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INTRO

Postoperative epidural analgesia (EA) is among the most frequently performed procedures in daily anesthetic practice. Traditionally, the evaluation of epidural analgesia effectiveness is categorized dichotomously as either successful or failed. However, clinical experiences highlight significant variability in what constitutes a failure, emphasizing the complexity of such evaluations.

Identifying partial or complete failures of epidural analgesia in the postoperative phase should incorporate clinically relevant criteria, expert consensus, and implications for patient outcomes. Notably, institutional variations in defining and assessing epidural analgesia failure introduce complexities in standardizing definitions and interpreting outcomes across different centers. Moreover, local hospital culture and clinical practices significantly influence the recognition and categorization of EA outcomes.

- This report presents a single-center review from Massachusetts General Hospital (MGH), outlining an expert-informed and literature-supported grading system for evaluating epidural analgesia effectiveness. Based on expert opinions and a comprehensive literature review, the authors developed a grading system to categorize epidural analgesia outcomes across a spectrum ranging from complete failure through partial success to full success. (Table 1) We hypothesize that partially successful epidural analgesia—where pain persists despite ongoing epidural use—may result in delayed hospital discharge and increased hospitalization costs, representing primary outcomes of interest—total morphine usage and out-of-bed time or hypotension between groups were our 2ndary outcomes.

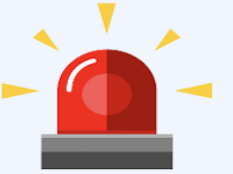
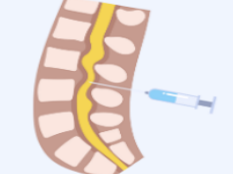
	Higher average Numerical Pain Rating [NPR] scores in 12 hours interval NPR < 4: 0 points, 4 ≤ NPR < 7: 1 point, NPR ≥ 7: 2 points	1-2 points
	Concomitant systemic narcotic use	1 point
	Concomitant IV-opioid PCA use	2 points
	Major EA complication (LAST, epidural hematoma, neurological deficit, infection, spinal anesthesia, subdural spread)	3 points
	Unexplained reversible neuro deficit with motor or sensory block	1 point
	Premature removal or replacement of EA catheter or need for another regional block	3 points
	Partial/patchy sensory loss	1 point

Table 1- Clinical criteria for grading the failure rate of the Epidural Analgesia

METHODS

- Data Collection:** Retrospective chart review (IRB #2023P003125) at a tertiary hospital, including patients receiving thoracic or lumbar EA between January 1, 2022, and September 1, 2024.
- Inclusion Criteria:** Adult patients (≥18 years) who received thoracic or lumbar epidural catheters for postoperative analgesia between May 2017 and September 2024.
- Exclusion Criteria:** Pregnancy, other regional analgesia techniques, multiple surgeries in one admission, opioid use disorder, cardiac surgery, pos-op intubation, or history of spine pathology.
- Outcome Classification:** Developed a novel scoring system categorizing EA outcomes into success (score = 0), partial success (score = 1-2), and failure (score >2), based on the following factors :
 - Statistical Analysis:**
 - Internal consistency measured using Cronbach's alpha and McDonald's omega.
 - Linear regression assessed the impact of EA outcomes on hospital length of stay (HLOS).
 - Cost analysis and opioid consumption comparisons were performed between groups by Non-parametric Kruskal-Wallis test.

RESULTS

- Patient Distribution:** Among 1,425 patients, 329 (23%) were classified as Successful, 718 as Partially Successful(50%), and 378 (27%) as Failure. Demographic and key outcomes are reflected in Table 2
- Reliability Metrics:**
 - Cronbach's alpha = 0.45
 - McDonald's omega = 0.52
- Hospital Outcomes:**
 - The Failure group had a significantly longer HLOS compared to the Successful group ($\beta = 1.02$, $p < 0.05$) and the Partially Successful group ($\beta = 0.8$, $p < 0.05$).
 - No significant HLOS difference between Successful and Partially Successful groups ($\beta = 0.24$, $p = 0.26$).
- Costs and Opioid Consumption:**
 - The Failure group incurred higher hospitalization costs and greater morphine equivalent consumption than the other groups.
 - No significant differences in out-of-bed time or hypotension between groups.

Association of surgical outcomes and epidural analgesia efficacy, a scoring analysis of success, partial success, and failure epidural analgesia

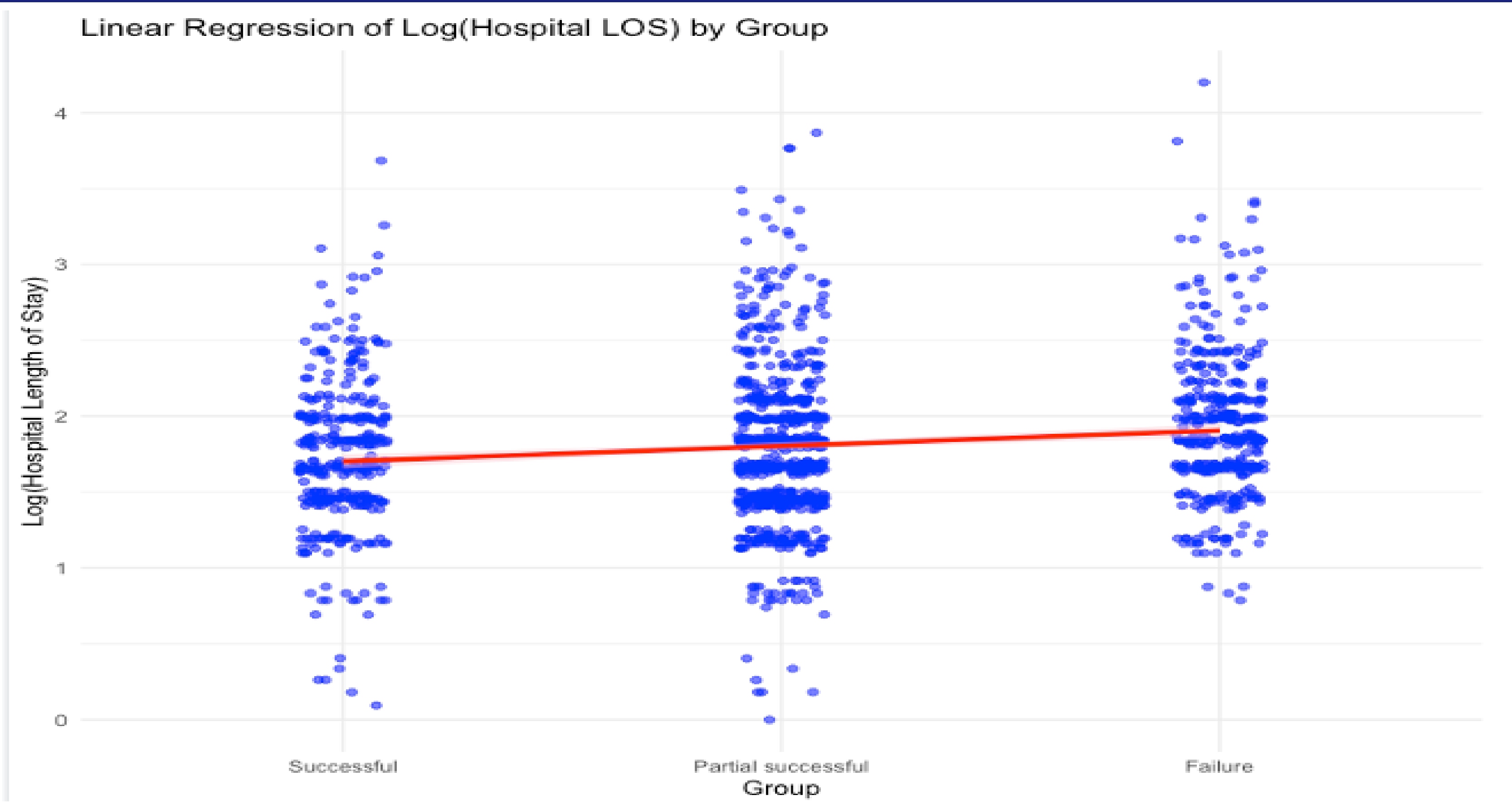


Figure 1 illustrates the linear regression of the log-transformed hospital length of stay (LOS) by group: Successful, Partial Successful, and Failure. The Failure group exhibited a significantly longer mean hospital LOS than the Successful group ($\beta = 1.02$, $p < 0.05$), with mean LOS values of 7.87 ± 5.56 days and 6.43 ± 3.89 days, respectively. No significant difference was observed between the Partial Successful (mean LOS: 6.86 ± 4.74 days) and Successful groups ($\beta = 0.24$, $p = 0.26$). The regression line demonstrates the positive association between reduced epidural success and prolonged hospital stays.

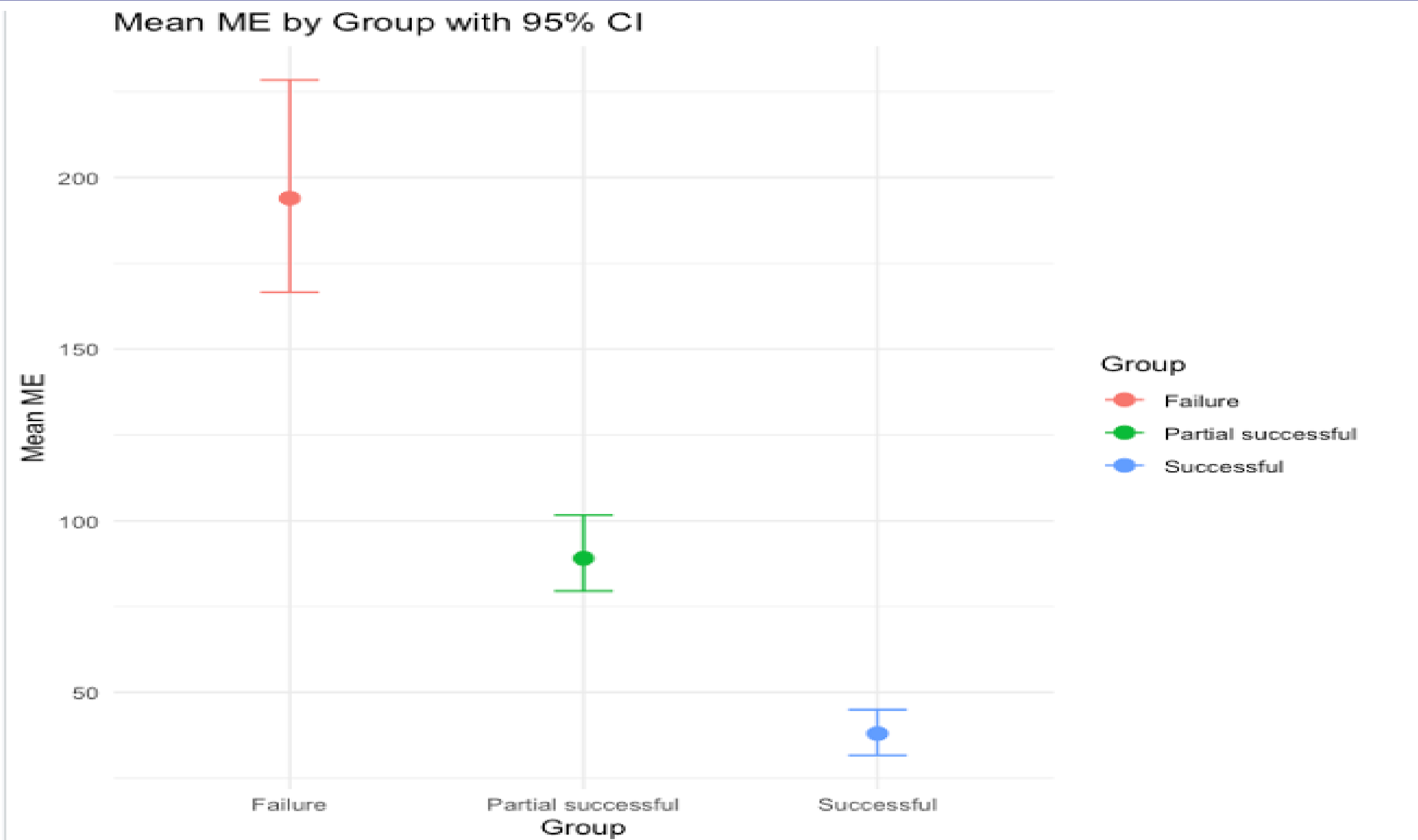


Figure 1 depicts the mean total oral morphine equivalents (OMEs) consumption during admission with 95% confidence intervals (CI) for the three patient groups: Successful, Partial Successful, and Failure. The Failure group demonstrated significantly higher OMEs consumption (mean 194.0 mg; 95% CI: 163.0–225.0) compared to the Partial Successful (mean 89.0 mg; 95% CI: 78.3–99.7) and Successful (mean 38.0 mg; 95% CI: 31.3–44.7) groups ($p < 0.001$). This stepwise increase highlights a substantial gradient in opioid usage associated with less favorable epidural outcomes.

Variable	Successful	Partial Successful	Failure
Age (mean±SD)	63.2 ± 14.5	60.8 ± 14.4	58.7 ± 15.1
BMI (mean±SD)	26.7 ± 5.2	27.4 ± 5.6	27.1 ± 5.9
ASA Classification (%)	1: 2; 2: 27; 3: 68; 4: 3	1: 2; 2: 27; 3: 67; 4: 4	1: 1; 2: 26; 3: 66; 4: 6
Thoracic Epidural Analgesia (n)	315	684	359
Lumbar Epidural Analgesia (n)	14	34	19
Number of Attempts (mean±SD)	1.4 ± 0.7	1.5 ± 0.7	1.5 ± 0.7
Procedure Length in minutes (mean±SD)	249.4 ± 130.7	263.3 ± 122.7	287.7 ± 129.0
LOS in days (mean±SD)	6.43 ± 3.89	6.86 ± 4.74	7.87 ± 5.56
Cost US Dollars (mean (95%CI))	19,446 (18,169–20,723)	20,750 (19,701–21,800)	23,799 (22,099–25,499)
Oral Morphine Equivalents (mean (95%CI))	38.0 (31.3–44.7)	89.0 (78.3–99.7)	194.0 (163.0–225.0)

Table 2 presents the demographic characteristics and key outcome measures for patients stratified into three groups: Successful, Partial Successful, and Failure. Demographic variables include age, BMI, ASA classification, number of attempts for epidural placement, and procedure length. Outcome measures comprise mean length of hospital stay (LOS) with standard deviation (SD), hospitalization costs in USD with 95% confidence intervals (CI), and opioid consumption quantified as oral morphine equivalents (OMEs) with 95% CI.

DISCUSSION

This study is the first to introduce a structured, point-based scoring system that classifies epidural analgesia (EA) outcomes into success, partial success, and failure. The findings reveal that EA failure is significantly associated with longer hospital length of stay (LOS), higher opioid consumption, and increased costs. Patients in the failure group had a mean LOS of 7.87 days, significantly longer than the partially successful (6.86 days) and successful (6.43 days) groups. Opioid use followed a stepwise increase, with the failure group consuming nearly double the morphine equivalents of the partial success group and five times that of the success group. The scoring system showed moderate internal consistency (Cronbach's alpha = 0.45, McDonald's omega = 0.52), indicating the need for further refinement while capturing key clinical dimensions of EA performance.

Despite the clear impact of EA failure on LOS and opioid use, no significant differences were observed in time to ambulation or hypotension rates, suggesting that suboptimal EA does not necessarily impair early mobilization or hemodynamic stability. The strong association between EA failure and increased resource utilization underscores the importance of early failure detection and intervention. Future efforts should refine this scoring system to improve predictive accuracy and integrate it into clinical practice, ensuring timely adjustments in analgesic management and optimizing patient outcomes.

Our study's findings are well-supported by existing literature. McLeod et al. reported epidural failure rates of approximately 20%, with 13% due to technical failure, reinforcing the need for a precise scoring system to classify outcomes. Groen et al.'s meta-analysis showed that epidural failures increase complications, length of stay, and opioid consumption, consistent with our results. Aloia et al. and Desai et al. also confirmed that successful epidurals reduce opioid use. However, Halabi et al. and Kone et al. noted that epidurals may prolong hospital stays and increase costs in some settings, supporting the need for a systematic approach to identify and manage epidural failure.

The criteria utilized within our grading system demonstrated strong internal consistency. This ongoing study has now expanded to include approximately 4,000 patients. The subsequent phase involves assessing both the internal and external validity of our grading system, followed by a comprehensive final analysis.

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