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## Improving timing of intravenous fluid bolus to reduce spinal-induced hypotension in elective cesarean sections: A quality improvement initiative

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### Abstract

**Background:** Spinal-induced hypotension (SIH) is a common complication during cesarean sections under spinal anesthesia, affecting maternal and fetal outcomes. Timing of intravenous (IV) fluid bolus administration may influence SIH incidence.

**Local Problem:** At our institution, IV fluid boluses were often administered 150.6 minutes before operating room (OR) entrance, potentially reducing effectiveness.

**Methods:** A literature review identified optimal IV fluid bolus timing within 20 minutes of spinal anesthesia. Labor and delivery nurses were educated on SIH physiology, evidence-based timing, and practice goals. Timing of IV bolus to OR entrance was recorded for one week pre- and post-intervention.

**Interventions:** Nurse in-service training on evidence based IV fluid bolus timing.

**Results:** Pre-intervention, mean time from IV bolus to OR entrance was 150.6 minutes (n=5). Post-intervention, it decreased to 17.7 minutes (n=3), an 88% reduction.

**Conclusions:** Nurse education improved adherence to evidence based IV fluid bolus timing, potentially reducing SIH risk. Ongoing data collection and annual in-services will sustain this practice change.

**Keywords:** Cesarean section, spinal-induced hypotension, IV fluid bolus, co-loading, quality improvement

### Introduction

#### Problem Description

Spinal-induced hypotension (SIH), defined as a systolic blood pressure <100 mmHg or a mean arterial pressure <80% of baseline, is a common complication of spinal anesthesia, occurring in 55–99% of cesarean deliveries <sup>[1, 2]</sup>. SIH can lead to maternal nausea, organ ischemia, and fetal hypoxia, posing significant risks during surgery. At our institution, a retrospective audit revealed that intravenous (IV) fluid boluses were administered an average of 150.6 minutes before operating room (OR) entry for elective cesarean sections. This prolonged interval likely reduces the effectiveness of fluid administration in preventing SIH, highlighting a critical practice gap.

#### Available Knowledge

Over 1.1 million cesarean sections are performed annually in the United States, with neuraxial anesthesia, particularly spinal anesthesia (subarachnoid block), preferred for its rapid onset and reliability <sup>[3, 4]</sup>. However, SIH remains a significant challenge, necessitating effective preventive strategies. Intravenous fluid administration, including preloading (fluids given before spinal anesthesia induction) and coload (rapid fluid infusion concurrently with or immediately following anesthesia), is widely used to mitigate SIH <sup>[6]</sup>. The timing of these interventions is critical to their hemodynamic benefits <sup>[7]</sup>.

A systematic literature review (PubMed, CINAHL, Cochrane Library, Google Scholar) addressed the PIOT question: “In parturients undergoing elective cesarean section, does a co-loaded IV fluid bolus, compared to a pre-loaded bolus, reduce the incidence of SIH?” A meta-analysis by Ni *et al.* <sup>[8]</sup> demonstrated that coload is more effective than preloading in reducing SIH incidence, emphasizing the importance of fluid administration in close temporal proximity to anesthesia induction. Recent studies further support optimized fluid

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strategies. Shang *et al.* [9] found that colloid preloading, when administered within 20 minutes prior to spinal anesthesia, significantly lowers SIH rates. Similarly, Hunie *et al.* [10] reported that combining preloading and coload, with fluids initiated within 20 minutes of anesthesia administration, enhances SIH prevention compared to either strategy alone. Additional evidence supports the efficacy of timely fluid administration. Williamson *et al.* [11] found that IV fluid boluses administered closer to spinal anesthesia induction reduced SIH incidence compared to earlier administration. Tawfik *et al.* [12] demonstrated that crystalloid coload was as effective as colloid preloading in preventing SIH, suggesting flexibility in fluid type when timing is optimized. These findings collectively suggest that IV fluid bolus, whether colloid or crystalloid, delivered within 20 minutes of spinal anesthesia induction, effectively minimizes SIH [8-12]. However, the optimal fluid type, volume, and precise timing require further investigation [13, 14].

### Rationale and Aims

Given the evidence supporting timely IV fluid bolus administration and the local practice gap of delayed fluid delivery (Average 150.6 minutes before OR entry), we hypothesized that targeted nurse education on evidence-based timing would improve adherence to best practices. This quality improvement (QI) project aimed to implement and evaluate a nurse education intervention to ensure IV fluid bolus administration within 20 minutes of OR entry for parturients undergoing elective cesarean sections, thereby reducing the incidence of SIH.

### Methods

#### Context

This project was conducted in the labor and delivery unit of a community hospital in Jacksonville, Florida performing approximately 140 cesarean sections annually. Standard practice involved IV fluid bolus administration before spinal anesthesia, but timing was inconsistent.

#### Intervention

A one-hour in-service was provided to 18 labor and delivery nurses, covering SIH physiology, evidence on IV fluid bolus timing (pre-load vs. co-load), and a goal to administer boluses within 20 minutes of OR entrance. The intervention was informed by a literature review and local baseline data showing delayed administration.

#### Study of the Intervention

We assessed the intervention's impact by comparing the time from IV fluid bolus administration to OR entrance pre- and post-in-service. The hypothesis was that education would reduce this interval, aligning with evidence-based timing.

#### Measures

The primary outcome was the time (in minutes) from IV fluid bolus initiation to OR entrance, recorded by the

assigned registered nurse (RN) via chart documentation. Data was collected for one week pre-intervention and one-week post-intervention.

### Analysis

Descriptive statistics (Mean, percentage reduction) were calculated using Excel. Percentage reduction was computed as [(pre-intervention mean – post-intervention mean) / pre-intervention mean] × 100. Due to the small sample size, statistical significance was not assessed.

### Ethical Considerations

As a QI project, formal ethical review was not required per institutional policy. No conflicts of interest were declared.

### Results

Pre-intervention, the mean time from IV fluid bolus to OR entrance was 150.6 minutes (n=5, SD unavailable). Post-intervention, after educating 18 nurses, the mean time decreased to 17.7 minutes (n=3, SD unavailable), an 88% reduction (Table 1). The small sample size was due to an unexpectedly low volume of scheduled cesarean deliveries during the three-week project period. No adverse events were reported.

### Discussion

#### Summary

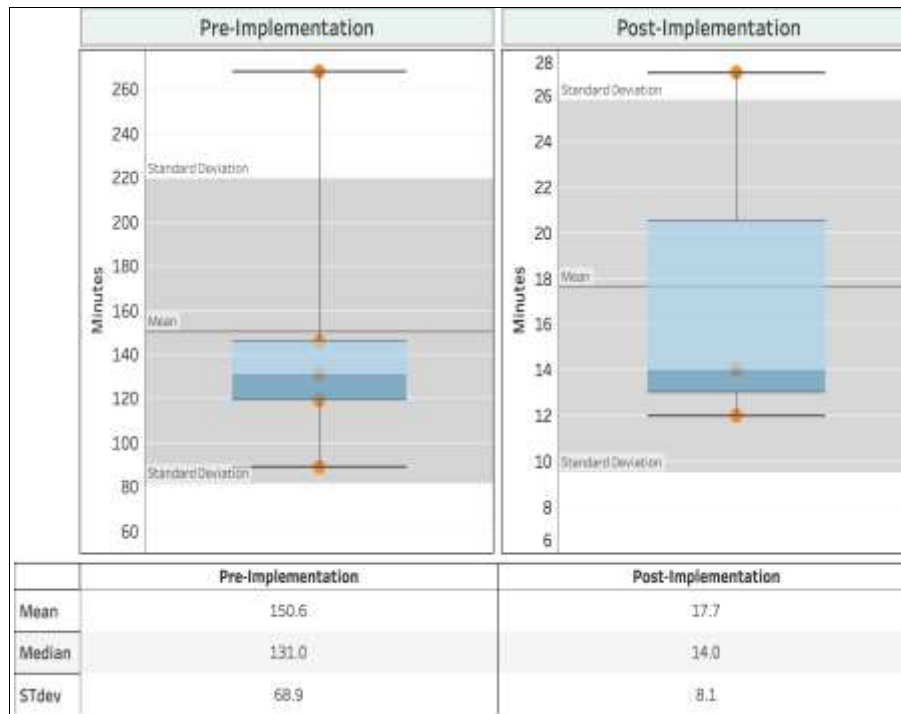
This QI project demonstrated that nurse education significantly reduced the time from IV fluid bolus administration to OR entrance, from 150.6 minutes to 17.7 minutes (88% reduction), aligning with evidence recommending administration within 20 minutes of spinal anesthesia [7-11].

#### Interpretation

The findings support the effectiveness of education in improving adherence to evidence-based practice, consistent with studies linking timely fluid administration to reduce SIH [7, 8, 12, 14]. Although SIH incidence was not directly measured, the improved timing likely enhances anesthesia care quality, potentially reducing maternal and fetal complications [2, 15]. Nurse education is a feasible, low-cost intervention that can address practice gaps in community hospitals with limited resources. The 20-minute target aligns with studies showing that coload or timely preloading maintains intravascular volume during spinal anesthesia-induced vasodilation [9, 10, 16].

#### Limitations

Limitations include a small sample size (n=5 pre-intervention, n=3 post-intervention) due to low cesarean volume, precluding statistical significance testing. SIH incidence and clinical outcomes (e.g., nausea, ephedrine use) were not measured, limiting conclusions about direct patient impact. Unmeasured confounders, such as OR scheduling changes, may have influenced results. The intervention's short duration (3 weeks) limits insights into long-term sustainability.

**Table 1:** Comparison of IV Fluid Bolus Timing Relative to Operating Room (OR) Entrance Before and After Educational Intervention

### Conclusions

Nurse education is a feasible strategy to improve IV fluid bolus timing, potentially reducing SIH risk in cesarean sections. To sustain this practice, in-services will be integrated into the annual skills fair, with ongoing monthly data collection to monitor adherence. Future studies should evaluate clinical outcomes (e.g., SIH incidence, neonatal Apgar scores) with larger samples and longer follow-up, incorporating additional strategies like vasopressor use or non-invasive monitoring to optimize SIH prevention [17, 18].

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