

# Thresholds for Spinal Anaesthesia-induced Hypotension During Caesarean Section

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## ABSTRACT

### Background

Spinal anaesthesia is the current standard for caesarean section. Hypotension, a common complication, potentially results in adverse foetal and maternal outcomes. However, hypotension-defining criteria are varied.

### Objective

To identify the blood pressure thresholds for spinal anaesthesia-induced hypotension during caesarean section.

### Method

This is a retrospective cohort study of spinal anaesthesia-induced hypotension that occurred till baby-delivery during caesarean section. Reports on intraoperative hypotension, collected previously from January to December 2019, were reviewed to identify the hypotension-defining thresholds. The thresholds were categorized into systolic blood pressure (SBP) of 80, 90 or 100 mmHg, mean arterial pressure (MAP) of 60, 65 or 70 mmHg, combinations, and others. Parturient and anaesthesia characteristics, and associated hypotensive symptoms were also recorded for descriptive analysis.

### Result

Spinal anaesthesia-induced hypotension was identified in 129 (11.5%) cases among 1116 caesarean sections. Altogether, 12 hypotension-defining thresholds were employed. Thresholds of SBP 90, MAP 60, and SBP 80 mmHg were used in 53 (41%), 28 (21.7%), and 21 (16.2%) cases respectively. Mean maternal age was 28 ( $\pm 4.22$ ) years and 87 (67.4%) cases underwent emergency surgery. Median sensory blockade level was T4. Nausea-vomiting, bradycardia, and tachycardia were associated during five (3.8%), six (4.6%), and 15 (11.6%) hypotensive incidents respectively. Two cases had unrecordable blood pressure but there was no maternal mortality.

### Conclusion

Systolic blood pressure of 90 mmHg and mean arterial pressure of 60 mmHg included the most common thresholds for spinal anaesthesia-induced hypotension during caesarean section. Identifying the safe and clinically relevant hypotension-defining criteria needs further investigation.

## KEY WORDS

*Caesarean section, Criteria, Definition, Hypotension, Spinal anaesthesia, Threshold*

## INTRODUCTION

Spinal anaesthesia (SA), for its efficiency and safety, is the technique of choice for caesarean section (CS). However, hypotension, the inherent complication and its serious negative impact on maternal and foetal outcomes are ever possible.<sup>1-4</sup> The incidence of hypotension with SA ranges between 7% and 74% depending on the definition chosen.<sup>5-7</sup>

Various thresholds, based on absolute or relative values of systolic blood pressure (SBP) and mean arterial pressure (MAP), have been considered for defining hypotension. Reduction of SBP at a range between 10% and 30% relative to the baseline value comprise the most commonly used hypotension-defining criteria during obstetric SA.<sup>5</sup> Maintaining the SBP at or more than 90% of its baseline during CS was recommended by a 2018 consensus statement.<sup>8</sup> More recently, absolute thresholds of SBP at 90 mmHg or MAP at 65 mmHg have been proposed for resource-limited settings.<sup>9</sup> However, there is no clear understanding of criteria defining hypotension during CS in our population.

The current study aims to identify the blood pressure (BP) thresholds for SA-induced hypotension during CS by reviewing the registry of reports on hypotension that were collected over the calendar year 2019.

## METHODS

This is a retrospective cohort study of reports on SA-induced hypotension occurring during CS, which were collected from January to December 2019 in the operating rooms of a teaching hospital from Nepal. Approval was obtained from the Institutional Review Committee of the hospital and written informed consent were taken from each parturient.

The study was designed to identify the BP thresholds used for defining hypotension during CS performed under SA. Hypotension in the parent study, from which the eligible reports were retrieved, was defined as a reduced BP requiring corrective medications.<sup>10</sup> Reports were submitted voluntarily by Anesthesiology residents involved in the anaesthetic management of the parturient. Only the reports that mentioned the threshold BP before administering vasopressors were included. Exclusion criteria comprised of repeated SA, and administration of epidural or general anaesthesia before the hypotension occurrence. Hypotension that existed before SA and that occurred after the time of baby-delivery were also excluded. The number of episodes of hypotension was not recorded to avoid the repetition bias.

For each included report, the threshold BP was categorized into SBP of  $\leq 80$ ,  $\leq 90$ ,  $\leq 100$  or  $> 100$  mmHg; MAP of  $\leq 60$ ,  $\leq 65$ ,  $\leq 70$  or  $> 70$  mmHg; any of their combinations; and others. These groupings were chosen based on a previous

study.<sup>9</sup> The values were recorded as they were mentioned in the reports; no derivations and calculations were performed. Maternal symptoms that appeared during hypotension were recorded. Bradycardia (heart rate  $< 60$ /min) and tachycardia (heart rate  $> 100$ /min) that occurred before administering vasopressors were also recorded.

Parturient characteristics included her age, American Society of Anesthesiologists physical status and co-morbidities. Surgical urgency was recorded as an elective or emergency. Information on SA included the agent (type and amount) used and the highest level of sensory blockade attained.

Data are presented as mean (standard deviation) for continuous normally distributed variables; median and range for data not normally distributed; and frequency (percent) for categorical variables. The BP thresholds are grouped and presented as number (percent), and sub-group comparisons were performed for the maternal symptoms.

## RESULTS

Among 1116 caesarean sections performed under SA during the study period, altogether 175 (15.68%) reports on maternal hypotension that required vasopressor was collected. Sixteen reports did not mention the threshold value and hypotension occurred after baby-delivery in 26 cases and were excluded from further analysis. One case with repeated SA and three cases in whom general anaesthesia was co-administered were also excluded. In total, 129 cases (11.55%) of SA-induced hypotension were identified and included for the final analysis.

Apart from two cases in whom BP was reported to be unrecordable, altogether 12 different definitions for hypotension were utilized. The hypotension-defining criteria were based on absolute SBP thresholds in 82 (63.56%), absolute MAP thresholds in 37 (28.68%), and their combinations in eight (6.2%) cases. The most commonly used threshold was SBP of 90 mmHg (Table 1).

Maternal age ranged between 19 and 39 years. Thirty-one women (24.03%) possessed at least one co-morbidity; the most common co-morbidities comprised of gestational diabetes mellitus and hypothyroidism (Table 2). For SA, hyperbaric bupivacaine 0.5% was the exclusively used agent. Its volume was 2.2 ml in 127 (98.44%) cases with a mean of 2.197 ( $\pm 0.02$ ) ml. Median sensory blockade level attained with SA was at the fourth thoracic (T4) dermatome, with the range between T7 and T1. The blockade reached higher than the T5 level in 107 (82.94%) cases and was higher than the T4 level in 53 (41.08%) cases.

During hypotension, at least one symptom was associated in 13 (10.07%) cases; the most common being nausea-vomiting (Table 3). Sub-group analyses among the parturients who manifested symptoms showed that six

**Table 1. Thresholds for defining hypotension**

Group	Definition criteria	n (%)
SBP (mmHg)	≤ 80	21 (16.27)
	81 to 90	53 (41.08)
	91 to 100	7 (5.42)
	> 100	1 (0.77)
MAP (mmHg)	≤ 60	28 (21.7)
	61 to 65	7 (5.42)
	66 to 70	2 (1.55)
Combinations (mmHg)	SBP ≤ 80 + MAP ≤ 60	1 (0.77)
	SBP ≤ 80 + MAP ≤ 65	1 (0.77)
	SBP ≤ 90 + MAP ≤ 60	4 (3.1)
	SBP ≤ 90 + MAP ≤ 65	1 (0.77)
	SBP ≤ 100 + MAP ≤ 65	1 (0.77)
Others	Unrecordable BP	2 (1.55)

SBP=systolic blood pressure, MAP=mean arterial pressure, BP=blood pressure

**Table 2. Characteristics of parturients**

Variable	Stratum	n (%)
Mean age (SD) years		28 (4.22)
ASA physical status	II	125 (96.89)
	III	4 (3.1)
Co-morbidity*	None	98 (75.96)
	Gestational diabetes mellitus	17 (13.17)
	Hypothyroidism	10 (7.75)
	Chronic hypertension	2 (1.55)
	Pregnancy-induced hypertension	1 (0.77)
	Gestational thrombocytopenia	1 (0.77)
	Obstetric cholestasis	1 (0.77)
	Chronic idiopathic urticaria	1 (0.77)
	Obesity	1 (0.77)
	Anaemia	1 (0.77)
Surgical urgency	Elective	42 (32.55)
	Emergency	87 (67.44)

SD=standard deviation, ASA=American Society of Anesthesiologists, \*single patient may have multiple co-morbidities

**Table 3. Maternal symptoms**

Symptom*	n (%)
Nausea	4 (3.1)
Vomiting	1 (1.55)
Dyspnoea	3 (2.32)
Dizziness	2 (1.55)
Restlessness	3 (2.32)
Sweating	3 (2.32)

\*single patient may have multiple symptoms

(46.15%) cases belonged to the SBP 80 mmHg group, two cases each (15.38%) to the SBP 90 mmHg, MAP 60 mmHg and the unrecordable groups, and a case (7.69%) to the MAP 70 mmHg group. During the incident, 15 (11.62%) cases had tachycardia, whereas six (4.65%) cases had bradycardia.

One case undergoing elective CS complained of dyspnoea two minutes after laying supine following SA. Sensory blockade level was at T4. She became restless, heart rate dropped to 42/min, and her BP was unrecordable. Another case with co-existing hypothyroidism had sensory blockade level of T3 during elective CS. She complained of dizziness when her heart rate dropped precipitously from 82 down to 39/min, with the BP being unmeasurable. All of the cases recovered well and there was no reported maternal mortality in the cohort.

## DISCUSSION

This retrospective analysis of reports on hypotension during CS under SA showed that 12 different hypotension-defining BP thresholds were in use. Only the absolute values were utilized, with an SBP threshold of 90 mmHg being the most common, followed by the MAP threshold of 60 mmHg.

Hypotension due to SA-induced sympatholysis is a well-known entity. Higher sensitivity to local anaesthetics, aortocaval compression and an increased basal sympathetic nervous tone in the last trimester of pregnancy render obstetric population at an added risk, despite using a relatively smaller amount of spinal anaesthetic agent.<sup>11-14</sup> Maternal symptoms including nausea-vomiting, dyspnoea and altered consciousness might manifest with the decrement in perfusion pressures.<sup>4,15</sup> More seriously, foetal circulation may get compromised, especially when the foetus is preterm or already compromised, and if maternal hypotension is intense or sustained.<sup>1-3</sup> Nonetheless, the exact BP value up to which the foetal jeopardy can be prevented is still uncertain, as numerous factors hinder in designing randomized studies to resolve the issue. This explains for the varying patterns to define and treat hypotension, emphasized also by the 12 thresholds observed in our study. Similar to our finding, Klohr et al. revealed 15 different definitions across 63 publications on hypotension during obstetric SA.<sup>5</sup> This variation exists even in non-obstetric population; one systematic review found 140 definitions from 130 articles.<sup>6</sup>

An SBP of 90 mmHg included the most common threshold used in our cohort. This threshold has also been utilized in other landmark studies.<sup>16,17</sup> The finding also compares to a survey, revealing an SBP of either 100 or 90 mmHg as the preferred threshold among obstetric anaesthesiologists from the UK.<sup>7</sup> Our cohort similarly comprised of 46% cases falling in between the SBP thresholds of 100 and 90 mmHg. Although the overall incidence of maternal symptoms in our cohort was low (10%), the subgroup analyses

suggested that none of the cases showed symptoms at an SBP greater than 90 mmHg. This finding also lends support for 90 mmHg SBP as a suitable threshold in our obstetric population.

The exclusive use of absolute thresholds in our cohort contrast with the 2018 consensus statement, which recommends a relative SBP threshold of 90% or more from the actual baseline during CS under SA.<sup>8</sup> However, except for the research settings, determining the true baseline value is difficult, since a consensus definition is still lacking. Baseline measurements are also liable to fallacies, especially for the anxious parturients in labour and for those undergoing emergent surgeries. Similarly, calculating the relative values for each parturient is not always practical. In addition, a retrospective study on non-cardiac surgeries has shown that absolute and relative thresholds are equally able to discriminate patients with myocardial or kidney injury from those without.<sup>18</sup> Emphasizing these evidences, a recent study recommended instituting vasopressors during the obstetric SA at absolute thresholds of either SBP 90 mmHg or MAP 65 mmHg for the resource-limited settings.<sup>9</sup> The former criteria matched with the most common threshold (41%) used in our cohort.

MAP threshold of 60 mmHg, the second most common hypotension-defining criteria observed in our cohort, does not correspond to any of the previous similar studies. Except for initial animal studies, which suggested that uteroplacental blood flow remains relatively constant at perfusion pressures of more than 60 mmHg, the evidence is minimal for clinically relevant MAP thresholds during obstetric SA.<sup>19</sup> However, the recent trend for using absolute MAP targets for the non-obstetric population is on the rise. The MAP targets of 60 and 65 mmHg respectively were shown to be appropriate in preventing kidney and myocardial injury for intensive care and non-cardiac surgical patients.<sup>18,20</sup> A 2014 guideline for patients with circulatory shock recommended a MAP target of 65 mmHg or more.<sup>21</sup> And, evidence suggests that even short intraoperative periods below a MAP of 55 mmHg are significantly associated with myocardial and kidney injury.<sup>22</sup> On this background, Zwane et al. have proposed a MAP threshold of 65 mmHg during CS under SA.<sup>9</sup> Their value was higher compared to our second most common threshold of 60 mmHg MAP. The minimal occurrence of maternal symptoms at a MAP of more than 60 mmHg might infer that assigning this threshold is reasonable for our obstetric population, but it merits further investigation.

Hypotension is categorized as severe when SBP measures below 80 mmHg.<sup>23,24</sup> And hence, 16% of our cases received vasopressors only after suffering severe hypotension. Among the cases showing hypotensive symptoms, the bulk (46%) belonged to the SBP 80 mmHg group, which mandates an improved practice in not letting BP drop to this level. This strategy might prove advantageous because a timely intervention would not only prevent symptoms

but also potentially avoid a precipitous and catastrophic BP drop. Still, sudden maternal collapse is possible, secondary to bradycardic reflexes such as Bezold-Jarisch reflex or a rapidly ascending spinal blockade, which we must be prepared for.<sup>8,11,13</sup> Two cases in our cohort with predominant bradycardia and unrecordable BP emphasize the same.

Definitions utilized and factors relating to the patient, anaesthesia and surgery contribute to the varying incidence of hypotension and diverse management strategies. We excluded the cases occurring after baby-delivery, aiming to avoid the confounding effects of oxytocics, anxiolytics, sedatives, analgesics and the ongoing blood loss. Also, preferred BP thresholds might differ for the same parturient, between before and after the baby-delivery. No parturient was excluded based on co-morbidities or surgical urgency, which can be considered a strength of the study in terms of generalizability of the findings. But this might also be a limiting factor since sticking to a single definition for all concerned may not be appropriate, especially the hypertensive and obese parturients who necessitate different considerations. Many have advocated for the prophylactic strategies against hypotension during obstetric SA.<sup>8,25</sup> For improving maternal comfort and safety, we believe that the reactive approach seems practicable only with the use of absolute thresholds above which poor outcomes are unlikely. We recommend large multi-centred trials to identify the BP thresholds which are clinically relevant and simple to use.

There are certain limitations to our study. The findings including the incidence of hypotension must only be carefully interpreted; since the anaesthetic management was not protocol-based, and as the reporting were voluntary. More importantly, unstandardized equipment and non-uniform intervals for BP measurements might have influenced the results. Finally, incomplete data, as are common in retrospective studies, limited us from analyzing the risk factors for hypotension, the exact time point for hypotension occurrence, the treatment approach, and the nature of the neonatal outcome.

## CONCLUSION

Retrospective analysis of practice pattern at a single institute showed a wide variation in the choice of blood pressure thresholds to define spinal anaesthesia-induced hypotension for initiating vasopressor therapy during caesarean sections. Only the absolute values of systolic blood pressure and mean arterial pressure were utilized. The most common thresholds included a systolic blood pressure of 90 mmHg and a mean arterial pressure of 60 mmHg. Studies are needed to assess how we can replicate the approach in different settings, as are large trials to examine the impact on maternal and foetal outcomes.

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