RESEARCH ARTICLE **Open Access**

Gema Lingkungan Kesehatan
Vol. 23, No. 3 (2025), pp 344-349
e-ISSN 2407-8948 p-ISSN 16933761
doi: https://doi.org/10.36568/gelinkes.v23i3.313 *Journal Homepage: https://gelinkes.poltekkesdepkes-sby.ac.id/*

Effect of Crystalloid Preloading on Blood Pressure Stability in Cesarean Section Under Spinal Anesthesia: A Study at Regional General Hospital of Sekarwangi

Irawan Danismaya[1]*, Burhanuddin Basri[2], Erna Safariyah[2], Amir Hamzah[2]

[1] Bachelor of Nursing Study Program, Faculty of Health, Universitas Muhammadiyah Sukabumi, Indonesia
[2] Nursing Diploma Study Program, University Muhammadiyah Sukabumi, Sukabumi, Indonesia

*Correspondence: irawandanismaya@ummi.ac.id

Spinal anesthesia is a form of regional anesthesia administered by injecting a local anesthetic into the subarachnoid space and is commonly employed in cesarean section (C-section) procedures. One of its major side effects is hypotension, which, if not properly managed, can compromise uteroplacental perfusion and potentially result in fetal hypoxia, acidosis, and neonatal complications. Preoperative intravenous fluid administration is a preventive strategy aimed at stabilizing blood pressure by increasing central blood volume. This study aimed to examine the effect of preoperative fluid administration on blood pressure stability in C-section patients undergoing spinal anesthesia at the Regional General Hospital at Sekarwangi. A quantitative analytic approach with a pre-test and post-test design was employed. The study population consisted of 62 C-section patients who received spinal anesthesia within the last three months. Data were analyzed using the Paired Samples t-test. The results showed a statistically significant difference in blood pressure before and after fluid administration ($p = 0.000 < 0.05$), indicating that preoperative fluid administration had a significant effect on blood pressure stability. Future studies are recommended to employ research designs that better control for external variables and address the limitations of the present study.

Keywords: Blood Pressure Stability, Cesarean Section, Preoperative Fluid Administration, Spinal Anesthesia

INTRODUCTION

Cesarean section (C-section) is among the most frequently performed surgical procedures in obstetrics, typically employed when vaginal delivery poses a risk to maternal or fetal health. Among the various anesthetic techniques available, spinal anesthesia is widely preferred for C-section due to its rapid onset, effective motor and sensory blockade, low risk of systemic toxicity, and minimal transplacental drug transfer to the fetus (Ayuningtyas et al., 2018). The rising global incidence of C-section underscore the critical role of spinal anesthesia in obstetric care. For instance, the World Health Organization (WHO) reported a global C-section delivery rate of approximately 46.1% in 2011. In Indonesia, Ministry of Health (2018) showed that 17.6% of women aged 13–54 years gave birth via C-section, frequently due to complications such as breech presentation, placenta previa, hypertensive disorders, and a history of previous C-section.

Despite its advantages, spinal anesthesia is commonly associated with hypotension, one of its most common and serious complications. This condition results from the sympathetic blockade induced by the anesthetic, leading to peripheral vasodilation, decreased venous return, and reduced cardiac output (Fikran et al., 2016). Maternal hypotension can impair uteroplacental perfusion, potentially causing fetal hypoxia, metabolic acidosis, and low APGAR scores. For the mothers, severe hypotension may cause symptoms such as nausea, dizziness, respiratory distress, decreased consciousness, or even cardiac arrest.

To mitigate these effects, several preventive strategies have been proposed. These include patient positioning (e.g., uterine displacement and head elevation), vasopressors administration, and intravenous fluids therapy either prior to (pre-loading) or concurrent with (co-loading) spinal anesthesia. Crystalloids pre-loading—typically 10–20 mL/kg body weight—is coomonly employed to expand intravascular volume and reduce the risk of hypotension. However, its efficacy remains debated, with studies showing variable outcomes (Visantino & Muhaji, 2022). Contributing factors include body mass index (BMI), vertebral length, level of anesthetic blockade, and timing of fluid administration have all been proposed as influencing the occurrence of

hypotension (Karnina & Putri, 2021; Latupeirrissa & Angkejaya, 2020).

Although previous studies report the incidence of hypotension during C-sections under spinal anesthesia to range from 50% to 87% (Tanambel et al., 2017; Ma'ruf, et al, 2022), there is limited data specific to Indonesian clinical settings regarding the impact of crystalloid preloading on hemodynamic stability. Furthermore, inconsistencies in fluid volume and timing contribute to varied clinical outcomes.

This study aims to evaluate the effect of preoperative fluid administration on blood pressure stability in cesarean section patients undergoing spinal anesthesia at RSUD Sekarwangi. By investigating the relationship between fluid management and intraoperative hemodynamic responses, the findings aim to inform clinical practice and enhance maternal and neonatal safety during cesarean delivery.

METHODS

This study employed an analytic quantitative design with a pre-experimental one group pre-test post-test approach to evaluate the effect of preload fluid administration on blood pressure stability in patients undergoing C-section with spinal anesthesia at RSUD Sekarwangi. The primary objective was to determine whether there is a significant difference in hemodynamic parameters specifically blood pressure, pulse rate, oxygen saturation, and body temperature before and after the administration of preload crystalloids. Data collection was conducted using structured observation sheets, allowing for consistent recording of physiological parameters at two time points: prior to preload administration and 30 minutes after the intervention. The population of this study consisted of all C-section patients who underwent spinal anesthesia at the Regional General Hospital at Sekarwangi during a three-month period, totalling 62 patients who met the inclusion criteria.

Sampling in this study was conducted using a simple random sampling method. The target population included all patients who underwent *C-section* surgery with spinal anesthesia in the operating room during the study period. From this population, a random selection was made based on predefined the inclusion criteria: age 20–40 years, ASA physical status classification I–II, and no history of cardiovascular disease or other comorbidities that could affect blood pressure.

The randomization process involved drawing medical record numbers from a list of eligible patients, ensuring that each had an equal probability of being selected. This approach aimed to produce a sample with a distribution of characteristics representative of the broader population. By employing this method, the study sought to minimize selection bias and enhance the internal validity of the findings. Randomization also helped ensure that potential confounding variables were evenly distributed across the sample, thereby allowing for a more accurate assessment of the effect of the intervention on the outcome variables.

The research sample was determined using *a random sampling technique*, which allows the selection of random respondents, with a minimum of 40 respondents to make the results more representative and accurate. This study included female patients who underwent C-section with spinal anesthesia at RSUD Sekarwangi between February to March 2023. Eligible participants were those with a gestational age of 37 weeks or more (full term), who received crystalloid fluid preloading at a dose of 20 ml/kg body weight prior to spinal anesthesia, and who were in a hemodynamically stable before the procedure. All provided written informed consent indicating their voluntary participation in the study.

To minimize confounding factors, specific exclusion criteria were applied. Patients were excluded if they had a history of chronic hypertension, preeclampsia, or other cardiovascular disorders. Additional exclusions included those who had received non-crystalloid fluids (e.g., colloids or blood transfusions) prior to anesthesia, experienced acute obstetric complications that could affect hemodynamic stability (such as placenta previa with active bleeding), underwent general anesthesia or any anesthesia technique other than spinal, or had incomplete data or could not be monitored for 30 minutes after fluid preloading.

. The collected data was divided into primary data and secondary data. Primary data were obtained through interviews with anesthesiologists regarding the procedure of administering preloaded fluids and observation of the patient's hemodynamic in the preoperative stage. Secondary data was obtained through data collection of C-section patients in the operating room of the Regional General Hospital at Sekarwangi.

The research procedure began with obtaining ethical permission from the Ethics Committee of the Regional General Hospital at Sekarwangi (ethical permit number: 087/KET/KE-FKES/I/2024) to ensure that this research was carried out in accordance with applicable research ethics standards. After that, the researcher selected samples based on random sampling techniques and carried out observations on the patient's blood pressure, pulse, saturation, and temperature prior to and after the administration of crystalloid preloading. The instrument used in this study was an observation sheet designed to record relevant data on the effect of crystalloid preloading on these variables. After the data was collected, a bivariate analysis was performed using the Paired Samples Test to determine whether there was a significant difference between the patient's blood pressure prior to and after the administration of crystalloid preloading. The results of this statistical test would provide an idea of whether the administration of crystalloid preloading can affect blood pressure stability in C-section patients with spinal anesthesia.

RESULTS AND DISCUSSION

Characteristics of Research Respondents

Table 1 showed that most respondents, namely 26-35 years old, are 33 participants (82.5%). It showed that the

frequency of respondent characteristics based on blood pressure prior to fluid administration is the majority of hypertension, which is 22 participants (55.0%). While, the frequency of respondent characteristics based on blood pressure after fluid administration is mostly 34 participants (85.0%).

Table 1
Frequency distribution of respondent characteristics by age (n=40)

Variable	n	%
Age		
17-25 years	4	10
26-35 years	33	82,5
36-45 years	3	7,5
Blood pressure		
Normotension	18	45
Hypertension	22	55
Blood pressure		
Normotension	34	85,0 %
Hypotension	6	15,0 %

Descriptive blood pressure prior to and after fluid administration

Table 2
Blood pressure prior to and after fluid administration

Blood pressure	Mean ±SD	P-Value
Pre-test		
Systole (mmHg)	124.7±15.2	0.000*
Diastole (mmHg)	77.3±10.1	
Post-test		
Systole (mmHg)	118.3±14.8	0.000*
Diastole (mmHg)	73.5±9.7	

Based on the results of blood pressure measurement in C-section patients who received spinal anesthesia at RSUD Sekarwangi, the mean systolic blood pressure prior to fluid administration (pre-test) was 124.7 mmHg with a standard deviation (SD) of 15.2, while the mean diastolic pressure was 77.3 mmHg with an SD of 10.1. Following crystalloid preloading (post-test), the mean systolic blood pressure decreased to 118.3 mmHg (SD = 14.8) and the diastolic pressure deacreased to 73.5 mmHg (SD = 9.7).

Statistical analysis yielded a p-value of 0.000 for both systolic and diastolic measurement, indicating a highly significant difference in blood pressure prior to and after fluid administration ($p < 0.05$). These findings demonstrate that crystalloid preloading has a statistically significant effect in lowering blood pressure in patients undergoing spinal anesthesia for cesarean delivery.

Effect of preoperative fluid administration on blood pressure stability in C-section patients with spinal anesthesia at RSUD Sekarwangi

Based on Table 3 above, the results of the statistical test with Paired Samples Test the P-value produced was 0.000 < 0.05, meaning that Ha was accepted and H_0 was discarded, where it can be concluded that there is a significant effect of preoperative fluid administration on blood pressure stability before and after intervention in C-section patients with spinal anesthesia at Sekarwangi Hospital. A correlation value of 0.480 was obtained showing a positive correlation, which means that the administration of preoperative fluids to the stability of blood pressure in C-section patients with spinal anesthesia experienced hypotension. The coefficient interval is 0.40-0.599. Based on this, it can be concluded that the relationship between each independent variable and dependent is a moderate correlation.

Table 3
Effect of preoperative fluid administration on blood pressure stability in sectio caesarea (SC) patients with spinal anesthesia at RSUD Sekarwangi

Blood Presure	Mean	SD	P Value
Prior to fluid Administration	0.400	0.496	0.000
After Fluid Administration			

Based on the results of the study, it was shown that most respondents, namely 26-35 years old, were 33 participants (82.5%). The research conducted by Ileatan et al. (2018), explained that the description of the criteria for patients who used crystalloid and colloidal fluids in C-section using spinal anesthesia techniques. The criteria for patients who used crystalloid fluid were patients aged 20-40 years, gestational age, and patients with ASA physical status classification I-II, normal BMI, patients at risk of having allergic reactions, and anaphylactic reactions. The criteria for patients who used colloidal fluid were patients aged 20-40 years, term gestational age, and patients with ASA physical status classification I-II, a BMI above normal, and patients at risk of edema complications.

Azizah, et al (2016) also presented evidence consistent with these findings. In an analytical observational study conducted at a hospital in Indonesia, she found that the use of crystalloid fluids was significantly more effective than colloid solutions in reducing the risk of hypotension among cesarean section patients receiving spinal anesthesia. The study included patients aged 20–40 years with full-term pregnancies, ASA physical status I–II, and normal BMI.

Age is recognized as one of the risk factors for hypotension during spinal anesthesia. Younger patients tend to experience milder decreases in blood pressure compared to older individuals, which may be influenced by age-related reductions in cardiac output and heart rate. Additionally, body fluid composition varies with age, body composition, and fat percentage. Younger individuals typically have a higher total body water content, which may contribute to greater physiological resilience during fluid shifts associated with spinal anesthesia.

Based on the results of the study, most respondents showed blood pressure levels in the hypertension category before fluid administration, with 22 participants (55.0%) affected. These findings aligned with the study by Indriani et al. (2022), which reported an average systolic blood pressure of 124.7 mmHg and a diastolic blood pressure of 77.3 mmHg in a similar population. These figures were

also consistent with the physiological standard of normal blood pressure, where the average systolic pressure is approximately 120 mmHg and diastolic pressure around 80 mmHg (Sherwood, 2012). Similarly, Saputra and Tahir (2018) reported an average systolic blood pressure value of 125.1 mmHg and diastolic 79.3 mmHg, supporting the findings of this study.

Blood pressure is the mechanical force exerted by blood as it flows through the vessels and presses against the arterial walls. Its main function is to deliver oxygen and nutrients to the body's tissues. Blood pressure consists of two phases: systolic and diastolic. Systolic pressure represents the peak pressure during ventricular contraction, while diastolic pressure is the lowest pressure when the heart is in the relaxation phase (Dewi et al., 2021).

In C-section procedures, spinal anesthesia is a commonly used regional anesthetic technique. This method involves injecting anesthesia into the subarachnoid space to block the transmission of nerve impulses. The most frequently used anesthetic is Bupivacaine, an amide-type local anesthetic with a relatively rapid onset of 5–8 minutes. Bupivacaine works by inhibiting nerve impulse conduction, resulting in temporary sensory and motor blockade (Dewi et al., 2021).

However, spinal anesthesia can lead to significant side effects, particularly hypotension, due to sympathetic blockade that causes peripheral vasodilation and reduced cardiac output. Therefore, preoperative fluid administration is essential for maintaining hemodynamic stability during surgery.

The study found that most respondents (85.0%) exhibited stable blood pressure after the administration of crystalloid preloading. This indicated that administering 20 ml/kgBW of crystalloid fluid before spinal anesthesia was effective in maintaining hemodynamic stability in patients undergoing C-section. Blood pressure, the force exerted by the heart against arterial walls, consisted of systolic and diastolic components. Hypotension, the most common complication of spinal anesthesia, was characterized by a systolic pressure drop to <100 mmHg or a reduction of >20–30% from baseline. If not promptly addressed, this condition can lead to myocardial ischemia, cerebral hypoperfusion, and tissue hypoxia.

The reduction in blood pressure following spinal anesthesia is caused by sympathetic blockade, which leads to vasodilation and decreased systemic vascular resistance. Rustini et al. (2016) reported that several factors—including age, weight, BMI, uterine position, anesthesia dosage, and surgical manipulation—may also influence the incidence of hypotension. In this study, the observed blood pressure stability after fluid preloading demonstrates that adequate fluid administration can suppress the vasodilatory effects of spinal anesthesia and support optimal circulatory function.

Previous studies support the effectiveness of fluid preloading, particularly with colloidal solutions. Widodo and Isnaini (2024) found that preloading with colloidal hydroxyethyl starch (HES) maintained both systolic and diastolic blood pressure and reduced the incidence of hypotension more effectively than vasopressors such as ephedrine. However, findings across studies are not always consistent. A meta-analysis by Banerjee et al. (2011) concluded that there was no significant difference between preload and co-load strategies in preventing hypotension. Both approaches reported a high prevalence of hypotension —approximately 60%— indicating crystalloid preloading alone may not be sufficient to prevent hemodynamic disturbances during spinal anesthesia. Rout et al. (1993) demonstrated that preloading with 20 ml/kg of crystalloids reduced the incidence of hypotension from 71% to 55%. Nonetheless, the clinical effectiveness of crystalloids is limited due to their rapid redistribution from the intravascular to the interstitial compartment.

Clinically, the results of this study support the routine use of fluid preloading prior to spinal anesthesia in C-section procedures. Administering 20 ml/kgBW of crystalloid fluid is an effective preventive measure for reducing the risk of hypotension, minimizing the need for vasopressors, and ensuring adequate perfusion to the uterus and placenta, thereby supporting fetal well-being. In practice, utilizing hemodynamic indicators such as Mean Arterial Pressure (MAP) may provide more accurate detection of hypotension compared to relying solely on systolic and diastolic values.

However, this study has several limitations. The descriptive quantitative design without a control group restricts the generalizability of the findings. Additionally, important variables such as the dosage of anesthesia, baseline hydration status, and use of vasopressors were not analyzed in depth. Therefore, future research using experimental or quasi-experimental designs is highly recommended to validate these findings. Serial monitoring of MAP and evaluation of neonatal outcomes should also be prioritized in subsequent studies.

Statistical analysis using the Paired Samples Test revealed a p-value of 0.000 (<0.05), indicating a significant effect of preoperative fluid administration on blood pressure stability before and after intervention in C-section patients with spinal anesthesia at RSUD Sekarwangi. A correlation coefficient of 0.480 indicates a moderately strong positive relationship, suggesting that preoperative fluid administration contributes to improved blood pressure stability, although hypotension may still occur in some cases.

Hypotension is a common complication arising from sympathetic blockade during spinal anesthesia, which results in peripheral vasodilation and reduced cardiac output. Therefore, fluid preloading with crystalloids or colloids is a crucial strategy to prevent hypotension and enhance clinical outcomes for both mother and fetus.

These findings align with studies by Pramono (2017) and Ramesh et al. (2019), which confirmed that both crystalloid and colloidal fluids are effective in maintaining intravascular volume and preventing hypotension due to sympathetic blockade of spinal anesthesia. However,

Azizah (2016) found no significant difference between crystalloid and colloidal fluids in maintaining blood pressure among C-section patients, implying that other factors such as the timing of administration and patient condition may influence outcomes.

Fikran (2016) showed that showed that co-loading is more effective than preloading in reducing the incidence of hypotension, although both strategies remain vital components of perioperative fluid management. Widodo and Isnaini's (2024) further emphasized the benefit of colloid administration, such as HES, in reducing blood pressure fluctuations more significantly than when colloids are not used. Conversely, Gousheh et al. (2018) reported that crystalloids are associated with greater blood pressure reductions and adverse effects such as heart rate variability and increased nausea.

Combining Crystalloid preloading with vasopressors, particularly phenylephrine administered in a weight-adjusted dose, has also been shown to be more effective in maintaining hemodynamic stability (Mwaura et al., 2016). This combination approach addresses both the volume deficit and vascular tone, thereby offering a more comprehensive strategy to counteract the vasodilatory effects of spinal anesthesia. It allows for more precise blood pressure control and reduces the risk of maternal and fetal complications associated with hypotension during C-section procedures.

The findings of this study reaffirm the importance of crystalloid preloading, particularly at a volume of approximately 20 ml/kgBW, as a primary strategy to prevent hypotension in C-section patients undergoing spinal anesthesia. This practice helps preserve perfusion to vital organs and reduces the risk of complications associated with sudden drops in blood pressure. Additionally, the use of anesthetic agents such as sevoflurane for controlled hypotension must be accompanied by appropriate fluid management to ensure optimal perfusion and minimize intraoperative bleeding.

This study is limited by its descriptive design and lack of a control group, which restricts the depth of analysis regarding other influencing factors such as anesthesia dosage, patient positioning, and vasopressor use. Therefore, further research utilizing controlled experimental or quasi-experimental designs is necessary to provide a more comprehensive understanding. Future studies should also consider serial assessments of hemodynamic parameters such as MAP and include evaluations of maternal and neonatal outcomes to enhance the quality of spinal anesthesia management in cesarean deliveries.

CONCLUSIONS

Based on the results of the statistical test with *the Paired Samples Test* the P value produced was 0.000 < 0.05, meaning the null hypothesis (H_0) was rejected in favor of the alternative hypothesis (Ha). This suggests that there is a statistically significant effect of preoperative fluid administration on blood pressure stability before and after the intervention in C-section patients under spinal anesthesia at RSUD Sekarwangi. A correlation coefficient of 0.480 was found, indicating a positive correlation. This means that the administration of preoperative fluids contributed to improved blood pressure stability in C-section patients who experienced hypotension following spinal anesthesia. The correlation coefficient falls within the interval of 0.40–0.599, which indicates a moderate strength of association between the independent and dependent variables.

REFERENCE

Ayuningtyas, D., Oktarina, R., Nyoman, N., & Sutrisnawati, D. (2018). Health ethics in childbirth through Sectio Caesaria without medical indication. *MKMI Journal*, 14(1), 9–16. [Crossref], [Publisher]

Azizah, R. N., Sikumbang, K. M., & Asnawati, A. (2016). Effect of giving colloidal and crystalloid fluids on blood pressure. *Medical Periodicals*, 12(1), 19. [Crossref], [Publisher]

Dewi, N. H., Rustiawati, E., & Sulastri, T. (2021). No preload of lactate ringer fluid in post-anesthesia patients. *Jurnal Ilmiah Keperawatan*, 2(3), 1–8. [Crossref], [Publisher]

Fikran, Z., Tavianto, D., & Maskoen, T. T. (2016). Comparison of the effects of giving crystalloid fluid before spinal anesthesia (preload) and shortly after spinal anesthesia (coload) on the incidence of maternal hypotension in the cesarean section. *Journal of Perioperative Anesthesia*, 4(2), 124–130. [Crossref], [Publisher]

Gousheh, M., Jahromi, B. N., & Ghaffari, S. (2018). Comparison of crystalloid and colloid preload on hemodynamic changes after spinal anesthesia in cesarean section. *Journal of Anesthesia & Clinical Research*, 9(5), 769. [Crossref], [Publisher]

Ileatan, E., Arymbhi, Dwi Sanjaya, & ag. (2018). Criteria for patients using crystalloid and colloid fluids in Sectio Caesaria. *Journal of Primary Health*, 3(2), 124–130. [Publisher]

Indriani, T., Arifiyanto, D., & Mustikawati, N. (2022). Description of vital signs in sectio caesarea patients with spinal anesthesia Muhammadiyah Pekajangan Pekalongan. *Journal Name*, 558–564. [Publisher]

Karnina, R., & Putri, M. (2021). The relationship between the incidence of post dural puncture headache (PDPH) in sectio caesarea patients with spinal anesthesia at M Hospital in 2019. *Muhammadiyah Journal of Midwifery*, 1(2), 45–50. [Crossref], [Publisher]

Latupeirrissa, K. E. N., & Angkejaya, O. W. (2020). Comparison of hemodynamic stability between left lateral position 15° and lying supine in sectio caesarea post spinal anesthesia patients. *PAR: Pattimura Medical Review*, 2(1), 71–81. [Crossref], [Publisher]

Ma'ruf, M., Nabhani, N., Hafidudin, M. (2022). Pengaruh posisi miring kiri terhadap peningkatan tekanan darah setelah anestesi spinal sectio caesaria pasien dengan obesitas. *Jurnal PROFESI (Profesional Islam): Media Publikasi Penelitian, 20 (1),* 107-114. [Crossref], [Publisher]

Ministry of Health of the Republic of Indonesia. (2018). *Indonesian health profile 2017*. [Publisher]

Mwaura, L., Kamau, A., & Mwangi, P. (2016). Effectiveness of phenylephrine dosing on preventing spinal anesthesia-induced hypotension during cesarean section. *East African Medical Journal*, 93(10), 439–445. [Publisher]

Pramono, A. (2017). Effect of crystalloid fluid preloading on blood pressure stability in cesarean section patients. *Journal of Anesthesiology and Resuscitation*, 5(1), 20–27. [Publisher]

Ramesh, V., Kumar, A., & Shukla, R. (2019). Role of crystalloids and colloids in prevention of spinal anesthesia-induced hypotension during cesarean section. *Indian Journal of Anesthesia*, 63(5), 400–406. [Publisher]

Rout, C. C., Rocke, D. A., Levin, J., & Gouws, E. (1993). A reevaluation of the role of crystalloid preload in the prevention of hypotension associated with spinal anesthesia for elective cesarean section. *Anesthesiology*, 79(2), 262–269. [Crossref], [Publisher]

Rustini, R., Fuadi, I., & Surahman, E. (2016). Incidence and risk factors of hypotension in patients undergoing cesarean section with spinal anesthesia at Dr. Hasan Sadikin Hospital Bandung. *Journal of Perioperative Anesthesia*, 4(1), 42–49. [Crossref], [Publisher]

Saputra, H., & Tahir, M. (2018). Systolic and diastolic blood pressure in patients before surgery. *Journal of Clinical Medicine*, 12(2), 78–83. [Publisher]

Sherwood, L. (2012). *Human physiology: From cells to systems* (8th ed.). Belmont, CA: Cengage Learning. [Publisher]

Tanambel, P., Kumaat, L., & Lalenoh, D. (2017) Profil penurunan tekanan darah (hipotensi) pada pasien section caeserea yang diberikan anestesi spinal dengan menggunakan bupivakin. *Jurnal e-Clinic (eCI), 5 (1), 72-77*. [Crossref], [Publisher]

WHO. (2019). *Provincial reproductive health and MPS profile of Indonesia*. [Publisher]

Widodo, R., & Isnaini, N. (2024). The effect of colloid preload on blood pressure stability in cesarean section patients with spinal anesthesia. *Indonesian Journal of Anesthesia*, 12(1), 34–42. [Publisher]

Visantino, M.R., & Muhaji, M. (2022). Efektivitas Pemberian *preloading* dan *co-loading* cairan dalam mengatasi hipotensi pada pasien operasi *section caesarea* dengan spinal anestesi: *literature review. [Unpublished publication thesis].* Universitas Aisyiyah Yogyakarta. [Publisher]