

# A study of hemodynamic medicine use in intensive cardiac care unit of dr. Soedarso regional public hospital, Pontianak

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## ABSTRACT

Hemodynamic medicines are important to recover patients with a critical period in the ICCU. Hemodynamic medicines have a small range of dose so that it has a large effect on the therapy. Therefore, a study on the use of hemodynamic medicines and doses is necessarily conducted. This study aims to investigate the use and doses of hemodynamic medicines administered to patients in the ICCU of dr. Soedarso Hospital Pontianak. This study is observational research with a descriptive cross-sectional design. The research sample was 49 patients who had met the inclusion criteria. The data were analyzed descriptively to describe the frequency and percentage. The results show that a single hemodynamic medicine is administered to 65% of the patients and a combination of hemodynamic medicines is administered to 35% of the patients. The single medicine refers to dobutamine administered to 84.4% of the patients. Meanwhile, the combination of hemodynamic medicines consists of dobutamine and norepinephrine that are administered to 52.9% of the patients. The doses of hemodynamic medicines frequently administered to patients are 3-5 µg/kg/min dobutamine, 3-10 µg/kg/min dopamine, 0.01-2-2 µg/kg/min norepinephrine, and 1 mg/ml epinephrine. This study concludes that dobutamine (inotropic) is the most frequently used single hemodynamic medicine, and norepinephrine (vasopressor) is the most frequently used combined hemodynamic medicine for the ICCU patients at dr. Soedarso Regional Public Hospital, Pontianak.

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## 1. Introduction

Hemodynamic condition is a blood flow that is normally maintained in a physiological condition. However, the hemodynamic status would not be stable or normal if a patient's condition is critical because the control mechanism does not perform its function normally. The hemodynamic drug is an important medication for patients who experience a critical period, especially in an intensive care unit. Critical patients will be transported to a different place and receive a continuation of patient care with the highest quality in the intensive cardiac care unit (ICCU) (Droogh et al., 2015). A hemodynamic study is a base associated with the pressure and flow distributions in a circulatory system. The circulatory system consists of the heart and blood vessels whose main function is to transport oxygen and other nutrients (TW, 2015). Heart and blood vessel diseases are cardiovascular diseases that become the major health problems in developed and developing countries. The 2018 Basic Health Research reports that the prevalence of heart disease according to the doctor diagnosis in Indonesia was 1.5%, and in West Kalimantan Province was 1.3 (Risksedas, 2018). The data show that there had been 1,569 patients suffering from cardiovascular diseases in dr. Soedarso Regional Public Hospital Pontianak from June 2018 to June 2019. ICCU is a hospital ward that treats patients with severe cardiovascular diseases, such as arrhythmia, heart failure, and cardiogenic shock. Patients with severe conditions need sustainable monitoring and intensive care (Kasaoka, 2017).

However, one of the biggest challenges to mobilizing critically ill patients is the occurrence of hemodynamic instability (Vollman, 2013). In general, patients with critical conditions and cardiovascular disorders in an intensive care unit have unstable hemodynamic conditions and require inotropic agents or vasopressors to stabilize blood flows. Hemodynamic instability causes a discrepancy between the oxygen delivery and oxygen demand; this is the main factor causing internal organ failure (Huygh et al., 2016). Moreover, unstable hemodynamic conditions will involve cardiac functions and oxygen delivery so that it is necessary to monitor, handle, and administer medications (Nirmalasari, 2017).

This research was conducted in the ICCU of dr. Soedarso Regional Public Hospital, Pontianak. In this hospital, the ICCU is a special intensive room for patients who suffer from cardiovascular disorders and consume more hemodynamic medicines than patients in ICU (Intensive Care Unit). (Jentzer et al., 2015) have revealed that the ICCU patients take hemodynamic medicines by considering the half life and rapid onset. Therefore, the researchers determined the ICCU to collect more specific data. This study aims to determine hemodynamic medicines as well as the percentage of use and variations of medicine doses in the ICCU of dr. Soedarso Regional Public Hospital, Pontianak. In addition, this study aims to assess medicines particularly used in the ICCU to design and prepare a standard drug therapy, namely a formulary of dr. Soedarso Regional Public Hospital, Pontianak. Based on these reasons, the researchers are interested in conducting a basic study on the use of hemodynamic medicines in the ICCU patients in dr. Soedarso Regional Public Hospital Pontianak. The data sources of this study were patient medical records and patients' daily prescriptions during the hospitalization period to explore what medicines were administered from June 2018 to June 2019. The research samples were collected using a total sampling technique. The research aims to investigate the use of hemodynamic medicines in ICCU patients.

## 2. Materials and Methods

### 2.1. Research Procedures

The tools used in this research were stationery and a laptop installed with Microsoft excel. Meanwhile, the materials used in this study were patients' medical records and prescriptions. This research is an observational study that employed a descriptive cross-sectional research design. This study obtained retrospective data, such as medical records and prescriptions of patients treated in ICCU of dr. Soedarso Regional Public Hospital from June 2018 to June 2019. The inclusion criterion of the research subject was all patients in ICCU of dr. Soedarso Regional Public Hospital who were administered hemodynamic medicines. Meanwhile, the exclusion criteria of the research subject were patients with incomplete medical records, such as not including hemodynamic medicine names, diagnosed diseases, ages, blood pressure values, respiration rates, oxygen saturation, and heart rates.

The data were collected from the medical records in dr. Soedarso Regional Public Hospital after receiving the research permit from the research site and being declared ethically worthy by the Commission on Health Research Ethics of dr. Soedarso Regional Public Hospital with the number 08/RSDS/kepik/2019. The data collection started with searching medical record data of ICCU patients. The medical record numbers of ICCU patients who administered hemodynamic medicines were then employed to obtain medical record data during hospitalization in the ICCU with the inclusion criterion. The medical record data comprised of medical record numbers, blood pressures, respiration rates, oxygen saturation, heart rates, disease diagnosis, types of medicines, and medicine doses.

## 3. Results and Discussion

The disease diagnoses of the ICCU patients who are administered hemodynamic medicines and suffer from comorbid diseases are presented in Table 1. Cardiovascular disease is one of the complex diseases and has many kinds of heart and blood vessel diseases. This research has revealed that the patients are not only diagnosed by one disease, but also other comorbid diseases, such as diabetes mellitus (DM), CKD, and hypertension.

**Table 1.** Disease diagnoses as well as the number of cases in this study

Types of diseases	Number of cases = 60	
	Frequency	Percentage (%)
Cardiogenic shock	14	20
CHF	14	20
STEMI	5	7.1
DM type II	5	7.1
ALO	5	7.1
IMA	4	5.7
CHD	3	4.3
Chest pain	3	4.3
CKD	3	4.3
AF	2	2.9
Hypertension	2	2.9
STEAM	1	1.4
Septic shock	1	1.4
Tachyarrhythmia	1	1.4
DVT	1	1.4
Dyspnea lung	1	1.4
NSTEMI	1	1.4
Pleural effusion	1	1.4
Cardiac arrest	1	1.4
COPD	1	1.4
SVT	1	1.4

The aforementioned data show that the most widely diagnosed disease suffered by the ICCU patients who take hemodynamic medicines are cardiogenic shock and CHF/congestive heart failure. These diseases are suffered by 14 patients (20%). The ICCU patients are categorized into high-risk and low categories depending on the disease complexity. The patients suffering from cardiogenic shock, congestive heart failure, arrhythmia, infarction, or chest pain require special care (Firdaus et al., 2017). This statement is supported by another previous study which revealed that the CHF diseases consist of hypertension, diabetes mellitus, dyspnea pulmonary, coronary heart disease, and acute coronary syndrome (Nadia et al., 2015).

Table 2 shows that hemodynamic medicines consist of single and combination uses, and the final average values of ambulatory hemodynamic parameters comprise of systolic blood pressure values, diastolic blood pressure values, respiratory frequency, heart rates, and oxygen saturation. Dobutamine is a sympathomimetic medicine used to treat heart failure and cardiogenic shock. The main mechanism is direct stimulation of the  $\beta_1$  receptor from the sympathetic nervous system. Dobutamine can be used for congestive heart failure to increase cardiac output (Shafia et al., 2016). Dobutamine is an inotropic agent to change the contraction pressure of heart muscles (heart rate). Heart failure with hypotension and peripheral hypoperfusion complications can receive inotropic agents (Pudiarifanti et al., 2015). The combination between vasopressors and inotropic when hypotension occurs serves to maintain the systolic blood pressures < 90 mmHg (Manolopoulos et al., 2020).

Vasopressors and inotropic medicines are used to produce vasoconstriction or increase patients' heart contractility with shock. The distinctive feature of shock is the decreasing perfusion to vital organs that result in multiple organ dysfunctions and death (Huygh et al., 2016). Norepinephrine medicines belong to a class of vasopressor medicines. The vasopressor administration is an initial therapy for patients with heart failure and cardiogenic shock complications (systolic blood pressure < 70 mmHg); this administration aims to maintain adequate arterial pressure and improve tissue perfusions (Pudiarifanti et al., 2015).

The first hemodynamic monitoring parameter is blood pressure. The majority of patients have experienced hypotension that agrees with the history of their illness, namely cardiogenic shock. The data of blood pressure of the patients were investigated to reveal their first time entering the ICCU room and the final check. Blood is divided into three: (1) low blood pressure (hypotension) with a systolic value of < 90 mmHg and a diastolic value of < 60 mmHg, (2) normal blood pressure with a systolic value of 90-140 mmHg and a diastolic value of 60-90 mmHg, and (3) high blood pressure (hypertension) with a systolic value of > 140-160 mmHg and a diastolic value of > 90-95 mmHg

(James et al., 2014). The second parameter is oxygen saturation whose value normally ranges from 95-100%. Impaired ventilation-perfusion mechanisms and exchanges of O<sub>2</sub> and CO<sub>2</sub> can decrease the amount of oxygen. Respiration rate (RR) or the frequency of breathing is the inspiration and expiration process in a unit of time or minute. Changes in the oxygen saturation will stimulate the peripheral chemoreceptors that will increase and decrease the frequency of breathing as the control center that responds to changes in oxygen saturation (Herdiyanti et al., 2018).

The last parameter is the heart rate (HR) as the pivotal monitoring in patients with a critical condition. This study has revealed that the initial average heart rate value is 91 times/min, and the final average heart rate value is 83 times/min. Heart rates are divided into bradycardia of < 60 times/minute, normal heart rate of 60-100 times/minute, and tachycardia of > 100 beats/min (Pudiarifanti et al., 2015). The respiratory rate in the hypotension condition declines a heart rate so that anotropic or vasopressor agent is needed to stimulate the work of the heart and blood vessels; consequently, the oxygen supply in the blood is insufficient (Herdiyanti et al., 2018). If the blood pressure increases, the heart will work more quickly to pump blood that carries oxygen supply; as a result, heart rates beat faster, and blood vessels contract (James et al., 2014).

**Table 2.** Hemodynamic medicines and final average values of the parameter

Hemodynamic medicines	Number of patients (n = 49)	Final averages				
		Systole (mmHg)	Diastole (mmHg)	RR (x/minutes)	HR (x/minutes)	SpO <sub>2</sub> (%)
<b>Single medicine</b>	n = 32					
1. Dobutamine	27	100.9	63.8	21.4	83.1	97.5
2. Dopamine	3	117.3	78	23	75.3	97.3
3. Norepinephrine	1	125	81	14	65	100
4. Epinephrine	1	79	49	26	53	95
<b>Medicine combination</b>	n = 17					
1. Dobutamine + Norepinephrine	9	105.7	63.7	23.1	92.4	96.7
2. Dobutamine + Epinephrine	4	84.3	51	25.5	82.3	97.3
3. Dopamine + Epinephrine	1	110	80	19	20	95
4. Dobutamine + Norepinephrine + Epinephrine	1	109	76	18	83	99
5. Dobutamine + Dopamine	1	90	60	36	50	59
6. Dopamine + Dobutamine + Norepinephrine	1	140	79	31	82	100

The variation of doses is divided into three categories: mild, moderate, and severe doses. All hemodynamic medicines are administered to patients through intravenous therapy (James et al., 2014). Dobutamine, dopamine, and norepinephrine are administered by a titration process with the assistance of a syringe pump while the epinephrine is administered via bolus. This variation is presented in Table 3.

**Table 3.** Dose Variations three categories which were mild, moderate, and severe doses

The Names of Medicines	Dose Variations	N = 66	
		n	(%)
Dobutamine	3-5 µg/kg/min	25	37.9
	5-15 µg/kg/min	11	16.7
	15-20 µg/kg/min	5	7.6
Dopamine	< 3 µg/kg/min	1	1.5
	3-5 µg/kg/min	5	7.6
NE	0.01-2 µg/kg/min	12	18.2
Epinephrine	1mg/ml (1 amp)	7	10.6

The results show that the dobutamine medicine is mostly used at a dose of 3-5  $\mu\text{g}/\text{kg}/\text{min}$  37.9%, the dopamine medicine at a dose of 3-10  $\mu\text{g}/\text{kg}/\text{min}$  of 7.6%, the norepinephrine medicine at a dose of 0.01-2  $\mu\text{g}/\text{kg}/\text{min}$  by 18.2%, and the epinephrine medicine at 1mg/ml or 1 ampoule of 10.6%. Dobutamine serves to increase the very low cardiac output and maintain the oxygen delivery on the heart failure and complications of cardiogenic shock. A moderate dose of dobutamine increases myocardial contraction without increasing the frequency of heart rates; in contrast, a higher dose of dobutamine increases blood pressure and heart rate frequency (James et al., 2014).

The following hemodynamic medicine is dopamine. The patients have taken two ranges of doses. The first dose is a small dose of  $< 3 \mu\text{g}/\text{kg}/\text{min}$  and is administered to 1.5 % of the patients. The second dose is a moderate dose of 3-10  $\mu\text{g}/\text{kg}/\text{min}$  and is administered to 7.6% of the patients. A low dose of dopamine is frequently used to increase glomerular filtration rates in the kidney circulation and increase blood flow. Medium and high doses of dopamine are used to stimulate the heart and the expected peripheral vasoconstriction in patients with cardiogenic shock as well as increase cardiac outputs. Dopamine is also used to correct hypotension and raise blood pressure (Pollard et al., 2015).

Norepinephrine with a dose of 0.01-2  $\mu\text{g}/\text{kg}/\text{min}$  is administered to 18.2% of the patients, and epinephrin 1mg/ml or 1 ampoule is administered to 10.6% of the patients. Norepinephrine is indicated for patients whose blood pressure and cardiac outputs decrease. A work mechanism of norepinephrine is to stimulate  $\beta_1$  and  $\alpha$  receptors. The stimulation of the  $\beta_1$  receptor increases the myocardium contractility and the frequency of heart rates, while stimulation of the  $\alpha$  receptor results in vasoconstriction arterioles and venules; thus, the heart blood flow improves (Aberg et al., 2009). Epinephrine is used when the ICCU patients' blood pressure and heart rate decrease, and their breathing stops. Epinephrine can increase the positive inotropic cardiac muscle contractility and the frequency of heart rates of shocked patients by considering the effects of epinephrine's stimulation on the  $\beta_1$  receptor. As a result, cardiac output increases. This effect increases the demand for myocardial on the increasing oxygen. The potential affinity of adrenergic agonists is divided into  $\alpha$  and  $\beta$  adrenoceptors. The order of potential affinity of  $\alpha$  and  $\beta$  adrenoceptors is that the epinephrine is greater than norepinephrine (Casu & Merella, 2015).

Table 4 describes that the administration of hemodynamic medicines for the ICCU patients consists of a single and combination use. This study has revealed that single drug use is found in dobutamine with the highest percentage of 84.4%. Meanwhile, the combination drug use is found in dobutamine and norepinephrine with the highest percentage of 52.9%. Dobutamine is a sympathomimetic medicine used to treat heart failure and cardiogenic shock. Dobutamine and dopamine medicines are classified as positive inotropic agents, whereas norepinephrine and epinephrine are classified as a vasopressor or antihypotension agent. The work mechanism of dobutamine is to directly stimulate the  $\beta_1$  receptor of the sympathetic nervous system; thus, it can increase the Myocardial contractility and cardiac outputs. Inotropic medicines will positively force the heart to contract more vigorously so that the need for oxygen supply on the tissue will increase. Dobutamine can increase heart rates and blood pressure by 30 times/min and systolic blood pressure by 50 mmHg (Shafia et al., 2016).

Dopamine works in stimulating the  $\beta_1$  receptor in a moderate dose to gain an inotropic effect; a high dose of dopamine will work on the  $\alpha$  receptor as vasoconstriction (Amado et al., 2016). Dobutamine is widely used as a safer option of inotropic medicine than dopamine because it does not produce a high tachycardia effect. Dobutamine is administered for patients with heart failure and systolic blood pressure of  $< 90$  mmHg without shock; meanwhile dopamine is administered for patients with a systolic blood pressure of  $< 90$  mmHg with shock (Bistola & Chioncel, 2017). Distribution of hemodynamic medicines administered by ICCU patients in dr. Soedarso.

Table 4 shows that the most combination of hemodynamic medicines is dobutamine and norepinephrine. A positive inotropic medicine, such as dobutamine, is used as the first line to handle the shock. Moreover, this study has found that there are more patients who receive the combination of dobutamine and norepinephrine medicines than those who receive dobutamine and dopamine. Such a condition occurs because norepinephrine works on the  $\alpha_1$  receptor with a strong vasoconstriction effect. Norepinephrine combined with dobutamine is used when dobutamine and dopamine do not produce adequate changes in blood pressure (Bistola & Chioncel, 2017). (Levy et al., 2011) have revealed that the most appropriate combination of dobutamine and norepinephrine is related to the patients' resistance to dopamine and other inotropic agents that frequently result in higher arrhythmia (Levy et al., 2011). The combination of hemodynamic drug use depends on the work mechanisms of

the receptor. Dobutamine works in the  $\beta_1$  receptor and will affect the heart muscles while the norepinephrine works in the  $\alpha_1$  receptor in the blood vessels; as a result, the work mechanisms of both formulas would provide the right nutrients for the heart and blood vessels.

**Table 4.** Regional Public Hospital from June 2018 to June 2019

The names of medicines	Number of patients	Percentage (%)
<b>Single hemodynamic medicine</b>	<b>n = 32</b>	
1. Dobutamine	27	84.4
2. Dopamine	3	9.4
3. Norepinephrine	1	3.1
4. Epinephrine	1	3.1
<b>Combined hemodynamic medicines</b>	<b>n = 17</b>	
1. Dobutamine + Norepinephrine	9	52.9
2. Dobutamine + Epinephrine	4	23.5
3. Dopamine + Epinephrine	1	5.9
4. Dobutamine + Norepinephrine + Epinephrine	1	5.9
5. Dobutamine + Dopamine	1	5.9
6. Dopamine + Dobutamine + Norepinephrine	1	5.9

#### 4. Conclusion

Hemodynamic medicines consist of a single drug administered to 65% of the ICCU patients in dr. Soedarso Regional Public Hospital and a combination drug administered to 35% of the ICCU patients in the hospital. The single drug frequently administered to the ICCU patients is dobutamine for 84.4% of the patients. Meanwhile, the combination drug frequently administered to the ICCU patients is dobutamine and norepinephrine for 52.9% of the patients. The ICCU patients in dr. Soedarso Regional Public Hospital frequently receive various doses of hemodynamic medicines, such as dobutamine dose of 3-5  $\mu\text{g}/\text{kg}/\text{min}$ , dopamine dose of 3-10  $\mu\text{g}/\text{kg}/\text{min}$ , norepinephrine dose of 0.01-2  $\mu\text{g}/\text{kg}/\text{min}$ , and epinephrine dose of 1mg/ml.

**Author Contributions:** Shoma Rizkifani conceived and designed the study. Shoma Rizkifani performed all data analyses. Shoma Rizkifani, Intan Khairunnisa, Eka Kartika Untari interpreted the results and revised the paper. Shoma Rizkifani wrote the manuscript. All authors read and approved the final manuscript.

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#### Competing Interests

The authors disclose no conflict.

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