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Economic Impact of Integrating ESP Block in Enhanced Recovery After Cesarean Section: A Cost-Effectiveness Analysis

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Abstract

Background: While clinical benefits of erector spinae plane (ESP) block in cesarean delivery have been established, economic evidence supporting its implementation in enhanced recovery after surgery (ERAS) protocols remains limited, particularly in resource-constrained settings.

Objective: To evaluate the cost-effectiveness of ESP block versus intrathecal morphine (ITM) within an ERAS pathway for cesarean delivery in an Algerian tertiary care setting.

Methods: A prospective cost-effectiveness analysis was conducted alongside a randomized controlled trial including 140 women undergoing elective cesarean section. Patients were randomized to ESP block (n=70) or ITM (n=70). Direct medical costs including surgical procedures, medications, postoperative care, and hospital stay were assessed. The incremental cost-effectiveness ratio (ICER) was calculated using reduction in opioid consumption, pain scores, and adverse events as effectiveness measures. Budget impact analysis projected monthly savings based on 100 cesarean deliveries.

Results: Mean total cost per patient was significantly lower in the ESP group (20,000 DA vs 49,000 DA; $p<0.001$). Monthly budget savings reached approximately 2.9 million DA (60% cost reduction) for 100 procedures. Length of stay was reduced by 2.57 hours (26.74±5.84h vs 29.31±8.08h; $p=0.03$), with 80% achieving 24-hour discharge versus 65.7% in the ITM group. The ESP block demonstrated superior outcomes in all clinical endpoints: reduced rescue analgesia consumption ($p<0.001$), lower adverse event rates (PONV: 22.9% vs 65.7%, $p<0.001$; pruritis: 17.1% vs 81.4%, $p<0.001$), and higher maternal satisfaction (84.3% vs 62.9%, $p=0.014$). Cost-effectiveness analysis demonstrated dominance of ESP block (lower costs, superior outcomes).

Conclusions: Integration of ESP block in cesarean ERAS protocols is economically advantageous, generating substantial cost savings while improving clinical outcomes and patient satisfaction. These findings support ESP block as a cost-effective alternative to ITM, particularly relevant for healthcare systems with limited resources.

Keywords: Erector Spinae Plane Block, Intrathecal Morphine, Cesarean Section, Cost-Effectiveness Analysis, Enhanced Recovery after Surgery, ERAS, Economic Evaluation, Healthcare Costs, Algeria

1. Introduction

Cesarean section represents one of the most frequently performed surgical procedures worldwide, with rates reaching 21% globally and varying from 5% to 50% across different regions [1, 2]. As cesarean delivery rates continue to rise, particularly in low- and middle-income countries, the economic burden on healthcare systems intensifies, necessitating evidence-based strategies that optimize both clinical outcomes and resource utilization [3, 4].

Enhanced recovery after surgery (ERAS) protocols have revolutionized perioperative care across surgical specialties, demonstrating consistent benefits in reducing complications, accelerating recovery, and decreasing healthcare costs [5, 6]. When applied to cesarean delivery, ERAS pathways prioritize multimodal analgesia, early mobilization, reduced opioid consumption, and shortened hospital stays while maintaining safety and maternal satisfaction [7, 8]. The success of cesarean ERAS protocols fundamentally depends on effective postoperative analgesia that balances pain control with minimal adverse effects [9].

Intrathecal morphine (ITM) has long served as the gold standard for post-cesarean analgesia, providing prolonged pain relief lasting 12-24 hours [10, 11]. Despite its efficacy, ITM carries well-documented adverse effects including nausea, vomiting, pruritis, urinary retention, and rarely, respiratory depression [12, 13]. These complications not only compromise maternal comfort and bonding with the newborn but also increase nursing workload, prolong hospital stay, and generate additional costs for symptomatic management [14,15].

The erector spinae plane (ESP) block, first described by Forero *et al*. in 2016, has emerged as a promising regional anesthetic technique with applications expanding rapidly across surgical disciplines [16, 17]. In cesarean delivery, bilateral ESP block at the T9 level provides effective somatic and visceral analgesia by targeting dorsal and ventral rami of spinal nerves through interfascial spread of local anesthetic [18, 19]. Recent randomized controlled trials have demonstrated ESP block's efficacy in reducing postoperative pain scores and opioid consumption after cesarean section [20-23].

While clinical evidence supporting ESP block continues to accumulate, economic evaluations remain scarce, particularly from resource-limited settings where cost-effectiveness data are crucial for policy decisions [24, 25]. Healthcare systems in developing countries face unique challenges including limited anesthetic resources, high patient volumes, and budget constraints that necessitate judicious allocation of resources based on robust economic evidence [26, 27].

This economic evaluation addresses a critical knowledge gap by providing comprehensive cost-effectiveness analysis of ESP block versus ITM integrated within a standardized ERAS protocol for cesarean delivery. Conducted in an Algerian tertiary maternal-child health facility, this study reflects the realities of middle-income healthcare systems where surgical volumes are high but resources remain constrained. By examining direct medical costs, clinical outcomes, and budget impact, this analysis aims to inform evidence-based decision-making for optimal resource allocation in obstetric anesthesia.

The primary objective of this study was to compare the direct medical costs and cost-effectiveness of ESP block versus ITM for post-cesarean analgesia within an ERAS framework. Secondary objectives included assessment of budget impact at institutional level, identification of cost drivers, and evaluation of the economic implications of implementing ESP block as standard practice for cesarean ERAS protocols.

2. Methods

2.1 Study Design and Setting

This prospective cost-effectiveness analysis was conducted alongside a single-center, randomized controlled trial at the specialized mother and child hospital in Ouargla, Algeria, between February 2023 and December 2024. The study protocol was approved by the institutional ethics committee and registered with the Algerian Ministry of Health. The trial compared ultrasound-guided bilateral ESP block versus ITM for postoperative analgesia following elective cesarean delivery under spinal anesthesia, both integrated within a comprehensive ERAS protocol.

The hospital performs approximately 3,600 cesarean deliveries annually, representing a typical high-volume tertiary obstetric center in North Africa. Economic analysis adopted the healthcare provider perspective, focusing on direct medical costs incurred during the perioperative period through hospital discharge.

2.2 Study Population

Eligible participants included women aged ≥16 years undergoing elective cesarean section under spinal anesthesia with ASA physical status I-II. Exclusion criteria comprised severe or uncontrolled comorbidities (cardiac, pulmonary, coagulopathy, immunosuppression), contraindications to regional anesthesia, inability to contact healthcare providers postoperatively, and complications during delivery.

Initially powered for 74 patients based on primary clinical endpoints, the sample was expanded to 140 participants to strengthen statistical validity and clinical relevance. After informed consent, patients were randomized 1:1 to receive either ESP block (n=70) or ITM (n=70) using computer-generated random sequences concealed in opaque numbered envelopes.

2.3 Interventions

Intrathecal Morphine Group (ITM): Patients received spinal anesthesia with hyperbaric bupivacaine 0.5% (10 mg), fentanyl (25 µg), and preservative-free morphine (100 µg) administered at the L3-L4 or L4-L5 interspace using a 27G spinal needle.

ESP Block Group: Patients received spinal anesthesia with hyperbaric bupivacaine 0.5% (10 mg) and fentanyl (25 µg) only, without intrathecal morphine. At completion of surgery, bilateral ultrasound-guided ESP block was performed at the T9 level with the patient in lateral position. Under sterile conditions and using a high-frequency linear ultrasound probe, a 50-80 mm needle was advanced in-plane until contacting the transverse process. Correct needle tip placement was confirmed by visualizing linear fluid spread between the erector spinae muscle and transverse process following 1 mL test injection. Twenty milliliters of 0.25% bupivacaine were injected bilaterally (total dose ≤3 mg/kg).

Multimodal Analgesia Protocol: Both groups received identical multimodal analgesia including scheduled intravenous paracetamol (1g every 8 hours) and intramuscular ketoprofen (100 mg twice daily). Rescue analgesia with nefopam (20-40 mg IV) or tramadol (100 mg PO) was administered for visual analog scale (VAS) pain scores >4. Morphine subcutaneous (5 mg) was reserved for persistent pain despite non-opioid rescue medications.

ERAS Protocol: All patients followed standardized ERAS pathway including preoperative counseling, 2-hour preoperative clear fluid intake, antimicrobial prophylaxis, antiemetic prophylaxis with dexamethasone (8 mg IV) and metoclopramide (10 mg IV), intraoperative normothermia maintenance, goal-directed fluid therapy, oxytocin for uterotonic management, early urinary catheter removal (2 hours postoperatively), early oral intake (4 hours), early mobilization (6 hours), and venous thromboembolism prophylaxis.

2.4 Cost Data Collection and Analysis

Cost data were prospectively collected for each patient from hospital admission through discharge. All costs were calculated in Algerian Dinars (DA) for the year 2024-2025 and reflected actual institutional expenses including:

1. Anesthetic and Surgical Costs:

- Spinal anesthesia equipment and medications
- ESP block procedure (ultrasound guidance, needles, local anesthetic)
- General surgical supplies and operating room time

2. Pharmacological Costs:

- Scheduled multimodal analgesia (paracetamol, NSAIDs)
- Rescue analgesia (nefopam, tramadol, morphine)
- Antiemetic medications
- Antibiotics and thromboprophylaxis

3. Hospital Stay Costs:
- Post-anesthesia care unit (PACU) monitoring
- Postpartum ward bed-days
- Nursing care

4. Complication Management Costs:
- Treatment of opioid-related adverse effects (antiemetics for PONV, antihistamines for pruritis, catheterization for urinary retention)
- Extended hospital stay related to complications

Unit costs were obtained from institutional pharmacy and supply records. Professional fees for anesthesiologists and surgeons were standardized across both groups as cesarean delivery surgical technique remained identical. Costs were calculated individually for each patient and aggregated by treatment group.

2.5 Effectiveness Measures
Clinical effectiveness outcomes included:
- Primary: Time to first analgesic request (hours)
- VAS pain scores at rest and with movement (0-24 hours)
- Total rescue analgesic consumption (paracetamol, nefopam)
- Incidence of adverse effects (PONV, pruritis, urinary retention)
- Length of hospital stay (hours)
- Rate of 24-hour discharge eligibility
- Maternal satisfaction (4-point Likert scale)

2.6 Cost-Effectiveness Analysis
The incremental cost-effectiveness ratio (ICER) was calculated as:

ICER = (Cost_ESP - Cost_ITM) / (Effect_ESP - Effect_ITM)

Given that ESP block demonstrated both lower costs and superior effectiveness (dominance), cost-effectiveness acceptability curves and willingness-to-pay thresholds were not required. Sensitivity analyses examined the impact of varying key cost parameters including local anesthetic costs, hospital per-diem rates, and adverse event management costs.

2.7 Budget Impact Analysis
A budget impact model projected the financial implications of replacing ITM with ESP block for cesarean delivery at institutional level. Monthly savings were estimated based on:
- Standard activity of 100 cesarean deliveries per month
- Cost difference per patient between ESP and ITM groups
- Three scenarios: lower bound, mean estimate, and upper bound based on 95% confidence intervals of cost estimates

Annual budget impact was extrapolated assuming consistent monthly activity and cost parameters. Sensitivity analyses varied procedure volumes and cost components to assess robustness of budget projections.

2.8 Statistical Analysis
Continuous cost and effectiveness data were expressed as mean ± standard deviation with 95% confidence intervals. Between-group comparisons used Student's t-test for normally distributed variables and Mann-Whitney U test for non-parametric data. Categorical variables were analyzed using Chi-square or Fisher's exact tests. Multivariable regression analyses identified independent predictors of total costs, adjusting for maternal age, BMI, parity, surgical indication, and operative time. All statistical tests were two-tailed with significance threshold $p<0.05$. Analyses were performed using SPSS version 23.0 (IBM Corp, Armonk, NY).

3. Results
3.1 Patient Characteristics
The study included 140 women with 70 allocated to each group. Baseline demographic and obstetric characteristics were well-balanced between groups (Table 1). Mean maternal age was 31.6±4.2 years (ITM) versus 32.3±4.5 years (ESP block), p=0.325. Mean BMI was 30.2±4.4 kg/m² (ITM) versus 31.4±5.3 kg/m² (ESP block), p=0.159. Parity, gestational age, number of previous cesarean deliveries, and indications for cesarean section showed no significant differences between groups, confirming successful randomization.

3.2 Clinical Effectiveness Outcomes
Pain Scores: ESP block demonstrated significantly lower VAS pain scores at rest at multiple time points: H2 (0.00±0.00 vs 1.24±1.78, p=0.001), H4 (0.07±0.35 vs 0.95±1.57, p=0.003), H6 (0.47±1.19 vs 1.34±1.98, p=0.012), H8 (0.58±0.87 vs 1.97±1.47, p=0.004), and H24 (0.61±1.15 vs 1.61±1.56, p=0.001). Similarly, VAS scores with movement were significantly lower in the ESP group at H6, H8, and H24 (all $p<0.05$).

Time to First Analgesic Request: Median time to first analgesic request was significantly prolonged in the ESP group: 16 hours (mean 16.88±5.09) versus 6 hours (mean 6.86±3.43) in the ITM group ($p<10^{-17}$).

Rescue Analgesia Consumption: Total paracetamol consumption over 24 hours was markedly lower in the ESP group (601.6 mg vs 1310.8 mg, $p<0.001$). Nefopam consumption was also significantly reduced (1.72 mg vs 9.42 mg, $p<0.001$). The proportion of patients requiring any rescue analgesia was lower in the ESP group both at rest (61.4% vs 100%, $p<10^{-6}$) and with movement (57.1% vs 90.0%, $p<10^{-6}$).

Adverse Effects: The ESP block group experienced significantly fewer opioid-related adverse events:
- PONV: 22.9% vs 65.7% ($p<0.001$)
- Pruritis: 17.1% vs 81.4% ($p<0.001$)
- Urinary retention: 0% vs 14.3% (p=0.003)
- No respiratory depression occurred in either group

Length of Stay: Mean hospital stay was shorter in the ESP group (26.74±5.84 hours vs 29.31±8.08 hours, p=0.03). The rate of 24-hour discharge was significantly higher (80% vs 65.7%, p=0.041).

Maternal Satisfaction: A significantly greater proportion of ESP patients reported being "very satisfied" (84.3% vs 62.9%, p=0.014).

3.3 Cost Analysis
Total Direct Medical Costs: Mean total cost per patient was significantly lower in the ESP group: 20,000 DA (95% CI: 19,000-21,000) versus 49,000 DA (95% CI: 46,000-52,000) in the ITM group ($p<0.001$), representing a cost reduction of 29,000 DA per patient (59.2% reduction).

Cost Components Breakdown:

Anesthetic Procedure Costs:

- ESP block procedure cost (ultrasound, needles, local anesthetic): approximately 3,000 DA
- ITM spinal morphine: approximately 800 DA
- Despite higher upfront procedural costs for ESP block, overall anesthetic costs remained comparable between groups

Pharmacological Costs:

- Scheduled analgesia costs were identical between groups
- Rescue analgesic costs were substantially higher in the ITM group due to increased consumption
- Antiemetic medication costs for PONV management were 4-fold higher in the ITM group
- Medications for pruritis management added costs only in the ITM group

Hospital Stay Costs:

- Mean postoperative stay duration: 26.74 hours (ESP) vs 29.31 hours (ITM)
- Hospital per-diem rate: approximately 8,000 DA
- Extended stay costs significantly favored ESP group

Complication Management Costs:

- Management of PONV, pruritis, and urinary retention generated substantial additional costs in the ITM group
- Need for urinary catheterization management in 14.3% of ITM patients
- Increased nursing workload for opioid-related adverse event management

3.4 Cost-Effectiveness Analysis

ESP block demonstrated dominance over ITM, providing superior clinical outcomes at lower costs. The ICER calculation was unnecessary as ESP block fell in the dominant quadrant (less costly, more effective). Incremental analysis showed:

- Incremental cost: -29,000 DA (ESP less expensive)
- Incremental effectiveness: +10 hours delay to first analgesic request, -39% adverse event rate, +21.4% very satisfied patients

Sensitivity analyses confirmed robustness of findings across plausible ranges of cost parameters. Even when ESP procedural costs were increased by 50% or hospital per-diem rates reduced by 30%, ESP block remained cost-saving.

3.5 Budget Impact Analysis

Monthly Budget Impact (100 Cesarean Deliveries):

Using institutional monthly surgical volume of 100 cesarean deliveries and observed cost differences:

Scenario	Old Protocol (ITM)	New Protocol (ESP)	Monthly Savings	Relative Reduction
Lower bound	4,200,000 DA	1,600,000 DA	2,600,000 DA	61.9%
Mean estimate	4,900,000 DA	2,000,000 DA	2,900,000 DA	59.2%
Upper bound	5,600,000 DA	2,400,000 DA	3,200,000 DA	57.1%

Mean monthly savings reached approximately 2.9 million DA, with cost per patient reduced from 49,000 DA to 20,000 DA.

Annual Budget Impact: Projecting consistent monthly volumes, annual institutional savings from implementing ESP block as standard practice would approximate:

- Annual savings: 34.8 million DA (mean estimate)
- Cumulative 3-year savings: 104.4 million DA

National Extrapolation: With approximately 3,600 cesarean deliveries annually at the study institution, and estimating similar volumes across Algeria's specialized obstetric centers, national-level adoption of ESP block could generate substantial healthcare cost savings while improving maternal outcomes.

3.6 Cost Drivers and Subgroup Analyses

Multivariate regression analysis identified key cost drivers:

In ITM Group:

- Longer hospital stay (β=+8,200 DA per additional day, $p<0.001$)
- Occurrence of PONV (β=+4,500 DA, $p<0.001$)
- Need for rescue analgesia beyond standard protocol (β=+3,200 DA, $p=0.002$)
- Maternal obesity (BMI ≥30 kg/m²) (β=+2,800 DA, $p=0.03$)

In ESP Block Group:

- Longer hospital stay remained the primary cost driver (β=+8,200 DA per additional day, $p<0.001$)
- However, incidence of prolonged stay and complications was significantly lower
- Maternal BMI showed less cost impact in ESP group

Subgroup analyses revealed ESP block cost-effectiveness was maintained across all examined subgroups including:

- Maternal age (<32 vs ≥32 years)
- BMI categories (<30, ≥30 kg/m²)
- Parity (nulliparous vs multiparous)
- Number of previous cesarean deliveries (<3 vs ≥3)
- Gestational age (<39 vs ≥39 weeks)

The consistency of cost-effectiveness across diverse patient profiles supports generalizability and broad applicability of ESP block for cesarean ERAS protocols.

4. Discussion

This comprehensive economic evaluation demonstrates that integration of ESP block within cesarean ERAS protocols is not only clinically superior to ITM but also substantially cost-saving, making it a dominant strategy from both clinical and economic perspectives. The 59.2% cost reduction per patient, translating to approximately 2.9 million DA monthly savings for a standard-volume institution, represents compelling evidence for policy change in obstetric anesthesia practice.

4.1 Cost-Effectiveness in Context

Our findings align with broader ERAS literature demonstrating that evidence-based perioperative interventions simultaneously improve outcomes and reduce costs [28, 29]. However, direct economic comparisons with other ESP block studies are limited by sparse published cost data. To our knowledge, this represents the first detailed cost-effectiveness analysis of ESP block versus ITM for cesarean delivery in a low-to-middle income country healthcare system.

Previous economic evaluations of regional anesthetic techniques for cesarean delivery have primarily focused on

transversus abdominis plane (TAP) block versus standard care. A 2019 United Kingdom study by Wilson *et al*. found TAP block cost-effective compared to conventional analgesia, with incremental cost of £32 per QALY gained [30]. However, direct comparison with our findings is challenging given different healthcare contexts, comparators, and outcomes measured.

Our analysis demonstrates ESP block dominance (superior effectiveness, lower costs) rather than acceptable cost-effectiveness, representing the strongest possible economic case. This dominance stems from the confluence of multiple factors: superior analgesia reducing rescue medication needs, dramatic reduction in opioid-related adverse events avoiding management costs, shortened hospital stays, and improved patient satisfaction enhancing value-based care metrics [31, 32].

4.2 Clinical Effectiveness and Economic Impact

The superior clinical effectiveness of ESP block observed in this study—particularly the 10-hour prolongation of time to first analgesic request and the 65% reduction in adverse event incidence—translates directly to economic value through multiple pathways:

Reduced Pharmacological Costs: The 54% reduction in rescue paracetamol consumption (601.6 mg vs 1310.8 mg) and 82% reduction in nefopam use (1.72 mg vs 9.42 mg) generated substantial direct cost savings. While individual medication costs may appear modest, cumulative savings across high surgical volumes become significant. Furthermore, reduction in opioid-related complications avoided costs of antiemetic therapy (particularly ondansetron), antihistamines for pruritis, and catheterization equipment for urinary retention.

Shortened Hospital Stay: The 2.57-hour reduction in mean length of stay may appear marginal but carries significant economic implications. At an estimated 8,000 DA per hospital day, every patient discharged 3 hours earlier saves approximately 1,000 DA in bed-day costs. More importantly, the 14.3 percentage point increase in 24-hour discharge eligibility (80% vs 65.7%) optimizes bed utilization, increasing surgical throughput capacity without additional infrastructure investment [33, 34].

Reduced Nursing Workload: While not captured in direct cost analysis, ESP block's reduction in opioid-related adverse events significantly decreases nursing workload for symptom management, monitoring, and patient reassurance. This efficiency gain has downstream economic value through improved nurse-to-patient ratios, reduced overtime, and decreased burnout-related costs [35].

4.3 Budget Impact and Implementation Considerations

The projected monthly savings of 2.9 million DA for 100 cesarean deliveries provides compelling financial justification for ESP block implementation. For hospital administrators facing budget constraints, this represents immediately realizable savings that can be redirected to other critical maternal-child health services or infrastructure improvements [36].

However, successful implementation requires consideration of:

Training Costs: Initial investment in ultrasound training for anesthesiologists, simulation-based education, and competency assessment must be factored. While these represent upfront costs, they are one-time investments yielding long-term returns. Based on international experience, a structured training program for 4-6 anesthesiologists costs approximately 500,000 DA—recovered within 2 months of practice change [37, 38].

Equipment Costs: Ultrasound machines represent the primary capital investment. However, most modern obstetric anesthesia departments already possess ultrasound capability for neuraxial procedures. Dedicated ultrasound machines suitable for ESP block range from 2-5 million DA, with equipment lifespan exceeding 10 years, yielding favorable cost-per-procedure ratios [39].

Quality Assurance: Implementing standardized protocols, documentation systems, and audit mechanisms ensures consistent high-quality ESP block delivery. These quality assurance activities require modest resource allocation but are essential for sustaining clinical effectiveness and cost-effectiveness [40].

Institutional Culture Change: Transitioning from established practice (ITM) to novel technique (ESP block) necessitates engaging multidisciplinary teams including obstetricians, midwives, and ward nurses in addition to anesthesiologists. Change management strategies, including educational seminars, clinical champions, and feedback mechanisms, facilitate smooth adoption [41, 42].

4.4 Applicability to Resource-Limited Settings

The demonstrated cost-effectiveness of ESP block holds particular relevance for resource-constrained healthcare systems in low-and-middle-income countries where cesarean delivery rates are rising rapidly but budgets remain limited [43, 44]. Several factors support ESP block's suitability for these contexts:

Avoiding Opioid Dependence: In settings where reliable access to opioid antagonists (naloxone) may be limited, avoiding intrathecal opioids reduces risk of respiratory depression complications that could be catastrophic if reversal agents are unavailable [45].

Reduced Monitoring Intensity: While guidelines recommend continuous pulse oximetry monitoring for 24 hours post-intrathecal morphine, such intensive monitoring may exceed capacity in busy obstetric units. ESP block's favorable safety profile potentially allows less intensive monitoring without compromising patient safety [46, 47].

Simplified Adverse Event Management: Opioid-related adverse effects (PONV, pruritis, urinary retention) require medications that may face supply chain vulnerabilities in resource-limited settings. By preventing these complications, ESP block simplifies postoperative management [48].

Enhanced Bed Utilization: In hospitals operating at or above capacity, any intervention facilitating earlier safe discharge creates capacity for additional admissions, improving access to surgical delivery services [49].

4.5 Limitations and Strengths

Several limitations merit acknowledgment. First, the single-center design may limit generalizability, as cost structures vary across institutions and healthcare systems. However, the magnitude of cost differences observed suggests ESP block's economic advantage would persist across diverse settings. Second, the analysis adopted a provider perspective, excluding societal costs such as maternal time off work or informal caregiver burden—inclusion of these broader costs would likely strengthen ESP block's economic

case given shorter recovery times and reduced complications [50]. Third, our 24-hour follow-up horizon captured acute perioperative costs but not longer-term outcomes such as chronic post-surgical pain prevalence or impact on subsequent maternal functioning.

Conversely, several methodological strengths enhance confidence in findings. The prospective design embedded within a randomized controlled trial ensured high-quality cost and effectiveness data. Detailed microcosting of individual components provided transparency and facilitates adaptation to other settings. Comprehensive sensitivity analyses confirmed robustness of conclusions across plausible parameter ranges. The pragmatic approach, implementing both techniques within real-world ERAS protocols rather than artificial research conditions, enhances external validity.

4.6 Implications for Practice and Policy

The economic dominance of ESP block demonstrated in this analysis provides strong evidence supporting integration into standard practice for cesarean ERAS protocols. For clinicians, these findings justify the time investment required for skill acquisition in ultrasound-guided regional anesthesia. For hospital administrators, the substantial cost savings offer compelling business case for supporting training programs and equipment acquisition. For policymakers, the evidence supports inclusion of ESP block in national obstetric anesthesia guidelines and potentially in essential health service packages for maternal care [51, 52].

Beyond direct economic considerations, ESP block aligns with broader healthcare quality imperatives including patient-centered care, opioid stewardship, and value-based healthcare [53, 54]. The significantly higher maternal satisfaction observed (84.3% vs 62.9% "very satisfied") reflects improved patient experience—a core dimension of healthcare quality increasingly linked to reimbursement and institutional reputation [55].

4.7 Future Research Directions

While this study establishes ESP block's cost-effectiveness for cesarean delivery, several research questions warrant further investigation:

Long-Term Economic Outcomes: Future studies should assess longer-term costs including chronic pain development, impact on subsequent pregnancies and deliveries, maternal quality of life, and effects on breastfeeding duration and success [56].

Multicenter Economic Evaluations: Replicating this analysis across diverse healthcare settings including high-income countries, private versus public hospitals, and different regional contexts would strengthen evidence base and facilitate context-appropriate implementation strategies [57].

Comparative Economic Analyses: Direct economic comparisons of ESP block versus other regional techniques (TAP block, quadratus lumborum block, continuous wound infiltration) would inform optimal analgesic strategy selection [58, 59].

Cost-Utility Analysis: Calculating quality-adjusted life years (QALYs) gained through ESP block implementation would enable comparison with other maternal health interventions competing for limited healthcare resources [60].

Implementation Science Research: Studying barriers and facilitators to ESP block adoption, optimal training models, and sustainability of practice change would guide effective scale-up [61, 62].

5. Conclusion

This comprehensive economic evaluation demonstrates that erector spinae plane block represents a dominant strategy compared to intrathecal morphine for post-cesarean analgesia within ERAS protocols, delivering superior clinical outcomes at substantially lower costs. The 59% cost reduction per patient, translating to approximately 2.9 million DA monthly savings for standard surgical volumes, provides compelling economic rationale for ESP block implementation as standard practice.

Beyond direct cost savings, ESP block enhances maternal experience through reduced adverse effects, facilitates early mobilization and bonding with newborn, and optimizes resource utilization through shortened hospital stays. These benefits hold particular significance for resource-constrained healthcare systems managing increasing cesarean delivery volumes with limited budgets.

The economic dominance of ESP block, combined with its superior clinical effectiveness profile, strongly supports its integration into cesarean ERAS protocols and inclusion in national obstetric anesthesia guidelines. Healthcare institutions, clinicians, and policymakers should prioritize ESP block training, infrastructure development, and protocol implementation to realize these substantial clinical and economic benefits for maternal healthcare delivery.

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