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THE EFFECT OF BODY REPOSITIONING ON HEMODYNAMIC STATUS IN PATIENTS WITH VASOPRESSOR THERAPY IN INTENSIVE CARE UNIT

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Abstract
Background: Repositioning the patients every 2 hours were often not implemented during patient care. One of the causes perceived by nurses as contraindications to repositioning in critical patients is the use of vasoactive agents. This condition increases the risk of decubitus, decreased orthostatic stability and muscle atrophy.
Objective: The purpose of this study was to identify the effect of body reposition on hemodynamic patients receiving vasopressor therapy in Intensive Care Unit (ICU).
Methods: The research method used Quasi Experiment with non-equivalent control group design. The subjects were ICU patients who received vasopressor therapy. The respondents recruited using consecutive sampling technique for a-four-month period and obtained 34 respondents, which was divided into control and intervention group. Data analysis used paired t-test to analyze the difference in the same group and unpaired t-test to test the difference between two groups.
Results: Pre-post hemodynamic differences in the intervention group when patients were repositioned from supine to the right lateral and right lateral to left lateral showed $p > 0.05$. The hemodynamic difference between the control and the intervention group also had $p > 0.05$. The results showed there were no significant difference.
Conclusions: In general, there is no effect of body repositioning on hemodynamic status. Critical nurses can perform body repositioning activities every two hours including in patients with vasopressor therapy to prevent complications of immobilization, still considering contraindication condition.

Keywords: hemodynamic; ICU; repositioning; vasopressor

INTRODUCTION

Repositioning patients every 2 hours is a standard that must be implemented during patient care, but in practice these standards were often not implemented (Tayyib, Lewis, & Coyer, 2013). The use of vasoactive agents that include inotropes and vasopressors in critical patients were often one of the reasons nurses did not provide lateral positions because nurses perceived these positions compromise the patient's hemodynamic status (Brindle et al., 2013). A study conducted in intubated patients found that patients who received vasopressor therapy tended to be rarely given a lateral position than a supine position compared to patients who were not receiving vasopressor therapy (Schallom et al., 2005). Nurses perceived the use of vasoactive agents is a contraindication for tilting, whereas in accordance with its objectives, vasoactive agents play a role in increasing mean arterial pressure (MAP) through vasoconstriction of systemic blood vessels and increasing cardiac output through inotropic and chronotropic combinations to stabilize patients' hemodynamics and can allow the patient to continue the repositioning activities (Brindle et al., 2013; Djogovic et al., 2015).

Based on the mechanism of human body homeostasis, repositioning the patient's body every 2 hours can maintain hemodynamic stability. A study on gravity and aerospace flight discovered that astronauts in space within a certain time period (not exposed to gravity) experienced a decline in hemodynamic parameters and orthostatic intolerance within the first few days on Earth (Convertino, 2005). The absence of gravity lowers the vestibular and baroreflex responses that function in the hemodynamic equilibrium mechanism of gravity. The same concept can explain the conditions in immobilized patients. Patients who are in the same position for a long period will experience orthostatic intolerance (intolerance to movement associated with gravity). The activity of repositioning the patient's body every 2 hours is useful in training the vestibular and baroreflex responses so that the patient's hemodynamic status becomes more stable (Brindle et al., 2013; Vollman, 2012; Yap, 2018). However, little literature explains this condition, so that further research needs to be held.

Patients with prolonged bed rest will have an increased risk of muscle atrophy. Literature found that bed rest and immobilization leads to a decrease in muscle mass that may affect the musculoskeletal, cardiovascular, and respiratory systems (Koukourikos, Tsaloglidou, & Kourkouta, 2014). Muscle weakness in critically ill patients is one of the most common problems seen in ICU patients that characterized by bilateral and symmetrical muscle weakness. The percentage of ICU patients with multi-organ failure experienced a loss of muscle mass up to 100%. Muscle atrophy occurs in 80% of patients who use mechanical ventilation for more than 7 days. While in patients who used mechanical ventilation for 4 days, the incidence of loss of muscle mass decreased by 50% and in patients who used mechanical ventilation for 3 days, incidence decreased to 33% (Koukourikos et al., 2014). Prevention of muscle atrophy should be one of the main goals of ICU patient care, as it can reduce the incidence of the disease, length of stay, and improve the quality of life of the patient.

Patients who get vasopressor therapy but are not repositioned have a higher risk of injury. Study revealed in a literature review that the use of norepinephrine drugs was a significant risk factor for the incidence of pressure ulcer in ICU (De Laat et al., 2007). This was explained by previous study, which also showed the result of a significant relationship between the incidences of pressure injuries with the use of vasopressor agents. The hypotension conditions combined with the use of a persistent vasopressor agent serve as a warning sign that the patient has decreased perfusion to the skin for a long time thus increasing the risk of injury (Cox & Roche, 2015).

However, the safety of repositioning the body in critical patients using vasopressor against hemodynamics therapy remains unclear, research on this is also rarely done. It is related to ICU patient characteristics include severe disease severity, ventilator use, and physical mobilization limitations that cause hemodynamic imbalance. So, it is necessary to ensure the safe of body repositioning to the hemodynamic status in ICU patients receiving vasopressor agent therapy.

METHODS

Study design and sample

The research design was Quasi Experiment with non-equivalent control group design. The population was all ICU patients at a referral hospital in Bandung, West Java, Indonesia who received vasopressor therapy with an average of 15 patients each month. The sample was determined using purposive sampling technique who had these following inclusion criteria: patients received vasopressor agent therapy; patients received a dose of a relatively stable vasopressor agent; patients' MAP between 60 - 110 mmHg; patients' heart rate more than 60 times/min and less than 130 times/min; patients' oxygen saturation more than 93%; patients had not pelvic fracture and spinal cord injury; and patients did not have high intra cranial pressure. The study also had dropout criteria, they were: patients' heart rate increased by more than 20 times/minute and did not recover after the first 10 minutes since the patients were tilted; patients' MAP increased more than 110 mmHg or decreased less than 60 mmHg which did not recover after the first 10 minute since patients were tilted; desaturation occur and did not recover after the first 10 minute since the patients were tilted.

A total of 34 sample were selected and divided into control and intervention groups, with the calculation of the number of samples used the unpaired analytic descriptive formula, with a 95% confidence level, 80% test strength, standard deviation based on previous study (Anchala, 2016), and a significant mean difference in the control and intervention groups was determined one. Based on the calculation, the number of respondents was 17 for each group

In the intervention group, the patient was repositioned every 2 hours. It was beginning with the supine position, then lateral right, left lateral, and returned to the supine position. Heart rate, MAP, and SpO2 data were taken 10 minutes after the patient was repositioned. In the control group there was no intervention only hemodynamic parameters were observed as long as the nurses performed nursing actions in accordance with routine care. Researchers observed and recorded heart rate, MAP, and SpO2 in the control group at the same time as recording hemodynamic parameters in the intervention group for one work shift (8 hours). **Figure 1** illustrates the collecting data procedure.

Instruments and data analysis

Data to obtain the characteristics of respondents were collected using instrument consists of diagnosis, level of awareness, age, vasopressor agent, and vasopressor dose while heart rate, MAP and oxygen saturation collected using noninvasive hemodynamic monitor. Blood pressure was obtained based on the results of measurements of noninvasive hemodynamic monitoring and validated through daily calibration of the monitor. Heart rate was obtained through ECG that appears in noninvasive hemodynamic monitors and validated through manual calculations by counting the radial artery pulses, and oxygen saturation was obtained using pulse oximetry.

Characteristics respondents were analyzed using frequency distribution, whereas hemodynamic data consisting of heart rate, MAP and saturation were analyzed using mean and median for data that were not normally distributed. In the bivariate analysis, the data were analyzed to see the difference in pre-posttest in each group, and then a different test was carried out between two different groups. Paired t- test was used to analyze hemodynamic differences in each group while the unpaired t test was used to see hemodynamic differences in the two groups.

Ethical consideration

Ethical clearance for data collection had been obtained from the Research Ethics Committee of the Health Research Committee Faculty of Medicine Universitas Padjadjaran No. 512/UN6.C10/PN/2017. Informed consent was given and obtained from the respondent's relatives, and all agreed.

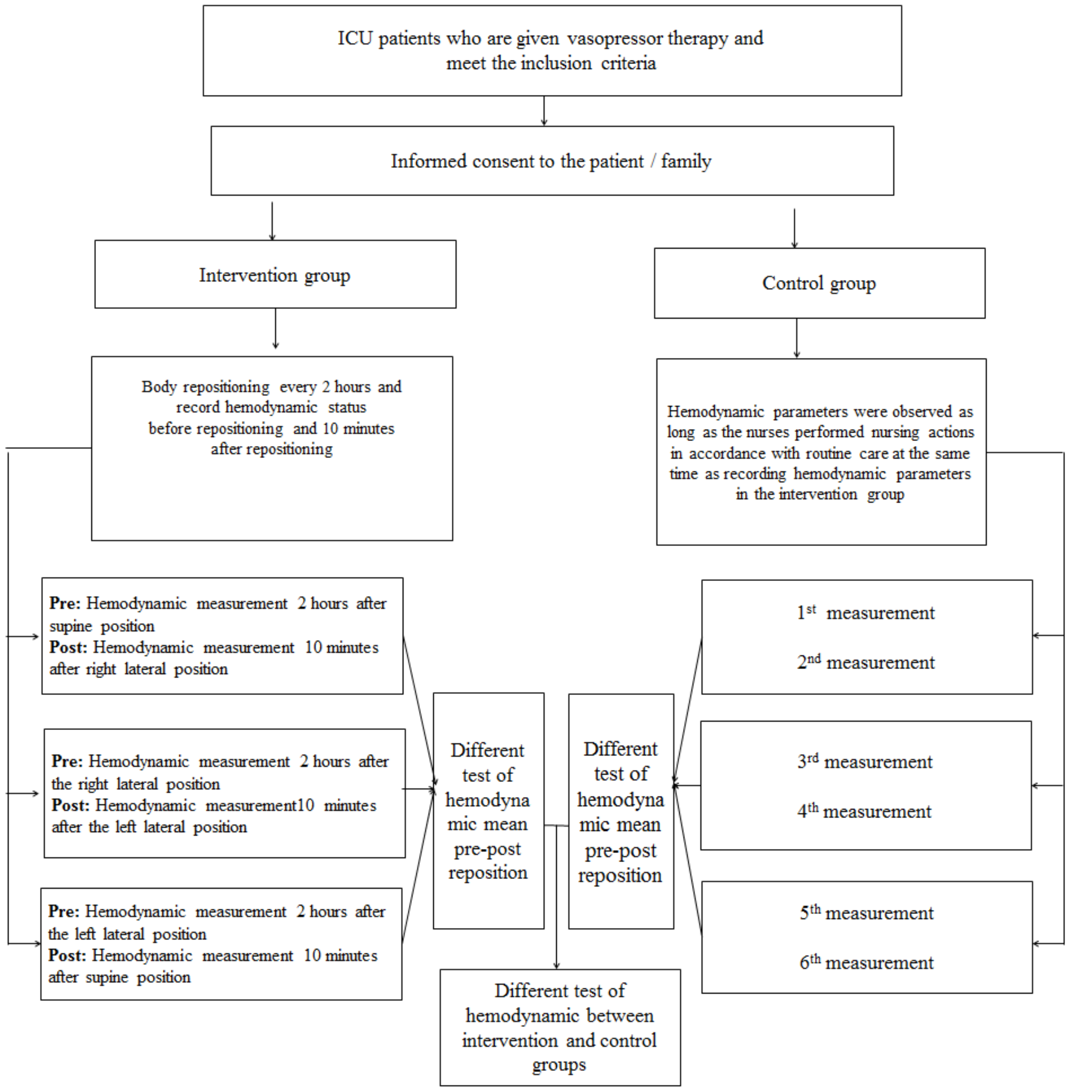

Figure 1 Research data collection procedure

RESULTS

Respondents in this study were 34 and divided into control group and intervention group each group consisted of 17 respondents. Based on **Table 1**, it is shown that more than half of respondents are over 65 years old, and have a level of awareness that varies from compos mentis, apathetic (apatis), somnolent, and soporo coma. More than 70% of respondents are using ventilator and all respondents used epinephrine as a vasopressor agent with a very large majority of respondents received a dose of ≤ 10.1 mcg/kg/min norepinephrine in the control and intervention groups.

Based on the result which is shown in the **Table 2** and **Table 3**, heart rate, MAP, and SpO2 between supine position (pre) and right lateral position (post) do not give significant changes ($p > 0.05$). Whereas in **Table 4**, HR between the left lateral position (pre) and supine position (post) shows significant changes ($p=0.047$; $p<0.05$), however, this significant change does not give meaning to the patient's clinical changes.

Table 1 Respondents' characteristics

Variable	Control Group n (%)	Intervention Group n (%)
Main Diagnosis		
Pneumonia	1 (5.8)	8 (47)
COPD	2 (11.7)	1 (5.8)
CKD on HD	4 (23.5)	2 (11.7)
Post Explore Laparotomy	3 (17.6)	2 (11.7)
Cancer	2 (11.7)	0 (0)
Sepsis	1 (5.8)	1 (5.8)
Anemia	1 (5.8)	0 (0)
Dehydration	1 (5.8)	2 (11.7)
Coronary Arterial Disease	1 (5.8)	0 (0)
Infarction stroke	1 (5.8)	1 (5.8)
Level of Awareness		
Compos Mentis	4 (23.5)	5 (29.4)
Apathetic (Apatis)	5 (29.4)	5 (29.4)
Somnolent	4 (23.5)	4 (23.5)
Soporo Coma (Stupor)	4 (23.5)	3 (17.6)
Using a ventilator	14 (82.3)	13 (73.4)
Age		
≤65 years	8 (47)	6 (35.2)
>65 years	9 (52.9)	11 (64.7)
Vasopressor Agent		
Norepinephrine	17 (100)	17 (100)
Vasopressor dose (mcg/kgweight/mnt)		
≤ 0.1	12 (70.5)	13 (76.4)
> 0.1	5 (29.4)	4 (23.5)

Table 2 Comparison of mean of hemodynamic status (heart rate, MAP, SpO2) between supine (pre) and right lateral (post)

Variable	Supine (pre)	Right Lateral (post)	P value
	Mean ± SD/	**Mean ± SD/**	
HR (x/min)	98.12 ± 13.43	97.12 ± 14.87	0.367
MAP (mmHg)	76.71 ± 10.67	79.94 ± 12.40	0.567
	Median (min-max)	**Median (min-max)**	
SpO2 (%)	100 (97-100)	99 (97-100)	0.112

Table 3 Comparison of mean of hemodynamic status (heart rate, MAP, SpO2) between right lateral (pre) and left lateral (post)

Variable	Right Lateral (pre)	Left Lateral (post)	P value
	Mean ± SD/	**Mean ± SD/**	
HR (x/min)	97.65 ± 14.74	97.29 ± 14.49	0.756
	Median (min-max)	**Median (min-max)**	
MAP (mmHg)	72 (60-101)	74 (10-110)	0.831
SpO2 (%)	100 (97-100)	100 (96-100)	0.739

Table 4 Comparison of mean of hemodynamic status (heart rate, MAP, SpO2) between left lateral (pre) and supine (post)

Variable	Left Lateral (pre)	***Supine*** **(post)**	P value
	Mean ± SD/	**Mean ± SD/**	
HR (x/min)	96.35 ± 15.00	94.53 ± 15.34	0.047
	Median (min-max)	**Median (min-max)**	
MAP (mmHg)	72 (60-108)	71 (61-102)	0.737
SpO2 (%)	100 (97-100)	100 (97-100)	0.480

Table 5 shows the data of mean of hemodynamic status (Heart Rate, MAP, SpO2) before and after 3 times reposition in intervention group. Based on the data HR, MAP and SpO_2 between pre and post reposition in intervention group do not give significant changes (p>0.05).

Statistical test results in the **Table 6** show that all noninvasive hemodynamic parameters have p> 0.05. This shows that there was no significant difference in the difference in changes in HR, MAP and SpO2 between the control group and the intervention group.

Table 5 Comparison of mean of hemodynamic status (heart rate, MAP, SpO2) before and after 3 times reposition in intervention group

Variable	***Supine* (pre)**	***Supine* (post)**	P value
	Mean ± SD/	**Mean ± SD/**	
HR (x/min)	98.12 ± 13.43	94.53 ± 15.34	0.091
MAP (mmHg)	76.71 ± 10.67	77.18 ± 13.14	0.858
	Median (min-max)	**Median (min-max)**	
SpO2 (%)	100 (97-100)*	100 (97-100)*	0.257

Table 6 Differences in changes in hemodynamic status (heart rate, MAP, SpO2) between the control group and the intervention group

Variable	**Control Group**	**Intervention Group**	P value
	Mean ± SD/	**Mean ± SD/**	
HR (x/min)	-0.008 ± 1.61	0.57 ± 0.98	0.513
MAP (mmHg)	-0.54 ± 2.01	-0.09 ± 1.47	0.700
SpO2 (%)	0.014 ± 0.37	0.034 ± 0.27	0.917

DISCUSSION

The results showed no significant changes in patients' hemodynamic status (HR, MAP and SpO2) before and after repositioned to the right and left lateral positions. The same with patients' HR, MAP and SpO2 before being repositioned and after following 3 changes in position every 2 hours-over a span of 8 hours-, did not experience significant changes. The same condition was shown by the hemodynamic difference between the intervention group and the control group. These results indicate the stability of the patients' hemodynamic status during repositioning.

The stability of the hemodynamic status shown during the study was maintained by the coordination of the work of the cardiovascular and the nervous system. The use of ventilators by most respondents (control group = 83.3%; intervention group = 73.4%) and the level of awareness of the majority of respondents who are not fully conscious cause immobilization. Patients who experience immobilization had the potential to experience a decrease in coordination of interactions between the cardiovascular and the nervous system (Scanlon & Sanders, 2007). Immobilization also causes a decrease in the skeletal muscle pump mechanism, which is effective against deep veins in the legs. A decrease in skeletal activity can reduce leg muscle contraction, this can cause a decrease in the blood pump back to the heart by a vein, thereby reducing the amount of blood returning to the heart and potentially causing a decrease in blood pressure and orthostatic hypotension. However, during the research process, respondents did not experience significant changes in hemodynamic status, because all respondents received vasopressor therapy, which can increase systemic vascular pressure through vasoconstriction of systemic blood vessels and increasing cardiac output.

Norepinephrine is a group of vasopressors that act as the main endogenous neurotransmitters released by the adrenergic postganglionic nerve and are strong α1-adrenergic receptor agonists with moderate β-agonist activity. Norepinephrine has a fast working effect within 1-2 minutes by reaching the peak in less than 5 minutes. Norepinephrine is a powerful vasoconstrictor that increases systemic vascular resistance and is slightly inotropic causing increased cardiac contractility and working on baroreceptor stimulation, thus able to maintain hemodynamic stability (Overgaard & Dzavík, 2008). However, it was found that the hemodynamics of patients after repositioning were not immediately stable, it took 5 to 10 minutes for the patient's hemodynamics to return to their initial values. This showed that ICU patients with vasopressor therapy were relatively safe to be repositioned periodically. Vasopressor agent was actually able to maintain hemodynamic stability even though hemodynamic changes occurred; the changes were temporary. This study reinforced previous research, which stated that there was no change in SpO2 in ARDS patients who used mechanical ventilation, before and after being given the right lateral and left lateral positions (Vollman, 2012). Another study also stated that repositioning patients did not have a significant effect on cardiac index included MAP, right arterial pressure, pulmonary artery pressure edge, and pulmonary artery pressure in post CABG patients (De Laat et al., 2007). Similar results were shown in patients receiving antihypertensive and or inotropic and vasoactive drug therapy. There was no significant cardiac index difference between the intervention group and the control group ($p = 0.34$). Patients with inotropic and or vasoactive therapy who were repositioned 4 hours after post-surgery tended to show a lower risk of cardiac index reduction compared to the control group ($p = 0.13$). During the study, there was no clinical cardiac index deviation, which could prevent the lateral position of the patient, even in patients using intra-aortic balloon pump.

Previous study with 20 ICU patients showed similar results where there were no differences in HR, SpO2, and MAP at various therapeutic positions including right lateral and left lateral positions. Anchala stated that scheduled therapeutic repositioning had an effect in maintaining stable hemodynamics and was also useful in preventing complications of immobilization. However, in his study it was not stated whether respondents used vasoactive drugs or not (Anchala, 2016).

Hemodynamic stability is supported by the consistency of vasopressor work. This is supported by the previous research (Oldenburg et al., 2001). The results of the study stated that conscious patients who were able to ambulate but experienced orthostatic hypotension due to primary autonomic failure were able to carry out sitting, standing, and walking activities after receiving norepinephrine drug therapy.

Based on the results of the study, there were different statistical test results. Statistical tests on HR when patients were repositioned from the left lateral position to the supine position showed significant differences (mean HR: 96.35 ± 15.00 to 94.53 ± 15.34; $p = 0.047$). This was different from the results of statistical tests on MAP and SpO2, which did not show significant changes ($p = 0.737$; $p = 0.480$; $p > 0.05$). HR changes can be caused because this parameter is the first cardiovascular system that responds when the sympathetic and parasympathetic nerves are activated when the patient is repositioned as a compensation mechanism. HR changes shown based on the study are not clinically meaningful and do not endanger the patient's hemodynamics, so that repositioning of the body can still be carried out.

There were differences in the results of the study, when repositioning is done with a higher degree of slope. This was shown by previous research (Aries et al., 2012) on 20 stable patients in the ICU who used invasive blood pressure measuring devices. Statistical tests showed a significant change in the mean MAP of 5 mmHg higher in the lateral position compared to the supine position (p <0.001), whereas between the right lateral position and the left lateral position there was no significant change, as well as the HR frequency and oxygen saturation which were relatively stable at all positions both supine and left lateral and right lateral position. This difference in results might be due to the respondents in the study being given a higher degree of slope (45^{o}) during the lateral position, because this could affect changes in venous return and arterial pressure.

Additional result of this study found that, after repositioning, the patient's hemodynamic parameters were not immediately stable. To obtain hemodynamic stability after repositioning, adaptation time was needed. In this study the process of adaptation to hemodynamic change took 5 to 10 minutes to return or approach to the initial value. This was because, when the patient was repositioned especially when given a lateral position with a slope of 30^{O}, there was gravity resistance, which causes an increase or decrease in arterial pressure. These pressure changes stimulated the nucleus tractus solitarius (NTS) in the brain stem causing the baroreceptors to respond and activate the sympathetic or parasympathetic nervous system and produced an increase or decrease in heart rate according to their need to maintain normal blood pressure (Carter & Ray, 2008). This mechanism is a temporary physiological mechanism, so that at the beginning of repositioning there is a temporary change in hemodynamic. The insignificant changes that are mostly shown in the results of this study can increase nurses' confidence in making a decision to choose to reposition the patient's every two hours considering the benefits to prevent various complications of immobilization.

This study supports the concept that patients in the ICU can generally be repositioned every 2 hours in accordance with the standards of nursing care (Brindle et al., 2013; Vollman, 2012). Vollman stated that the hemodynamics of patients with critical illness will be affected by changes in position, but most of the hemodynamic changes are transient. ICU nurses play an important role in carrying out the process of critical thinking and decision making so that the repositioning activities of the patient's every 2 hours can be done without endangering the patient (Vollman, 2012).

Limitation of the study

The limitation of this study was the diagnosis of the patient's disease was very varied with a small number of respondents and the simultaneous use of other drug therapies that might influence the hemodynamic status of patients was not considered in the study because research only focused on vasopressor use.

CONCLUSION

The results of the study statistically showed a significant change in HR when the patient was repositioned from the left lateral position to the supine position, but clinically the range of change was not significant. In general, there were no significant differences in hemodynamic status before and after the patient was repositioned. It can be concluded that there was no repositioning effect on hemodynamic status in ICU patients receiving vasopressor agent therapy.

Declaration of Conflicting Interest
None.

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Author contribution
All authors have contributed in the preparation of the manuscript. **VOS** provided article development, ideas, reviewed theories and literatures, analyzed and interpreted data. **AN** wrote the manuscript interpreted data, wrote and criticized the manuscript and made final approval of the manuscript.

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1

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