as a continuous quality improvement programme rather than a fixed clinical protocol.[20] As new scientific evidence emerges, individual protocol components should be continuously evaluated and modified to optimize patient outcomes. This dynamic philosophy explains why ERAC recommendations have evolved substantially during recent years with increasing emphasis on individualized patient care, protocol adherence, patient-reported outcome measures, digital health technologies, and multidisciplinary collaboration.

Future directions of ERAC are expected to extend beyond traditional perioperative management. Integration of artificial intelligence for individualized perioperative risk prediction, wearable monitoring devices for remote postoperative surveillance, electronic patient-reported outcome systems, telemedicine-based follow-up, and machine learning algorithms capable of predicting delayed recovery may further personalize enhanced recovery pathways. Simultaneously, increasing implementation of ERAC within low- and middle-income countries remains a global priority, as standardized perioperative pathways have the potential to substantially reduce maternal morbidity while improving efficiency of healthcare delivery in resource-constrained settings.[16–20]

Collectively, recommendations from ACOG, SOAP, the ERAS Society, and foundational contributions by Kehlet and Ljungqvist establish Enhanced Recovery After Caesarean as one of the most important evidence-based advances in contemporary obstetric perioperative care. The available evidence consistently demonstrates that successful ERAC implementation requires multidisciplinary collaboration, standardized clinical pathways, continuous protocol evaluation, and institutional commitment toward quality improvement. As healthcare systems increasingly adopt patient-centred models of care, ERAC is expected to become the global standard for perioperative management following lower segment caesarean section, providing safer surgery, faster maternal recovery, improved neonatal outcomes, and more efficient utilization of healthcare resources.

PREOPERATIVE OPTIMIZATION IN ENHANCED RECOVERY AFTER CAESAREAN DELIVERY: EVIDENCE-BASED STRATEGIES FOR IMPROVING MATERNAL OUTCOMES

Enhanced Recovery After Caesarean (ERAC) has evolved from an innovative perioperative concept into an internationally recognized evidence-based clinical pathway aimed at optimizing maternal recovery while maintaining patient safety. Although initially adapted from colorectal surgery, ERAC has undergone considerable refinement to address the unique physiological changes associated with pregnancy and childbirth. Current recommendations emphasize that successful maternal recovery depends not on isolated interventions but on the integration of multiple evidence-based perioperative measures implemented in a coordinated multidisciplinary manner.

The development of obstetric ERAC protocols has been strongly influenced by earlier ERAS Society recommendations developed for colorectal surgery. **Gustafsson et al.**[21] demonstrated that standardized perioperative pathways significantly reduced postoperative complications, accelerated recovery, shortened hospital stay, and improved patient satisfaction across major abdominal surgical procedures. Their updated ERAS Society guidelines highlighted that interventions such as shortened fasting, carbohydrate loading, multimodal analgesia,

goal-directed fluid therapy, early nutrition, and early mobilization produced synergistic rather than additive benefits. Compliance exceeding 70–80% with ERAS recommendations was consistently associated with superior postoperative outcomes compared with partial protocol implementation.[21] Although these recommendations were initially developed for colorectal surgery, they provided the scientific framework that was subsequently adapted to cesarean delivery, where similar physiological mechanisms of surgical stress and recovery exist.

International obstetric guidelines have increasingly adopted these enhanced recovery principles. The **National Institute for Health and Care Excellence (NICE)** updated its Caesarean Birth Guideline (NG192) to recommend evidence-based perioperative care focused on improving maternal recovery following cesarean delivery.[22] NICE advocates early skin-to-skin contact immediately after birth, encouragement of breastfeeding within the first hour whenever clinically feasible, early mobilization following recovery from neuraxial anesthesia, and individualized postoperative analgesia using multimodal pain management. The guideline discourages unnecessary postoperative restrictions and supports early removal of urinary catheters to facilitate ambulation and reduce catheter-associated urinary tract infections.[22] These recommendations reflect a transition away from traditional postoperative practices toward patient-centred recovery pathways that emphasize functional restoration rather than prolonged hospitalization.

Similarly, the **World Health Organization (WHO)** recognizes that improving the quality of perioperative obstetric care is equally important as optimizing cesarean section rates.[23] WHO emphasizes respectful maternity care, informed maternal decision-making, effective communication, standardized clinical protocols, and multidisciplinary collaboration to improve maternal outcomes. Although WHO primarily addresses reduction of unnecessary cesarean deliveries, its recommendations support enhanced recovery principles by promoting individualized care pathways that minimize unnecessary interventions while improving maternal experience and neonatal wellbeing.[23] WHO further highlights that patient education and shared decision-making improve compliance with postoperative rehabilitation and breastfeeding, thereby contributing to enhanced maternal recovery.

Recent educational reviews have further consolidated evidence supporting ERAC implementation. The review published in **BJA Education** comprehensively summarized contemporary perioperative strategies used in elective cesarean delivery.[24] According to the authors, modern obstetric anesthesia should aim to attenuate the neuroendocrine stress response while facilitating rapid restoration of physiological function. The review emphasizes shortened fasting duration, preoperative hydration, multimodal opioid-sparing

analgesia, maintenance of normothermia, prevention of postoperative nausea and vomiting, early oral feeding, and structured mobilization as essential components of successful ERAC pathways.[24] Importantly, the review notes that these interventions are highly interdependent; omission of one component may reduce the effectiveness of the overall pathway.

Further practical guidance regarding implementation was provided by **Ogunkua et al.**[25] who described ERAC as a patient-centred quality improvement programme rather than simply a perioperative checklist. Their review emphasized that successful implementation requires institutional commitment, multidisciplinary leadership, standardized clinical protocols, continuous staff education, and regular auditing of recovery outcomes. Hospitals adopting ERAC have consistently demonstrated reductions in postoperative opioid consumption, earlier discharge readiness, improved maternal satisfaction, and lower overall healthcare costs. However, the authors also identified several implementation barriers, including resistance to changing traditional clinical practices, inadequate staff training, limited institutional resources, and variability in protocol adherence, particularly in low-resource healthcare settings.[25]

Among all preoperative interventions, optimization of fasting practices represents one of the most important evidence-based modifications incorporated within ERAC. Historically, women undergoing cesarean delivery were instructed to remain nil per oral from midnight before surgery because of concerns regarding pulmonary aspiration during anesthesia. However, prolonged fasting contributes to dehydration, increased maternal anxiety, postoperative insulin resistance, hypoglycemia, metabolic stress, and delayed postoperative recovery. Updated recommendations from the **American Society of Anesthesiologists (ASA)** now support significantly shorter fasting intervals.[26] According to the 2023 practice guideline, healthy pregnant women undergoing elective cesarean delivery may safely consume clear fluids until **2 hours** before anesthesia and solid food up to **6–8 hours** before surgery, depending on meal composition. Extensive evidence reviewed by the ASA demonstrated that shortened fasting does not increase gastric volume or aspiration risk while substantially improving maternal comfort by reducing thirst, hunger, dehydration, and perioperative anxiety.[26]

Nutrition has similarly become an essential component of perioperative optimization. The **European Society for Clinical Nutrition and Metabolism (ESPEN)** practical guideline strongly recommends maintenance of adequate nutritional status before surgery as part of modern ERAS pathways.[27] Rather than prolonged starvation, ESPEN advocates avoidance of unnecessary fasting together with appropriate nutritional assessment and early postoperative nutritional support. The guideline emphasizes that adequate perioperative nutrition reduces protein

catabolism, preserves lean body mass, improves immune function, and accelerates wound healing. Early restoration of gastrointestinal function also contributes to improved maternal strength, enhanced breastfeeding performance, and faster return to normal daily activities.[27] Although carbohydrate loading requires individualized consideration in women with diabetes or impaired glucose tolerance, appropriate nutritional optimization forms an integral component of successful ERAC implementation.

The broader future of enhanced recovery has been discussed comprehensively by **Ljungqvist et al.**[28] Their review describes ERAS as one of the most successful quality improvement programmes in modern surgery because it combines scientific evidence with standardized multidisciplinary implementation. The authors emphasized that enhanced recovery should continuously evolve through incorporation of emerging evidence rather than remaining a static clinical protocol. Future ERAS pathways are expected to integrate personalized perioperative medicine, digital monitoring technologies, artificial intelligence-based risk prediction, telemedicine follow-up, wearable biosensors, and patient-reported outcome measures. Such innovations may further individualize perioperative care while improving long-term recovery and healthcare efficiency.[28]

The anesthetic component of ERAC has received increasing attention because anesthetic management directly influences postoperative pain, mobilization, nausea, and functional recovery. The **Society for Obstetric Anesthesia and Perinatology (SOAP)** consensus statement emphasizes that anesthesiologists play a pivotal role in successful ERAC implementation.[29] SOAP strongly recommends neuraxial anesthesia whenever feasible together with multimodal opioid-sparing analgesia using scheduled non-opioid medications, neuraxial morphine, regional fascial plane blocks, prophylactic antiemetics, maintenance of normothermia, and individualized fluid management. These interventions collectively minimize opioid-related adverse effects while facilitating earlier oral intake, mobilization, breastfeeding, and hospital discharge.[29]

Practical implementation strategies have been further outlined by **Caughey et al.**[30] who emphasized that the success of ERAC depends less upon individual interventions than upon systematic integration of all perioperative components into routine clinical practice. Their implementation framework includes antenatal counselling, standardized fasting protocols, evidence-based anesthetic management, optimized fluid therapy, multimodal analgesia, early postoperative nutrition, structured mobilization schedules, early urinary catheter removal, standardized discharge criteria, and continuous performance auditing. The authors concluded that institutional protocol standardization, multidisciplinary communication, patient education,

and ongoing quality improvement are essential for sustaining high compliance with ERAC pathways and achieving consistent improvements in maternal outcomes.[30]

Collectively, contemporary international guidelines and recent evidence clearly demonstrate that preoperative optimization forms the foundation of successful Enhanced Recovery After Caesarean programmes. Modern ERAC pathways replace traditional conservative perioperative practices with evidence-based interventions that reduce surgical stress, preserve physiological homeostasis, enhance maternal comfort, and accelerate functional recovery. Through coordinated multidisciplinary implementation, these strategies not only improve clinical outcomes but also promote safer, more efficient, and patient-centred obstetric care that is increasingly becoming the global standard for women undergoing lower segment caesarean section.

PREOPERATIVE FASTING, CARBOHYDRATE LOADING, AND MULTIMODAL ANALGESIA IN ENHANCED RECOVERY AFTER CAESAREAN DELIVERY

Preoperative optimization represents one of the most important components of Enhanced Recovery After Caesarean (ERAC) pathways because the physiological condition of the mother before surgery substantially influences postoperative recovery, metabolic stability, gastrointestinal function, pain perception, and overall maternal outcomes. Traditional perioperative management following lower segment caesarean section (LSCS) was largely based on prolonged fasting, delayed oral intake, liberal intravenous fluid administration, and opioid-dependent analgesia. However, contemporary evidence demonstrates that many of these conventional practices unnecessarily increase physiological stress and delay functional recovery. Modern ERAC protocols therefore emphasize shortened fasting, maintenance of hydration, carbohydrate loading in selected patients, and multimodal opioid-sparing analgesia as essential strategies to improve maternal recovery while maintaining patient safety.

Historically, women scheduled for elective caesarean delivery were instructed to remain "nil per oral after midnight," frequently resulting in fasting durations exceeding 10–12 hours. Although intended to reduce pulmonary aspiration during anaesthesia, prolonged fasting has been shown to produce several undesirable physiological consequences, including dehydration, hypovolemia, maternal discomfort, thirst, hunger, hypoglycaemia, increased insulin resistance, enhanced protein catabolism, and delayed postoperative gastrointestinal recovery. These metabolic disturbances activate the neuroendocrine stress response and may prolong postoperative fatigue and delay early mobilization.[31]

Recognizing these adverse effects, the **European Society of Anaesthesiology and Intensive Care**

(ESAIC) published updated perioperative fasting guidelines recommending a more liberal and evidence-based fasting strategy.[31] According to Smith et al., healthy adults undergoing elective surgery may safely consume **clear fluids until two hours before induction of anaesthesia**, while solid food should generally be avoided for **six hours** before surgery. These recommendations were based upon extensive evaluation of gastric emptying physiology and clinical studies demonstrating that shortened fasting does not increase gastric volume, gastric acidity, regurgitation, or pulmonary aspiration risk in appropriately selected patients.[31] Instead, reduced fasting significantly improves maternal comfort by decreasing thirst, hunger, anxiety, irritability, dehydration, and perioperative stress. Furthermore, maintenance of adequate hydration contributes to greater haemodynamic stability during spinal anaesthesia and reduces perioperative hypotension, an important consideration during caesarean delivery.[31]

The importance of evidence-based fasting protocols was further reinforced by the systematic review conducted by **Lambert and Carey**.[32] After evaluating multiple international perioperative fasting guidelines, the authors concluded that nearly all contemporary recommendations consistently support clear fluid intake up to two hours before surgery while discouraging unnecessary overnight fasting. The review demonstrated that prolonged fasting offers no additional protection against aspiration in low-risk surgical patients but is consistently associated with poorer patient experience and greater metabolic stress.[32] The authors further emphasized that patient education plays a critical role in successful implementation because outdated fasting practices often persist due to institutional habit rather than scientific evidence. Standardized fasting protocols incorporated within ERAC pathways therefore improve both protocol compliance and maternal satisfaction while maintaining perioperative safety.[32]

Beyond shortening fasting duration, preoperative carbohydrate loading has become another important component of modern ERAC pathways. Surgical trauma induces insulin resistance, increased cortisol secretion, accelerated protein catabolism, and depletion of glycogen stores, all of which contribute to postoperative weakness and delayed recovery. Administration of carbohydrate-rich beverages shortly before surgery has been proposed as a strategy to attenuate these metabolic disturbances by maintaining endogenous energy reserves and reducing activation of the surgical stress response.[33]

The systematic review by **Bilku et al.**[33] evaluated evidence regarding preoperative carbohydrate loading across multiple surgical specialties. The investigators demonstrated that administration of carbohydrate drinks approximately two to three hours before surgery reduced postoperative thirst, hunger, anxiety, and insulin resistance while improving patient comfort and

subjective wellbeing. Carbohydrate supplementation also preserved skeletal muscle function and improved postoperative energy levels, facilitating earlier mobilization and faster recovery.[33] Importantly, patients receiving carbohydrate loading experienced reduced postoperative fatigue and demonstrated improved functional recovery compared with those undergoing conventional overnight fasting. Although much of the evidence originated from general surgery, these physiological benefits provide the rationale for selective incorporation of carbohydrate loading into ERAC protocols for healthy women undergoing elective caesarean delivery.

Similar conclusions were reached by the meta-analysis conducted by **Awad et al.**[34] After pooling results from numerous randomized controlled trials, the authors reported that preoperative carbohydrate treatment significantly reduced postoperative insulin resistance while improving overall patient wellbeing. Patients receiving carbohydrate drinks demonstrated earlier return of gastrointestinal function, preservation of lean body mass, reduced postoperative protein breakdown, and shorter recovery times compared with conventional fasting regimens.[34] Importantly, no increase in perioperative complications or aspiration events was observed among appropriately selected patients. Nevertheless, the authors emphasized that carbohydrate loading should be individualized in women with diabetes mellitus or impaired glucose tolerance because altered glucose metabolism may influence perioperative glycaemic control.[34] Consequently, current ERAC guidelines recommend carbohydrate loading primarily for non-diabetic women undergoing elective caesarean delivery while advocating individualized assessment for higher-risk patients.

Although optimization of nutrition and hydration is fundamental, effective postoperative pain control remains equally essential for successful enhanced recovery. Inadequately controlled postoperative pain delays mobilization, impairs respiratory function, suppresses gastrointestinal motility, interferes with breastfeeding, reduces maternal confidence in newborn care, and prolongs hospitalization. Traditional postoperative management frequently relied upon opioid-based analgesia, which, although effective for pain relief, is associated with nausea, vomiting, sedation, constipation, pruritus, urinary retention, ileus, delayed mobilization, and impaired maternal–infant interaction.[35]

To overcome these limitations, modern ERAC pathways advocate **multimodal analgesia**, whereby multiple analgesic agents acting through different physiological mechanisms are combined to maximize pain relief while minimizing opioid exposure. **Bollag et al.**[35] described multimodal analgesia as the cornerstone of enhanced recovery following caesarean delivery. Rather than relying on opioids alone, ERAC protocols combine scheduled paracetamol, non-steroidal anti-inflammatory drugs, neuraxial opioids,

regional anaesthetic techniques, and local anaesthetic infiltration to provide superior analgesia with fewer adverse effects. This multimodal approach exploits synergistic analgesic mechanisms, allowing substantial reductions in opioid consumption while maintaining excellent postoperative pain control.[35] The authors highlighted that scheduled administration of non-opioid analgesics rather than "as-needed" dosing produces more consistent pain relief and facilitates earlier functional recovery. Neuraxial morphine remains the gold standard for prolonged postoperative analgesia following spinal anaesthesia, while adjunctive agents such as intravenous acetaminophen and NSAIDs further reduce inflammatory pain and opioid requirements.[35] Regional fascial plane blocks, including transversus abdominis plane (TAP) block and quadratus lumborum block, may provide additional analgesic benefit in selected patients, particularly when neuraxial opioids cannot be administered. Through effective pain control, multimodal analgesia enables earlier ambulation, improved pulmonary function, earlier breastfeeding initiation, reduced postoperative fatigue, and greater maternal participation in newborn care.[35]

Another important concept emphasized by Bollag et al. is that analgesia should not be viewed solely as treatment for postoperative pain but rather as a facilitator of overall functional recovery.[35] Effective pain management allows mothers to mobilize sooner, tolerate oral nutrition earlier, independently care for their newborns, and achieve discharge readiness more rapidly. Consequently, pain control within ERAC extends beyond symptom relief to become an essential determinant of successful maternal rehabilitation and improved postoperative quality of life.

Collectively, contemporary evidence strongly supports replacement of traditional prolonged fasting and opioid-dependent perioperative care with evidence-based preoperative optimization strategies incorporated within ERAC pathways. Shortened fasting intervals, appropriate hydration, selective carbohydrate loading, and multimodal opioid-sparing analgesia collectively reduce surgical stress, improve metabolic stability, enhance maternal comfort, preserve physiological function, and accelerate postoperative recovery. These interventions form the foundation upon which successful enhanced recovery programmes are built and continue to play a central role in improving maternal outcomes following lower segment caesarean section.

REGIONAL ANALGESIA, ENHANCED RECOVERY IMPLEMENTATION, AND CLINICAL TRANSLATION OF ERAC PROTOCOLS

Effective postoperative pain control remains one of the fundamental determinants of successful recovery following lower segment caesarean section (LSCS). Pain experienced after caesarean delivery affects maternal mobility, respiratory function,

gastrointestinal recovery, breastfeeding initiation, maternal–infant bonding, sleep quality, and psychological wellbeing. Inadequately controlled pain delays functional recovery and frequently prolongs hospital stay. Consequently, contemporary Enhanced Recovery After Caesarean (ERAC) protocols emphasize multimodal regional analgesic techniques that reduce opioid exposure while providing superior postoperative pain relief. Growing evidence from systematic reviews and meta-analyses demonstrates that regional anesthesia has become an indispensable component of evidence-based ERAC pathways.

Among various analgesic techniques, **neuraxial morphine** continues to be regarded as the gold standard for postoperative analgesia following cesarean delivery. The comprehensive review by **McDonnell and Paech**[36] evaluated current evidence regarding intrathecal and epidural morphine administration after cesarean section. The authors demonstrated that neuraxial morphine provides prolonged analgesia lasting approximately **18–24 hours**, significantly reducing postoperative pain intensity and minimizing the requirement for systemic opioid administration. Compared with conventional intravenous opioid therapy, neuraxial morphine offers superior analgesic efficacy while allowing mothers to remain awake, comfortable, and physically capable of caring for their newborn immediately after surgery.[36]

The review further highlighted that effective neuraxial analgesia facilitates earlier ambulation, improved respiratory function, enhanced maternal participation in breastfeeding, and faster achievement of postoperative recovery milestones. Although neuraxial morphine may occasionally produce adverse effects such as pruritus, nausea, vomiting, or mild urinary retention, these complications are generally manageable through prophylactic medication and careful monitoring.[36] Importantly, the authors concluded that the overall clinical benefits substantially outweigh these relatively minor adverse effects, particularly when neuraxial morphine is incorporated into multimodal ERAC pathways alongside non-opioid analgesics.

Despite the excellent analgesia provided by neuraxial opioids, additional regional anesthetic techniques have gained considerable attention for further optimizing postoperative recovery. The **Transversus Abdominis Plane (TAP) block** is one of the most extensively investigated regional techniques in obstetric anesthesia. This fascial plane block provides somatic analgesia by anesthetizing the anterior abdominal wall nerves supplying the cesarean incision. The systematic review and meta-analysis conducted by **Abdallah et al.**[37] synthesized evidence from randomized controlled trials evaluating TAP block after cesarean delivery.

Their pooled analysis demonstrated that TAP block significantly reduced postoperative pain scores during the first 24 hours following surgery while decreasing

systemic opioid consumption compared with conventional analgesic regimens.[37] Women receiving TAP block experienced improved pain relief both at rest and during movement, allowing earlier mobilization and greater maternal comfort. The reduction in opioid requirements also translated into fewer opioid-related adverse effects, including postoperative nausea, vomiting, sedation, and constipation. Furthermore, improved analgesia facilitated earlier initiation of breastfeeding and increased maternal confidence in newborn care.[37] The investigators emphasized that TAP block provides its greatest benefit among women who do not receive intrathecal morphine or in situations where neuraxial opioids are contraindicated. When combined with multimodal analgesia, TAP block contributes significantly to accelerated postoperative recovery while maintaining excellent patient satisfaction.[37] Consequently, TAP block has become an important adjunct within many ERAC protocols worldwide.

More recently, the **Quadratus Lumborum (QL) block** has emerged as a potentially superior regional anesthetic technique because of its ability to provide both somatic and visceral analgesia. Unlike TAP block, which primarily anesthetizes the anterior abdominal wall, QL block permits wider spread of local anesthetic toward the thoracolumbar fascia and paravertebral space, thereby producing more extensive pain relief following abdominal surgery. The systematic review and meta-analysis by **El-Boghdadly et al.**[38] evaluated multiple randomized controlled trials comparing QL block with conventional analgesia after cesarean delivery.

The authors demonstrated that women receiving QL block consistently experienced lower postoperative pain scores, prolonged duration of analgesia, and significantly reduced opioid consumption during the first postoperative day.[38] The prolonged analgesic effect frequently extended beyond **24 hours**, reducing the need for rescue analgesics while improving maternal comfort during the early postpartum period. Improved analgesia also facilitated earlier ambulation, greater participation in infant care, and enhanced maternal satisfaction. Importantly, no significant increase in procedure-related complications was observed, supporting the safety profile of ultrasound-guided QL block when performed by experienced anesthesiologists.[38]

The analgesic advantages of QL block were further confirmed by the meta-analysis performed by **Hussain et al.**[39] After evaluating available randomized studies, the investigators reported that QL block significantly reduced cumulative opioid requirements and improved postoperative pain control compared with standard analgesic protocols. Women receiving QL block demonstrated lower visual analogue pain scores both at rest and during movement, particularly during the first postoperative day when postoperative discomfort is greatest.[39] Reduced opioid consumption also resulted in lower incidence of

opioid-associated adverse effects, including nausea, vomiting, excessive sedation, pruritus, and delayed bowel recovery.

An additional important finding reported by Hussain et al. was the improvement in overall functional recovery.[39] Superior postoperative analgesia enabled mothers to mobilize earlier, tolerate oral nutrition sooner, breastfeed more comfortably, and achieve postoperative recovery milestones more rapidly than women receiving conventional analgesic management. These findings support increasing incorporation of ultrasound-guided fascial plane blocks into modern ERAC pathways as part of comprehensive multimodal analgesic strategies.

Although regional analgesic techniques constitute an essential component of ERAC, successful enhanced recovery requires integration of these interventions within standardized multidisciplinary perioperative pathways. **Kalogera et al.**[40] comprehensively reviewed implementation of Enhanced Recovery pathways within gynecologic surgery and provided important principles directly applicable to obstetric practice. Their review emphasized that enhanced recovery is fundamentally a systems-based quality improvement strategy rather than merely a collection of individual clinical interventions.

According to Kalogera and colleagues, successful ERAS implementation requires coordinated collaboration among surgeons, anesthesiologists, nursing personnel, physiotherapists, nutritionists, pharmacists, and hospital administrators.[40] Each member of the multidisciplinary team contributes specific responsibilities throughout the perioperative period, ensuring consistent application of evidence-based interventions from admission through discharge. The authors demonstrated that institutions implementing standardized ERAS pathways consistently achieved shorter hospital stays, lower postoperative complication rates, reduced healthcare costs, improved patient satisfaction, and earlier return to normal daily activities across multiple surgical specialties.

Another important observation made by Kalogera et al. concerns the relationship between **protocol compliance and clinical outcomes**. [40] Hospitals achieving higher adherence to ERAS recommendations consistently reported superior postoperative recovery compared with institutions implementing only selected protocol components. Continuous staff education, standardized clinical pathways, regular multidisciplinary meetings, ongoing performance auditing, and institutional leadership were identified as major determinants of successful implementation. These findings reinforce the concept that enhanced recovery depends upon coordinated delivery of multiple evidence-based interventions rather than isolated modifications of perioperative practice.

The review also highlighted several barriers limiting widespread ERAS adoption, including resistance to

changing traditional clinical practices, insufficient staff training, limited institutional resources, and variability in clinical practice patterns.[40] Overcoming these barriers requires organizational commitment, continuous professional education, and integration of ERAS principles into routine clinical workflows. Increasing utilization of electronic clinical pathways, standardized order sets, digital documentation systems, and quality improvement dashboards may further improve protocol compliance and sustainability.

Collectively, contemporary evidence strongly supports the incorporation of neuraxial morphine, ultrasound-guided regional anesthetic techniques, and standardized multidisciplinary ERAC pathways into routine obstetric practice. Neuraxial morphine continues to provide the foundation for postoperative analgesia, while TAP block and quadratus lumborum block offer valuable adjunctive strategies that further reduce opioid requirements and improve maternal comfort. Simultaneously, successful implementation of these interventions within structured ERAC programmes enhances functional recovery, accelerates mobilization, promotes breastfeeding, shortens hospitalization, improves patient satisfaction, and optimizes healthcare resource utilization. As evidence continues to accumulate, these regional analgesic techniques and multidisciplinary implementation strategies are expected to remain central components of modern Enhanced Recovery After Caesarean programmes, contributing substantially to safer, more efficient, and patient-centred obstetric care.

POSTOPERATIVE RECOVERY, EARLY REHABILITATION, AND MATERNAL-CENTRED OUTCOMES IN ENHANCED RECOVERY AFTER CAESAREAN DELIVERY

The postoperative phase represents the most critical component of Enhanced Recovery After Caesarean (ERAC), as successful implementation of evidence-based recovery strategies during this period directly determines the speed of maternal rehabilitation, functional independence, breastfeeding success, patient satisfaction, and healthcare resource utilization. Conventional postoperative management after lower segment caesarean section (LSCS) traditionally involved prolonged fasting, delayed initiation of oral feeding, extended bed rest, prolonged urinary catheterization, opioid-dependent analgesia, and hospitalization until complete recovery. Although these conservative practices were historically considered safe, increasing scientific evidence has demonstrated that many of these interventions unnecessarily delay physiological recovery and contribute to increased postoperative morbidity. Contemporary ERAC pathways therefore advocate early oral nutrition, early mobilization, prompt urinary catheter removal, breastfeeding support, and multidisciplinary postoperative rehabilitation to accelerate maternal recovery without compromising patient safety.

One of the earliest modifications incorporated into ERAC protocols is the initiation of oral nutrition shortly after surgery. Traditionally, women were maintained nil per oral until bowel sounds returned or passage of flatus occurred because of concerns regarding postoperative ileus, nausea, vomiting, and aspiration. However, these prolonged fasting practices frequently resulted in dehydration, increased insulin resistance, maternal fatigue, delayed gastrointestinal recovery, and prolonged hospitalization. The updated **Cochrane Pregnancy and Childbirth Review** evaluated randomized controlled trials comparing early versus delayed postoperative feeding after caesarean delivery.[41] The review concluded that initiation of oral fluids and food within the first few postoperative hours did not increase postoperative ileus, nausea, vomiting, abdominal distension, or surgical complications compared with conventional delayed feeding protocols. Instead, women receiving early nutrition demonstrated significantly faster recovery of bowel function, earlier passage of flatus, greater maternal comfort, and reduced length of hospital stay.[41]

The physiological basis for these findings is well established. Early enteral nutrition stimulates gastrointestinal motility, preserves intestinal mucosal integrity, reduces bacterial translocation, minimizes postoperative insulin resistance, and promotes earlier restoration of normal metabolic function. Consequently, modern ERAC pathways recommend introduction of clear fluids within approximately two hours after surgery followed by gradual advancement to a normal diet as tolerated, replacing the outdated practice of prolonged postoperative starvation.[41]

Further evidence supporting early feeding was provided by the systematic review and meta-analysis conducted by **Hsu et al.**[42] After pooling multiple randomized controlled trials, the investigators demonstrated that early oral feeding significantly accelerated return of bowel function and reduced postoperative gastrointestinal discomfort without increasing adverse events. Women who commenced oral intake early experienced earlier bowel sounds, earlier passage of flatus, improved tolerance to solid food, and higher patient satisfaction compared with women receiving delayed feeding.[42] The authors further reported that early nutritional support improved maternal energy levels, reduced postoperative weakness, and facilitated earlier mobilization. Importantly, no increase in wound complications, aspiration, postoperative nausea, or postoperative ileus was observed, confirming that early feeding represents a safe and effective component of ERAC pathways.[42]

Alongside nutritional optimization, **early mobilization** has become another cornerstone of enhanced postoperative recovery. Traditional postoperative care frequently recommended prolonged bed rest because of concerns regarding wound disruption, pain, dizziness, or residual spinal

anaesthesia. However, immobilization contributes to muscle wasting, venous stasis, pulmonary complications, constipation, insulin resistance, delayed bowel recovery, and thromboembolic events. Modern ERAC pathways therefore encourage mobilization within **6–8 hours** after surgery once adequate motor function has returned.[43]

The review by **Grass et al.** comprehensively examined the physiological mechanisms underlying early postoperative mobilization.[43] The authors demonstrated that ambulation stimulates pulmonary ventilation, improves diaphragmatic function, enhances tissue oxygenation, promotes venous return, reduces lower limb venous stasis, and accelerates gastrointestinal motility. Early mobilization also preserves skeletal muscle mass, reduces insulin resistance, minimizes postoperative fatigue, and facilitates faster return to normal daily activities.[43] Beyond physiological benefits, mobilization contributes substantially to psychological recovery by restoring maternal independence and confidence in caring for the newborn. These combined effects explain why early ambulation consistently remains one of the strongest predictors of successful ERAC implementation.

Practical aspects of mobilization were further explored by **Fiore et al.**[44] who emphasized that mobilization should be regarded as a structured therapeutic intervention rather than simply encouraging patients to walk. The authors recommended development of standardized mobilization protocols with clearly defined recovery milestones, nursing support, physiotherapy involvement, and continuous monitoring of patient progress. Hospitals incorporating structured mobilization pathways consistently demonstrated earlier discharge readiness, fewer pulmonary complications, improved gastrointestinal recovery, reduced thromboembolic risk, and greater patient satisfaction compared with conventional postoperative management.[44] The review also highlighted that adequate pain control, patient education, and multidisciplinary collaboration are prerequisites for successful early ambulation within ERAC programmes.

Another important determinant of postoperative recovery is the timing of urinary catheter removal. Conventional postoperative practice frequently maintained urinary catheters for **12–24 hours or longer** following cesarean delivery because of concerns regarding urinary retention after neuraxial anesthesia. Unfortunately, prolonged catheterization delays ambulation, increases maternal discomfort, and substantially increases the risk of catheter-associated urinary tract infection. The systematic review and meta-analysis conducted by **Li et al.** evaluated evidence regarding optimal catheter removal following cesarean section.[45] Their analysis demonstrated that early catheter removal significantly reduced urinary tract infection rates while facilitating earlier mobilization and improving maternal comfort.

Importantly, no clinically significant increase in postoperative urinary retention requiring recatheterization was observed among appropriately selected women.[45] These findings support current ERAC recommendations advocating catheter removal within approximately **6–12 hours** following surgery, thereby promoting earlier functional recovery without compromising patient safety.

Breastfeeding represents another essential indicator of successful maternal recovery. Early initiation of breastfeeding improves neonatal nutrition, strengthens maternal–infant bonding, enhances uterine contraction through oxytocin release, reduces postpartum haemorrhage, and provides substantial long-term health benefits for both mother and child. Recognizing these advantages, the **World Health Organization (WHO)** recommends immediate skin-to-skin contact after birth together with breastfeeding initiation within the **first hour of life** whenever clinically feasible.[46] WHO further emphasizes that healthcare facilities should establish supportive environments that facilitate breastfeeding through staff education, maternal counselling, avoidance of unnecessary mother–infant separation, and implementation of evidence-based maternity care practices.[46] These recommendations closely align with ERAC principles emphasizing maternal-centred recovery and early neonatal bonding.

The long-term importance of breastfeeding was comprehensively summarized by **Victora et al.** in their landmark Lancet review.[47] Drawing upon evidence from numerous epidemiological studies, the authors demonstrated that breastfeeding substantially reduces neonatal mortality, infectious diseases, childhood obesity, diabetes, and long-term cardiovascular risk while simultaneously decreasing maternal risk of breast cancer, ovarian cancer, and type 2 diabetes mellitus.[47] Within ERAC pathways, effective postoperative analgesia, early mobilization, reduced maternal sedation, and rapid functional recovery facilitate successful breastfeeding initiation, thereby extending the benefits of enhanced recovery beyond the immediate postoperative period.

Recent implementation studies further illustrate the effectiveness of comprehensive ERAC pathways in routine clinical practice. **Cojocaru et al.** evaluated the impact of standardized ERAC implementation within a quality improvement programme and demonstrated significant improvements in postoperative recovery milestones.[48] Women managed under ERAC achieved earlier oral intake, earlier ambulation, earlier urinary catheter removal, reduced opioid consumption, and lower postoperative pain scores compared with conventional perioperative care. Importantly, these improvements occurred without increasing postoperative complications or hospital readmissions, confirming that accelerated recovery can be achieved safely through standardized multidisciplinary pathways.[48]

Evidence supporting ERAC in emergency obstetric

surgery was further strengthened by the randomized controlled trial conducted by **Mundhra et al.**[49] Although emergency cesarean sections are generally associated with greater physiological stress and higher complication rates than elective procedures, women managed under ERAC still demonstrated significantly shorter hospital stays, earlier bowel recovery, earlier mobilization, earlier catheter removal, improved pain scores, and superior quality-of-life outcomes compared with conventional postoperative management.[49] These findings indicate that the benefits of ERAC extend beyond elective surgery and may be successfully implemented even within emergency obstetric settings.

The highest level of contemporary evidence is provided by the updated systematic review and meta-analysis published by **Lestari et al.**[50] Incorporating **23 studies involving more than 18,000 women**, this review confirmed that ERAC consistently improves nearly every important postoperative recovery parameter. Women managed under ERAC experienced significantly shorter hospital stays, earlier oral feeding, earlier ambulation, earlier urinary catheter removal, faster gastrointestinal recovery, reduced postoperative opioid requirements, and improved maternal satisfaction without any increase in postoperative complications, wound infection,

readmission, or adverse neonatal outcomes.[50] The authors concluded that ERAC should be regarded as the preferred evidence-based perioperative pathway for women undergoing cesarean delivery and recommended wider implementation across both developed and developing healthcare systems.

Overall, current evidence strongly demonstrates that postoperative recovery within ERAC extends far beyond simple pain control or reduction in hospital stay. Early nutrition, structured mobilization, timely urinary catheter removal, breastfeeding support, and multidisciplinary rehabilitation collectively restore maternal physiological function, reduce postoperative complications, improve maternal independence, strengthen mother–infant bonding, and enhance overall quality of obstetric care. The consistency of findings across randomized controlled trials, systematic reviews, meta-analyses, international guidelines, and quality improvement programmes confirms that ERAC has transformed postoperative care following lower segment caesarean section from a traditionally passive recovery process into an active, evidence-based, patient-centred pathway that optimizes maternal and neonatal outcomes while improving healthcare efficiency.

Table 1. Comparison of Traditional Perioperative Care and Enhanced Recovery After Caesarean (ERAC) Pathways

Perioperative Component	Traditional Pathway	Enhanced Recovery After Caesarean (ERAC)	Expected Clinical Benefit
Patient counselling	Limited preoperative counselling	Comprehensive antenatal counselling and recovery planning	Reduced anxiety and improved patient participation
Preoperative fasting	Nil per oral after midnight (8–12 h or longer)	Clear fluids until 2 h and solids until 6 h before surgery	Reduced dehydration, thirst, insulin resistance, and discomfort
Carbohydrate loading	Not routinely practiced	Recommended for eligible non-diabetic women	Improved metabolic stability and reduced postoperative fatigue
Antibiotic prophylaxis	Variable timing	Within 60 min before skin incision	Reduced surgical site infection
Fluid management	Liberal intravenous fluids	Goal-directed individualized fluid therapy	Better hemodynamic stability and reduced fluid overload
Anaesthesia	Conventional spinal/general anaesthesia	Standardized neuraxial anaesthesia with multimodal analgesia	Improved pain control and faster recovery
Pain management	Predominantly opioid-based	Multimodal opioid-sparing analgesia	Lower opioid requirement and fewer adverse effects
Regional analgesia	Limited use	TAP block or Quadratus Lumborum block when indicated	Prolonged postoperative analgesia
Oral intake	Delayed until bowel sounds/flatus	Early oral fluids and feeding within hours	Earlier gastrointestinal recovery
Mobilization	Delayed (12–24 h)	Early mobilization within 6–8 h	Reduced thromboembolism and faster functional recovery
Urinary catheter	Removed after 12–24 h	Early removal (6–12 h)	Reduced urinary tract infection and earlier ambulation

Breastfeeding	Frequently delayed	Early skin-to-skin contact and breastfeeding	Improved maternal–infant bonding and neonatal outcomes
Hospital discharge	Conventional prolonged stay	Early discharge based on recovery criteria	Reduced hospital stay and healthcare costs

Table 2. Major Clinical Evidence Supporting Enhanced Recovery After Caesarean (ERAC)

Author (Reference)	Study Design	Sample	Major Findings	Clinical Significance
Sultan et al. [11]	Systematic review & meta-analysis	17,607 women	Hospital stay reduced by 0.51 days; ambulation earlier by 11.05 h; catheter removal earlier by 13.19 h; opioid use reduced by 21.85 mg morphine equivalents	Strong evidence supporting ERAC implementation
Cojocaru et al. [12]	Quality improvement study	ERAC implementation cohort	Opioid consumption reduced from 30 mg to 16.8 mg morphine equivalents; improved recovery milestones	Demonstrated successful clinical implementation
Mundhra et al. [13]	Randomized controlled trial	Emergency LSCS	Hospital stay reduced (53.87 vs 73.92 h); earlier feeding, ambulation, bowel recovery, and catheter removal	ERAC effective even in emergency cesarean delivery
Lestari et al. [14]	Systematic review & meta-analysis	23 studies; 18,368 women	Earlier feeding, mobilization, catheter removal, shorter hospital stay, lower opioid use without increased complications	Confirms safety and effectiveness of ERAC
Hsu et al. [42]	Systematic review & meta-analysis	Multiple RCTs	Early oral feeding improved bowel recovery without increasing complications	Supports early postoperative nutrition
Li et al. [45]	Systematic review & meta-analysis	Multiple comparative studies	Early catheter removal reduced urinary tract infection and improved mobilization	Supports early decatheterization
Cojocaru et al. [48]	Quality improvement study	ERAC cohort	Earlier recovery milestones with reduced opioid consumption	Improved postoperative recovery
Mundhra et al. [49]	Randomized controlled trial	Emergency LSCS	Better pain scores, shorter hospitalization, earlier mobilization	Demonstrated ERAC feasibility in emergency surgery
Lestari et al. [50]	Updated systematic review & meta-analysis	>18,000 women	Faster recovery, shorter hospital stay, reduced opioid use, no increase in readmission or complications	Highest contemporary evidence supporting ERAC

CONCLUSION

Enhanced Recovery After Surgery (ERAS), specifically Enhanced Recovery After Caesarean (ERAC), has transformed perioperative care in lower segment caesarean section from a conventional, procedure-oriented approach into a multidisciplinary, evidence-based, patient-centred model that prioritizes rapid physiological recovery, maternal comfort, and improved healthcare efficiency. The accumulated evidence from international guidelines, systematic reviews, meta-analyses, randomized controlled trials, and quality improvement studies consistently demonstrates that ERAC is both safe and effective across diverse obstetric populations.

Compared with traditional perioperative pathways, ERAC incorporates evidence-based interventions including comprehensive preoperative counselling, shortened fasting with appropriate nutritional

optimization, multimodal opioid-sparing analgesia, goal-directed fluid therapy, maintenance of normothermia, early oral feeding, structured early mobilization, timely urinary catheter removal, and breastfeeding support. Collectively, these interventions attenuate the surgical stress response, reduce insulin resistance, improve gastrointestinal recovery, facilitate earlier ambulation, decrease postoperative pain and opioid consumption, shorten hospital stay, and enhance maternal satisfaction without increasing postoperative complications, readmissions, or adverse neonatal outcomes. Recent high-quality evidence further supports the widespread implementation of ERAC. Large systematic reviews involving more than 18,000 women have consistently demonstrated earlier recovery milestones, reduced healthcare utilization, and improved functional outcomes while maintaining

excellent maternal and neonatal safety profiles. Furthermore, emerging evidence indicates that ERAC is equally beneficial in emergency caesarean deliveries and can be successfully implemented through multidisciplinary collaboration, standardized institutional protocols, continuous auditing, and quality improvement initiatives.

Despite these advances, variability in protocol adherence, institutional infrastructure, healthcare resources, and clinical practice continues to limit universal adoption, particularly in low- and middle-income countries. Future research should focus on multicentre randomized controlled trials, long-term maternal and neonatal outcomes, patient-reported outcome measures, cost-effectiveness analyses, and the integration of digital health technologies, artificial intelligence, and personalized perioperative care into ERAC pathways. Establishing standardized global protocols while allowing appropriate adaptation to local healthcare settings will be essential for maximizing the benefits of enhanced recovery programmes.

In conclusion, ERAC represents the current standard of evidence-based perioperative care for women undergoing lower segment caesarean section. Its implementation not only accelerates postoperative recovery but also improves maternal experience, optimizes resource utilization, strengthens mother–infant bonding, and supports high-quality obstetric practice. Continued refinement, wider implementation, and sustained adherence to ERAC principles have the potential to further improve maternal healthcare outcomes worldwide and establish enhanced recovery as an integral component of modern obstetric surgery.

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