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Original Research Article

Positional changes in blood pressure and heart rate as a predictor of post-spinal hypotension in patients undergoing elective caesarean section: An observational study

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Abstract

Background: The most widely used anaesthesia technique for caesarean section is spinal anaesthesia, however hypotension is the most frequent complication of spinal anaesthesia in pregnant patients. This study was designed to evaluate whether or not the changes in blood pressure and heart rate obtained prior to spinal anesthesia in different positions, would be useful to predict a subset of pregnant patients that might be at high risk for post spinal hypotension.
Aim: To record the positional changes in blood pressure and heart rate in patients undergoing elective caesarean delivery and to study the correlation of positional changes in blood pressure and heart rate with post spinal hypotension in these patients.
Methods: The study was conducted at Lalla Ded Hospital which is an associated hospital of Government Medical College, Srinagar. Total number of patients studied was 65 who were term parturient (≥37 weeks gestation) with singleton pregnancy. Patients with multiple pregnancy or with preexisting diseases like hypertension, preeclampsia, eclampsia, diabetes, cardiovascular, renal, hepatic or thyroid diseases were excluded from the study. In this study the changes in the systolic, diastolic, mean arterial pressure and heart rate in various positions (supine, right lateral, and sitting) was measured. Then, the patients underwent spinal anesthesia for caesarean section and again the systolic and diastolic blood pressures, mean arterial pressure and heart rate were measured and recorded.
Results: Positional change (Right lateral-Supine) in Systolic Blood Pressure, Diastolic blood Pressure, MAP and Heart Rate in Hypotensive and non-hypotensive groups was statistically significant (P-value < 0.05). Positional change (Sitting-Supine) in Systolic Blood Pressure and Heart Rate in Hypotensive and non-hypotensive groups was statistically significant (P-value < 0.05) whereas the positional change (Sitting-Supine) in Diastolic Blood Pressure and

MAP was statistically insignificant with P-values 0.177 and 0.60 respectively.
Conclusion: Higher the blood pressure and heart rate variation in different positions (supine/sitting and lateral), the higher the probability of post spinal hypotension. The blood pressure and Heart rate variation in the lateral position from base line (supine) is statistically more significant than sitting position.

Keywords: Spinal anesthesia, hypotension, positional changes, bupivacaine, ephedrine

Introduction

Caesarean section is the most frequently performed obstetric surgical procedure worldwide with an estimated twenty three million procedures carried out each year [1]. It may be accomplished either under general or neuraxial anesthesia (i.e. spinal anesthesia, combined spinal-epidural anesthesia and epidural anesthesia). General anaesthesia for caesarean section entails the risk of life-threatening complications such as difficult airway management and aspiration pneumonia and it is therefore recommended that it be avoided whenever possible in favour of neuraxial anaesthesia [2]. Neuraxial anesthesia is the preferred technique, and is used for >95 percent of caesarean deliveries worldwide. The most common complication of spinal anaesthesia in pregnant patients is hypotension, with incidence of up to 80% despite fluid preload, lateral uterine displacement and use of vasopressors [3, 4, 5]. Neuraxial anesthesia-induced sympathetic blockade causes vasodilation and decrease in venous return to the heart, which can result in maternal hypotension [6]. Therefore many methods have been advocated for preventing and treating hypotension in obstetric anaesthesia like careful positioning with left uterine displacement, volume preloading with crystalloids or colloids and prophylactic phenylephrine or ephedrine administration [7].

Material and Methods

After taking approval from Institution Ethical Committee, the present study was conducted in Department of Anaesthesia and Critical Care at Government Medical College, Srinagar (Lalla Ded Hospital) from July 2018 to June 2020. Total number of patients studied was 65.

Methodology: Informed written consent was obtained from the included patients. Intravenous access was gained using an 18-G cannula in the right forearm. Electrocardiography and pulse oximetry was monitored. The cuff of an automated noninvasive blood pressure device was attached to the left arm. Patient in the supine position with wedge under the right buttock, blood pressure (systolic, diastolic and mean arterial pressure) and heart rate was measured 3 times at 1-minute intervals. The average value of the second and third mean blood pressure readings was recorded as the baseline value. After changing to the right lateral position, blood pressure and heart rate was measured twice and averaged. The positional blood pressure change between lateral and supine positions (BPlateral-BPSupine) was recorded. Likewise average of the heart rate in the supine and lateral position was noted and the difference between them was recorded (HRlateral-HRsupine). Before administering spinal anaesthesia, hemodynamic parameters were again noted in this sitting position and the difference between blood pressure in the sitting and supine positions (BPsitting-BPsupine) were noted. Also average heart rate in sitting position were noted and any change from that of supine heart rate (HRsitting-HRsupine) were also recorded at the same time.
Spinal anesthesia was induced in the sitting position at the L3-L4 interspace with 0.5% hyperbaric bupivacaine 3 ml through a 25G Quincke needle. Immediately after giving spinal we coloaded with 15 ml/kg of Ringers Lactate. Oxygen (5 L/min) was supplied via facemask.

After the intrathecal injection, blood pressure and heart rate was measured every two minutes for first 10 minutes and every five minutes thereafter until completion of surgery.
Hypotension was defined as MAP < 80% of the baseline value and it was treated with ephedrine 5 mg IV bolus. If hypotension persisted or reoccurred, additional ephedrine 5 mg was administered at 2-minute intervals. The total amount of administered ephedrine was recorded. Bradycardia (Heat rate <50 bpm) was recorded and treated with 0.3mg bolus of atropine IV. Uppermost dermatomal levels of anaesthesia (Block height) was assessed by pinprick test at 2 minute intervals. Neonatal APGAR scores at 1 and 5 minutes were recorded.

Statistical method

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then analyzed using SPSS Version 23.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean ± SD and categorical variables were summarized as frequencies and percentages. Graphically the data was presented by bar diagrams and line diagrams. A P-value of less than 0.05 was considered statistically significant. All P-values were two tailed.
Blood pressure and heart rate changes over time were analyzed with a repeated-measures analysis of variance (ANOVA). Baseline hemodynamic variables were compared between parturient who developed hypotension (hypotension group) and those who did not (no hypotension group) by the unpaired t-test. Positional changes in hemodynamic variables were also compared between parturient who developed hypotension and those who did not by the unpaired t-test.

Conflict of interest: Nil.

Funding: Nil.

Results

Total number of patients studied was 65 who were term parturient (≥37 weeks gestation) with singleton pregnancy. 5 patients were excluded because of either repeated spinal anaesthesia or conversion to general anaesthesia.
The demographic profile of the study population given in (Table 1).

Table 1: Demographic profile of the study population

Variable	Mean	SD	Range
Age (years)	28.8	3.73	20-40
Height (cm)	165.22	4.02	155-175
Weight (kg)	69.46	3.89	60-80
BMI (kg/m2)	25.44	1.07	22-30

Mean of Systolic BP, Diastolic BP, MAP and Heart Rate in Right lateral position was (131.94±10.03), (84.17±7.81), (99.77±7.78) and (103.85±15.03) respectively and was higher than in Sitting (124.83±10.10), (78.57±7.52), (93.55±7.67) and (98.86±10.77) and Supine position (119.83±11.39), (75.83±9.029), (90.20±9.16) and (94.55±11.22). The statistical difference was significant (p value <0.001). Out of 65 study patients, 46 (70.77%) had post spinal hypotension whereas in 19 (29.23%) patients hypotension was absent.

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Table 2: Hemodynamic Data in Different Positions in Hypotensive and Non Hypotensive Groups

Position	Hypotension	n	Mean ± SD	P-value
Supine systolic blood pressure (mmHg)	YES	46	116.26±10.184	<0.001
	NO	19	128.47±9.536	
Supine Diastolic blood pressure (mmHg	YES	46	73.83±8.322	<0.004
	NO	19	80.68±9.031	
Supine mean arterial pressure (mmHg)	YES	46	87.67±8.273	<0.001
	NO	19	96.32±8.453	
Supine heart rate (b/minute)	YES	46	100.11±7.493	<0.001
	NO	19	81.11±6.136	
Right lateral systolic blood pressure (mmHg)	YES	46	132.70±10.445	0.348
	NO	19	130.11±8.962	
Right lateral diastolic blood pressure (mmHg)	YES	46	85.39±7.443	0.049
	NO	19	81.21±8.087	
Right lateral mean arterial pressure (mmHg)	YES	46	100.83±7.625	0.089
	NO	19	97.21±7.764	
Right lateral heart rate (b/minute)	YES	46	111.78±9.131	<0.001
	NO	19	84.63±6.693	
Sitting systolic blood pressure (mmHg)	YES	46	122.33±9.548	<0.001
	NO	19	130.89±8.962	
Sitting diastolic blood pressure (mmHg)	YES	46	77.22±6.716	0.023
	NO	19	81.84±8.513	
Sitting mean arterial pressure (mmHg)	YES	46	91.80±6.901	0.003
	NO	19	97.79±7.962	
Sitting heart rate (b/minute)	YES	46	103.26±8.288	<0.001
	NO	19	88.21±8.496	

Supine and Sitting systolic blood pressure in hypotensive and non-hypotensive group is statistically significant (P-value <0.05).

Right lateral systolic blood pressure in hypotensive and non-hypotensive groups is statistically not significant (P-value=0.348).

(Supine, Right lateral and Sitting) diastolic blood pressure in hypotensive and non-hypotensive group is statistically significant (P-value < 0.05). Supine and Sitting MAP (mean arterial pressure) in hypotensive and non-hypotensive group is statistically significant (P-value <0.05).

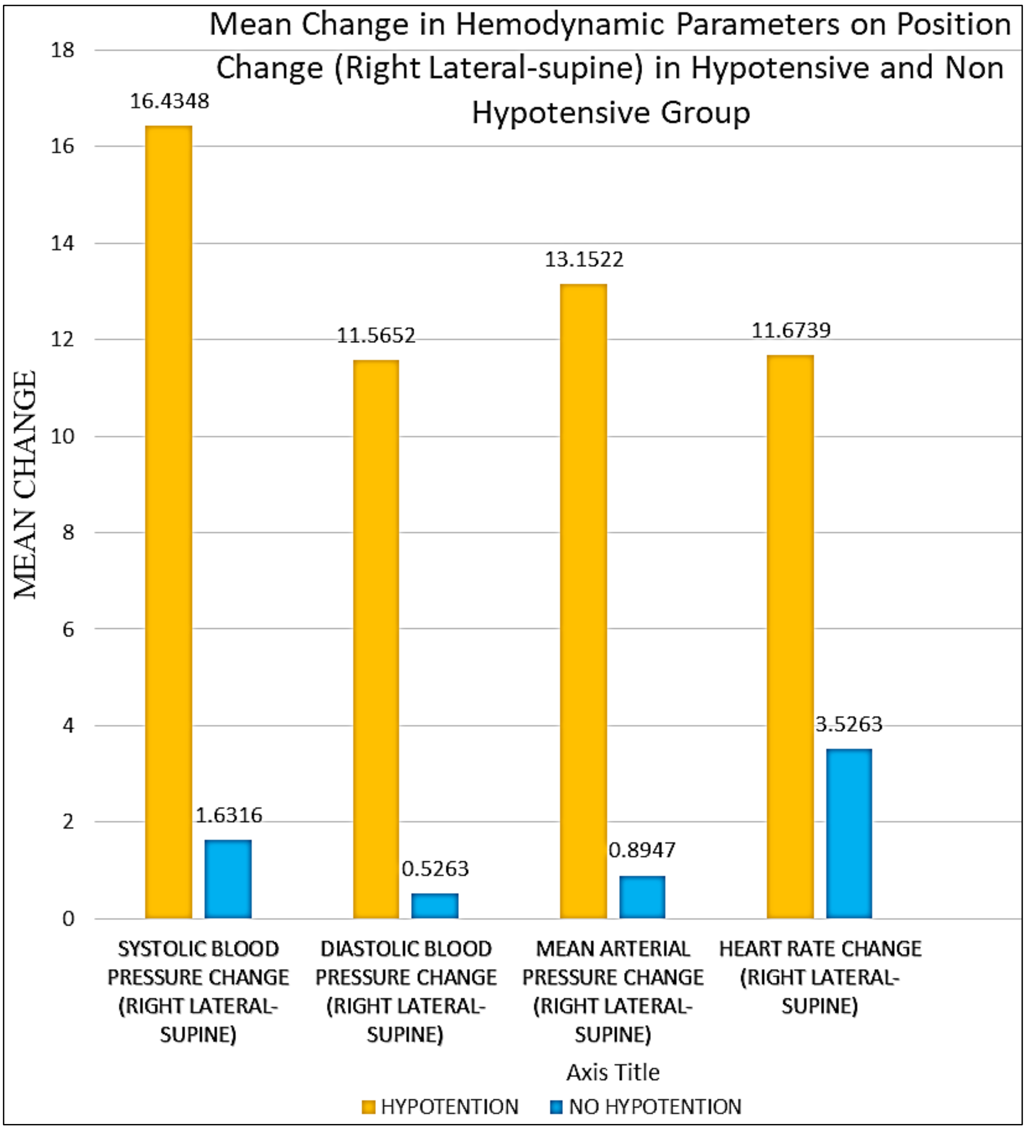
Right lateral MAP (mean arterial pressure) in hypotensive and non-hypotensive groups is statistically not significant (P-value = 0.089)

(Supine, Right lateral and Sitting) Heart Rate in hypotensive and non- hypotensive group is statistically significant (P-value <0.05).

Table 3: Positional Changes in Hemodynamic Parameters (Mean) in Hypotensive and Non Hypotensive Groups

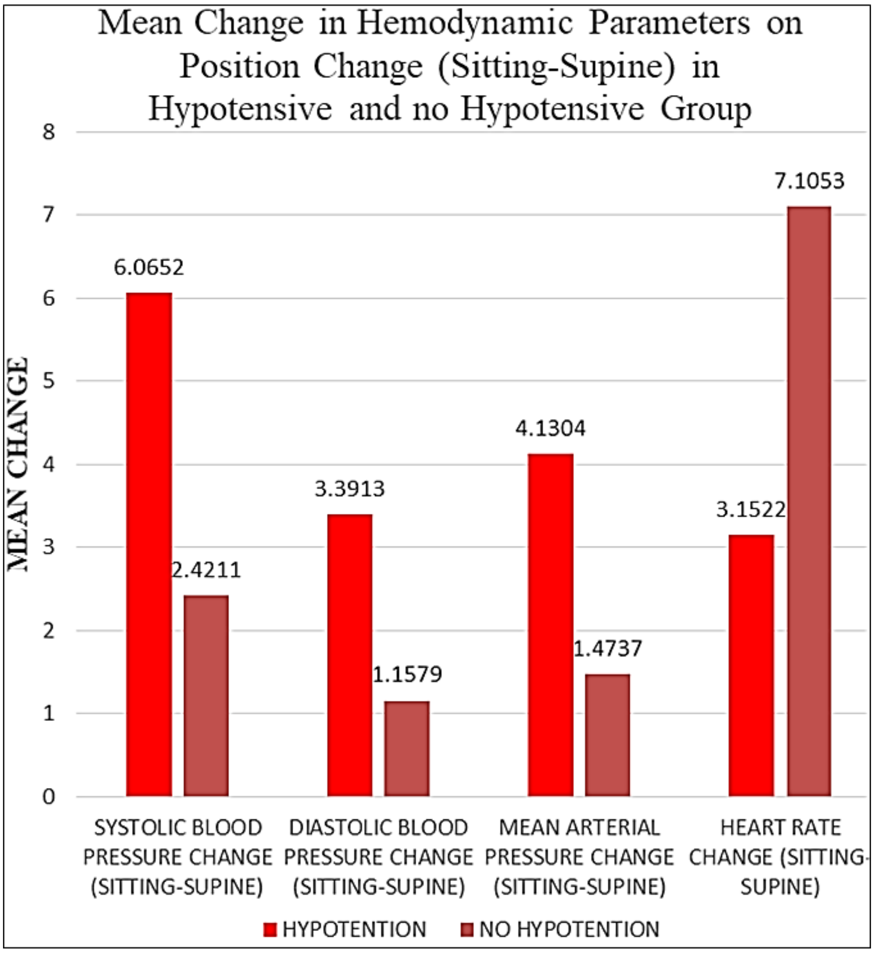
Position	Hypotension	n	Mean ± SD	P-value
Systolic Blood Pressure Change (Right Lateral-Supine)	YES	46	16.4348±7.05424	<0.001
	NO	19	1.6316±3.94702	
Diastolic Blood Pressure Change (Right Lateral-Supine)	YES	46	11.5652±5.89407	<0.001
	NO	19	0.5263±4.33805	
Mean Arterial Pressure Change (Right Lateral-Supine)	YES	46	13.1522±5.55365	<0.001
	NO	19	0.8947±3.98462	
Heart Rate Change (Right Lateral-Supine)	YES	46	11.6739±4.21138	<0.001

	NO	19	3.5263±3.32279	
Systolic Blood Pressure Change (Sitting-Supine)	YES	46	6.0652±6.79674	0.10
	NO	19	2.4211±4.03204	
Diastolic Blood Pressure Change (Sitting-Supine)	YES	46	3.3913±6.45490	0.177
	NO	19	1.1579±4.63397	
Mean Arterial Pressure Change (Sitting-Supine)	YES	46	4.1304±5.49993	0.60
	NO	19	1.4737±3.86391	
Heart Rate Change (Sitting-Supine)	YES	46	3.1522±6.14263	<0.021
	NO	19	7.1053±6.00828	



Positional change (Right lateral-Supine) in Systolic Blood Pressure, Diastolic blood Pressure, MAP and Heart Rate in Hypotensive and non-hypotensive groups is statistically significant (P-value<0.05). However change in hypotensive group is significantly more than non-hypotensive group. Mean positional change (Right lateral-Supine) in systolic blood pressure is 16.4348±7.05424 in hypotensive group as compared to 1.6316±3.94702 in non-hypotensive group. Mean Diastolic blood pressure change is 11.5652±5.89407 in hypotensive group as compared to 0.5263 ±4.33805in non-hypotensive group. Mean MAP change is 13.15±5.55365 and 0.8947±3.98462 in hypotensive and non-hypotensive groups respectively.

Mean heart rate change (right lateral-supine) is 11.6739± 4.21138 and 3.5263±3.32279 in hypotensive and non- hypotensive groups respectively.



Positional change (Sitting-Supine) in Systolic Blood Pressure and Heart Rate in Hypotensive and non-hypotensive groups is statistically significant (P-value <0.05). Positional change (Sitting-Supine) in Diastolic Blood Pressure and MAP is statistically insignificant with P-values 0.177 and 0.60 respectively. However change in hypotensive group is significantly more than non- hypotensive group. Mean positional change (Sittin-Supine) in systolic blood pressure is 6.0652±6.79674 in hypotensive group as compared to 2.4211±4.03204 in non-hypotensive group. Mean Diastolic blood pressure change is 3.3913±6.45490 in hypotensive group as compared to 1.1579±4.63397 in non-hypotensive group. Mean MAP change is 4.1304±5.49993 and 1.4737±3.86391 in hypotensive and non-hypotensive groups respectively. Mean heart rate change (Sitting-Supine) is 3.1522 ± 6.14263 and 7.1053± 6.00828 in hypotensive and non- hypotensive groups respectively.

Table 4: Postoperative complication among the study population

Variables	Frequency	Percentage
Post spinal hypotension	46	70.76
Ephedrine requirement	46	70.76
Bradycardia	2	3.1
Nausea/vomiting (intra-op-period)	27	41.5

Out of 65 study patients, 46 (70.77%) had post spinal hypotension whereas in 19 (29.23%) patients hypotension was absent. Out of a total of 65 study patients, 19 (29.2%) did not required ephedrine. 16 (24.6%) patients received 10 mg of ephedrine, 12 patients (18.5%) received 15 mg, 10 patients (15.4%) received 5 mg, 4 patients (6.2%) received 25 mg, 3 patients (4.6%) received 20 mg and 1 patient (1.5%) received 30 mg of ephedrine. Out of a total of 65 study patients, 2 patients (3.1%) developed bradycardia. Out of a total of 65 study patients, 27 (41.5%) had nausea/vomiting whereas 38 (58.5%) were free from nausea/ vomiting in the intraop- period (Table 4).

Discussion

The most widely used anaesthesia technique at present for caesarean section is spinal anaesthesia because it is easier to perform, safe to the mother and the fetus and has a high degree of success rate. However hypotension is the most frequent complication of spinal anaesthesia in pregnant patients. This study was designed to evaluate whether or not the changes in blood pressure (BP) and heart rate (HR) obtained prior to spinal anesthesia (SA) in different positions, would be useful to predict a subset of pregnant patients that might be at high risk for post spinal hypotension. In this study the changes in the systolic, diastolic, mean arterial pressure and heart rate in various positions (supine, right lateral, and sitting) was measured in 65 patients. Then, the patients underwent spinal anesthesia for caesarean section and again the systolic and diastolic blood pressures, mean arterial pressure and heart rate were measured and recorded. The results of analysis revealed that the preoperative positional blood pressure and heart rate changes is correlated with the decrease in blood pressure after spinal anesthesia for caesarean delivery. Our data is in line with the results of previous studies; for example, Young *et al*. (2010) [8] conducted a study on 66 pregnant women and recorded their blood pressure and heart rate in supine and lateral positions. Finally it was concluded that higher the orthostatic changes, the greater the reduction of blood pressure in patients after spinal anaesthesia.
Moreover, in our study the hypotension incidence rate was 70.7%, which was similar to the statistics obtained in previous studies (upto 80%) [3, 4, 5]. In addition, in this study, the repetitive C-section was found as most common cause of the non-emergent caesarean cases at L.D. Hospital. Furthermore, the incidence rate of bradycardia and as well as the dosage of atropine and ephedrine were measured so that 3.07% of the patients developed bradycardia to need atropine. The prevalence rate of nausea and vomiting was 41%.
Several other studies have investigated methods to predict hypotension during spinal anesthesia. Hanss *et al*. [9] reported that hypotension in caesarean delivery correlates with an increased sympathetic outflow before spinal anesthesia. Increased sympathetic outflow was detected using heart rate variability analysis; this analysis requires a special device or software. In comparison, we simply observed the positional blood pressure change because sympathetic nervous system reactivity is the driving force of the immediate increase in blood pressure observed after a position change [10]. The response of blood pressure to the change in body position has been used for measuring cardiovascular reactivity and for the prediction of adverse clinical outcome [11, 12]. Excessive positional blood pressure change predicts adverse health outcomes, including myocardial infarction and hypertension.
Froelich and Caton [13] reported that heart rate in the lateral position had a significant positive correlation with the incidence of hypotension during spinal anesthesia. However, they did not find a correlation between preoperative orthostatic blood pressure change and hypotension. The use of different measurement methods may explain the difference in results. Although we used the blood pressure measured immediately after position change, Froelich and Caton averaged 5 blood pressure values obtained every minute after changing from the supine to a standing position. Because peak positional change in blood pressure occurs by 1 minute after changing position [14], analysis based on delayed blood pressure values may produce different results.

In a study of 27 patients in 1996, Kinsella *et al*. [15] couldn't find any relationship between the changes in orthostatic blood pressure and heart rate and the incidence of post spinal hypotension. The results of that study were inconsistent with that of our's, which might be due to the difference of the measurement tools or sample size. We changed the position from supine to the right lateral instead of using the tilt test investigated in previous studies. We found that positional blood pressure and pulse rate change in those who developed hypotension after spinal anesthesia was higher than it was in those who did not develop hypotension. This observation suggests that patients who developed hypotension had higher sympathetic reactivity on positional change. Blood pressure decrease after spinal anesthesia results from the blockade of the sympathetic nervous system. Higher preoperative sympathetic activity is associated with more profound sympathetic blockade by spinal anesthesia [16]. It can be said that the higher the blood pressure and heart rate variation between the supine, sitting and lateral positions, the higher the probability of post-spinal hypotension; nevertheless, due to the fact that there is no significant difference between the patient's blood pressure and pulse rate in sitting and supine positions, it is enough to obtain only the difference between their blood pressure and pulse rate in sitting or supine positions and the lateral position. However, a limitation of this study is that we did not measure sympathetic tone or sympathetic hormonal responses to position change. Positional blood pressure change may be useful in obese parturients [17], because it predicts hypotension independent of body weight, abdominal circumference, or sensory block level. Hence, the probable cases of intraoperative hypotension can be pre-identified and, thereby, the incidence of hypotension can be reduced by using the necessary measures, which is beneficial both for the baby and the mother.

References

1. Molina G, Weiser TG, Lipsitz SR, *et al*. Relationship between Caesarean Delivery Rate and Maternal and Neonatal Mortality. JAMA. 2015;314(21):2263-2270.
2. Guglielminotti J, Landau R, Li G. Adverse Events and Factors Associated with Potentially Avoidable use of General Anesthesia in Caesarean Deliveries. Anesthesiology. 2019;130(6):912-922.
3. Morgan PJ, Halpern SH, Tarshis J. The effects of an increase of central blood volume before spinal anesthesia for caesarean delivery: a qualitative systematic review. Anesth Analg. 2001;92(4):997-1005.
4. Klöhr S, Roth R, Hofmann T, Rossaint R, Heesen M. Definitions of hypotension after spinal anaesthesia for caesarean section: literature search and application to parturients. Acta Anaesthesiol Scand. 2010;54(8):909-921.
5. Rout CC, Rocke DA, Levin J, *et al*. A reevaluation of the role of crystalloid preload in the presentation of hypotension associated with spinal hypotension for elective caesarean section. Anesthesiology. 1993;79:262-9.
6. Reiz S. Pathophysiology of Hypotension Induced by Spinal/Epidural Analgesia. In: Wüst HJ, Stanton-Hicks M. editors. New Spects in Regional Anesthesia 4. Berlin, Heidelberg: Springer, 1986, 176.
7. Ueyama H, He YL, Tanigami H, Mashimo T, Yoshiya I. Effects of crystalloid and colloid preload on blood volume in the parturient undergoing spinal anesthesia for elective Caesarean section. Anesthesiology. 1999;91(6):1571-1576.
8. Jeon YT, Hwang JW, Kim MH, *et al*. Positional blood pressure change and the risk of hypotension during spinal anesthesia for caesarean delivery: an observational study. Anesth Analg. 2010;111(3):712-715.
9. Hanss R, Bein B, Ledowski T, Lehmkuhl M, Ohnesorge H, Scherkl W, *et al*. Heart rate variability predicts severe hypotension after spinal anesthesia for elective caesarean

delivery. Anesthesiology, 2005, 10-26.
10. O'Leary DD, Kimmerly DS, Cechetto AD, Shoemaker JK. Differential effect of head-up tilt on cardiovagal and sympathetic baroreflex sensitivity in humans. Exp. Physiol. 2003;88:769-74.
11. Nardo CJ, Chambless LE, Light KC, Rosamond WD, Sharrett AR, Tell GS, *et al*. Descriptive epidemiology of blood pressure response to change in body position. The ARIC study. Hypertension. 1999;33:1123-9.
12. Sparrow D, Rosner B, Vokonas PS, Weiss ST. Relation of blood pressure measured in several positions to the subsequent development of systemic hypertension. The Normative Aging Study. Am J Cardiol. 1986;57:218-21.
13. Frölich MA, Caton D. Baseline heart rate may predict hypotension after spinal anesthesia in prehydrated obstetrical patients. Can J Anaesth. 2002;49(2):185-189.
14. Borst C, Van Brederode JF, Wieling W, Van Montfrans GA, Dunning AJ. Mechanisms of initial blood pressure response to postural change. Clin Sci. (Lond.). 1984;67:321-7.
15. Kinsella SM, Norris MC. Advance prediction of hypotension at caesarean delivery under spinal anesthesia. Int. J Obstet. Anesth. 1996;5(1):3-7.
16. Ledowski T, Preuss J, Kapila R, Ford A. Skin conductance as a means to predict hypotension following spinal anaesthesia. Acta Anaesthesiol Scand. 2008;52:1342-7.
17. Panni MK, Columb MO. Obese parturients have lower epidural local anaesthetic requirements for analgesia in labour. Br J Anaesth. 2006;96:106-10.